Mergers & Acquisitions and Efficiency in European Banking: Testing a catching-up hypothesis

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Introduction

The European banking sector has experienced a rapid process of mergers and acquisitions (M&A) over the last two decades. Deregulation and liberalisation, financial globalisation, technological and financial innovations, the progress made towards the completion of an integrated European financial market and the imperative of value creation are some of the principal forces that have fuelled the process of banking consolidation in Europe. M&As are among the principal responses aimed at achieving external growth and at increasing size, as opposed to organic growth.

To explain the underlying economic reasons behind M&As, the empirical literature mainly focused on examining their effects on short- versus long-term performance and then on discerning their effects on the competition in the sector in question. Undoubtedly, economies of scale and scope offer the main explanation behind the performance change following an M&A, leading to a number of empirical studies that aimed at examining the relationship between size and costs. However, these findings were far from conclusive owing to the conceptual and technical limitations encountered when testing for the relevant hypotheses and in practice M&A generally fail to deliver their promised value. Indeed, if there is little evidence of the positive impacts of M&A on performance, it is important to investigate other potential rationales for the occurrence of such transactions in the financial sector.

This paper strives to respond to the question whether M&As between banks secure an **efficiency catching-up effect**. Generally, the catching-up effect is defined as the tendency of the least efficient bank to catch-up with the more efficient one. In other words, the least productive banks are gradually aligned to the more efficient ones if there is a negative and significant correlation between the initial level of efficiency and its growth rate over the period.

Our sample consists of 42 M&A transactions during 1996-2003 period and 587 non-merging banks from which we extract a matched group composed of banks with similar output-input levels and mixes as the merging banks group. These banks are observed during 1996-2006.

To perform our analysis, we employ a two-steps approach. First we estimate **the technical efficiency** (efficient use of resources to reach a given output level for each individual bank (before and after mergers) and **the structural efficiency** (efficient choice of output-input mixes to improve the

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productivity of the consolidated group) using a non-parametric framework (Data Envelopment Analysis), while constructing the best practice frontier with the non parametric Free Disposal Hull (FDH) approach and using a directional distance function in the input space to measure individual and aggregated efficiency scores. We then test convergence for both technical and structural efficiency.

After reviewing the theoretical background and the empirical findings on banking M&A in section 2, the paper examines the efficiency catching up hypothesis using a two steps approach based on the directional distance function under DEA methodology and an econometric test in section 3. The aim is to examine whether M&As secure a catching-up effect for European banks. Section 4 summarizes the main results of the paper. Our conclusions are set forth in section 5.

2. Theoretical and empirical backgrounds

The economic literature has justified banking M&A on the ground that it enhances shareholder value. Indeed, the strengthening of the shareholders' role, the increasing importance of institutional investors in banking capital (pension funds, mutual funds, private equity and hedge funds), the pressure of value creation have encouraged managers to orient their business objectives towards value-maximisation.

The traditional argument that M&A increase shareholder value is based on the assumption that the anticipated value of the entity created by the merger of two groups will exceed, in terms of potential wealth creation, the sum of the respective values of the two separate groups. Two main types of synergies are achieved: operating synergies and financial synergies. The former may either be revenue enhancement or cost reduction. The latter also refers to the possibility that the cost of capital may be lowered by combining one or more companies.[2]

In theory, M&A operations in the banking sector could create value by obtaining gains either in terms of economic efficiency or in terms of market power.

An M&A allows the resulting company to obtain economic efficiency gains through better allocation of resources (technical efficiency), better output-input mixes to improve productivity of the consolidated group (structural efficiency), better use of mix of resources given their prices (allocative efficiency) to produce maximum output (given a set of prices), cost reductions (or cost synergies), revenue increases (or revenue synergies), the exchange of best practices and/ or risk diversification.

Cost synergies result from an improved organisation of banking production, a better scale and/or a better combination of production factors. The core objective is to extract benefits from cost complementarities and economies of scale and scope. The cost synergies allow an increase in the allocative efficiency and result in economies of scale and economies of scope. In practice, cost synergies might be derived from: a) the integration of different skilled teams or information technology infrastructures, b) the combination of different back-office and general services or c) the rationalisation of the domestic and/or international banking networks. Revenue synergies also derive from a better combination of production factors. Improvements in the organisation of activities, however, offer benefits from product complementarities which help to enhance revenues. In practice, revenue synergies might result from the harmonisation of product ranges, the existing complementarities between activities, cross-selling and the generalisation of a 'multi-distribution channel' approach to the various segments of customers.[3] Revenue synergies are to improve the technical efficiency by increasing the scale of production.

It should be noted, however, that revenue synergies are much more difficult to obtain compared to cost synergies, because they depend not only on managers' decisions but also on customer behaviour. In this respect, it was estimated that some 5% to 10% of a bank's customers leave the bank after a merger.[4]

In sum, efficiency gains are obtained by input and output adjustments in order to better allocate resources, to improve the input-output mix, to reduce costs, increase incomes (through external growth) and/or reduce risks (through improved diversification). Restructuring operations can also allow efficiency gains through the reorganisation of teams (managers and employees) and/or the generalisation of 'best

[2] Copeland and Weston (1988).

[3] Ayadi and Pujals (2004, 2005) and Ayadi (2007).

[4] See Burger (2001).

practices', known as 'X-efficiency' that is the managerial ability to decide on input and output in order to minimise cost (or maximise revenues).[5]

Efficiency may be improved following a merger or an acquisition, if the acquiring institution is more efficient *ex ante* and brings the efficiency of the target up to its own level by spreading its superior managerial expertise, policies and procedures.[6] Simulation evidence suggests that large efficiency gains are possible if the best practices of the acquirers reform the practices of inefficient targets.[7]

The M&A event itself may also improve efficiency by awakening management to the need for improvement or to implement substantial restructuring. Alternatively, efficiency may worsen because of the costs of consummating the M&A (legal and consultancy fees, severance pay and so forth) or disruptions from downsizing, difficulties in integrating corporate cultures, and in managing transition process. Efficiency may also decline because of organisational diseconomies in operating or monitoring a more complex institution.[8]

M&As can also be motivated by non-maximising value reasons[9]. These are derived from the separation of ownership and control. Instead of enhancing shareholders' wealth, a manager might prefer to serve his/her own interests when engaging the company into M&A. Managing a larger entity provides more power and influence.[10]

In this paper, another hypothesis, largely used in the growth literature (Barro and Sala-i-Martin (1992), relates to the **catching-up motivation of M&A**, is tested. Being a dynamic process, M&A could be explained by the incentives of the management to catch-up with the best practice frontier. The efficiency catching-up secured by M&As is another explanation of x-efficiency. It results from the ability of managers to drive successful M&A transactions, by allowing the consolidated group to catch –up with successful peers. Such a result can differentiate a successful manger, who acts more for the interests of the shareholders and the company as a whole from a bad manager who only looks after his/her interests. Obviously, such as result could be used to design the executive compensation of successful versus unsuccessful managers. Empirically, the catching up hypothesis uses the β- and σ-convergence.

Our contribution aims at assessing the extent to which M&As result in a catching up effect of consolidating banks to the frontier of best practices in terms of performance. The expectation is that consolidating group is less inefficient than before the M&A.

Several studies have tried to assess the performance of M&A in banking in the 1990s. The majority have concentrated on the impact on shareholder value and efficiency. However, the results were rather mixed.

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[5] Originally the concept of X-inefficiency was introduced by Leibenstein (1966) who noted that, for a variety of reasons, people and organisations normally work neither as hard nor as effectively as they could. In technical terms, X- efficiency refers to the deviations from the production efficient frontier that depicts the maximum attainable output for a given level of output.

[6] Generally, the acquiring bank in a merger is more cost efficient and more profitable than the institution being acquired. As noted in a recent survey (Berger and al., 1999), this holds for the US (Berger and Humphrey, 1992; Pilloff and Santomero, 1997; Peristiani, 1997; Cummins and al., 1999 and Fried and al., 1999) as well as for Europe (Vander Vennet, 1996 and Focarelli and al., 2002). The expectation is that the more efficient and profitable acquiring bank will restructure the target institution and implement policies and procedures to improve its performance. It seems to be confirmed by the stock market performance: after a merger bidders usually loose, targets gains. The overall results is expected be positive.

[7] Shaffer (1993).

[8] Ayadi and Pujals (2004, 2005) and Ayadi (2007).

[9] Referred to as 'agency relation' by Jensen and Meckling (1976).

[10] The "Managerial power" hypothesis argues that CEOs may be able to control board decision due to their higher managerial influence, (see Berle and Means, 1932; Williamson, 1964).

The majority of empirical studies has been carried out in the United States, using a wide range of methodologies, from the most basic (event studies or balance-sheet-based indicators) to the most sophisticated (efficiency frontiers), but their findings have not been conclusive.

A large number of event studies have been carried out to assess the effects of M&A on stock market values. They all tend to evaluate the change in total market value of the acquiring company plus target institutions – adjusted for changes in overall stock market values – associated with an M&A announcement. This embodies the present value of expected future changes in terms of efficiency and market power. Although these effects cannot be disentangled, the change in market value may be viewed as an understatement of the expected efficiency improvement, since it is unlikely that an M&A would reduce the market power of the participants.[11]

In the US, the empirical results were mixed.[12] On average, the combined shareholder value (i.e. the bidder and the target) is not affected by the announcement of the deal since the bidder suffers a loss that offsets the gains of the target.[13] Therefore, an M&A only implies a transfer of wealth from the shareholders of the bidder to those of the target. Compared to the 1980s, however, the evidence from the 1990s was more favourable[14] where average abnormal returns have been higher for both bidders and targets.[15]

Other studies examined the stock market reaction to different types of deals. Houston and Ryngaert (1994) found that the combined gains tend to be greater when the bidding firm is unusually profitable or when there is significant overlap between institutions. The first result is consistent with a market for corporate control favouring competent over incompetent managers. The second result is consistent with the market power hypothesis, according to which a higher market share leads to higher profits. DeLong (2001) found that mergers that concentrate banks geographically or in product create value while those that diversify them don't create value.

On the other hand, Zhang (1995) found results consistent with the diversification hypothesis, according to which geographical diversification leads to a lower variability of income; and that out-of-market transactions create value for shareholders. Higher market concentration is likely to lead to an increase in prices for retail financial services, leading in turn to an increase in profits. It is also true, however, that firms operating in more concentrated markets are generally found to be less efficient.[16] This effect might

[11] Berger (2003).

[12] Rhoades (1994) and Pilloff and Santomero (1997) provide a survey of event studies. Some studies of US banking M&A found increases in the combined value around the time of the M&A' announcement (Cornett and Tehranian, 1992 and Zhang, 1995); others found no improvement in combined value (Hannan and Wolken, 1989; Houston and Ryngaert, 1994; Pilloff, 1996 and Kwan and Eisenbeis, 1999); while still others found that the measured effects depended upon the characteristics of the M&A (Houston and Ryngaert, 1997). A study of domestic and cross-border M&A involving US banks found more value created by the cross-border M&A (DeLong, 1999).

[13] Stock market event studies of bank mergers have shown that merger announcements typically result in a fall in the equity value of the acquiring firm and no significant gain in the combined value of the two firms together. This result suggests that the market believes that, on average, there are unlikely to be substantial gains realised from bank mergers. And since the value of the acquiring firm typically falls, the market also believes that acquiring firms tend to overpay for acquisitions in anticipation of merger benefits that are not likely to be realised. This is a common finding and is not limited to bank mergers, which points in the direction of a more general problem associated with the corporate governance of M&A.

[14] DeLong & DeYoung (2004) have advanced the 'learning by observing' hypothesis which supposes that the mergers of the mid- or late 1990s would have been more likely to create value than the mergers of the 1980s, due to the fact that bank managers would have benefited from having observed a large number of mergers before starting one. This is typically linked to the information spillover hypothesis. It also suggests that the stock market would have been a more accurate predictor of the long-run performance of banking mergers announced during the 1990s than those announced during the 1980s.

[15] Becher (2000), Houston and al. (2001).

[16] Berger and Hannan (1998).

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offset the gains from an increase in market power and thus leave unchanged the market value of the bank.

In Europe, the few studies carried out to assess the value creation through M&A in banking found positive abnormal combined returns. In the study conducted by Van Beek and Rad (1997), these returns were not statistically significant. In contrast, Cybo-Ottone and Murgia (2000) found that shareholder value gains were positive and significant, mostly driven by domestic bank-to-bank deals and diversification of banks into insurance. In 2001, Beitel and Schiereck found an increase of the combined value of bidders and targets for domestic M&A but a decrease in the case of cross-border M&A. These findings were confirmed in Beitel et al. (2004) on a sample of 98 M&A in 1985-2000, showing that transactions focussing activities and those on which targets are less performing increase value.

These positive abnormal returns, however, do not necessarily mean that mergers improve efficiency; in fact, one possible explanation for the difference between the European and American markets is that weaker antitrust enforcement in some European countries allows gains in monopoly power from in-market mergers.[17]

Finally, it seems that the large majority of M&A undertaken in Europe or in the US are far from having proved their effectiveness in terms of value creation in the short run.[18]

The empirical research based on event studies should however be taken with caution since the methodology suffers from several limitations.[19] One problem is that the announcement of a deal mixes information concerning the proposed merger with information on its financing. Because investors consider the announcement of a stock issuance as 'bad news', the negative returns to the bidding bank could reflect the fact that mergers tend to be financed with stocks. Consistent with this notion, few studies find that returns to bidders are significantly higher when mergers are financed with cash relative to mergers financed with new equity.[20] Also, event studies rely heavily on investors' perception and their anticipations of the future gains when there are rumours around the transactions. This may inflict a pure speculation effect.

Empirical studies which have tried to analyse the impact of M&A on the efficiency of the banking sector have led to controversial conclusions. The studies carried out on a sample of US banks showed, on average, very little or no *cost efficiency* improvement from M&A in the 1980s.[21] However, the results of studies using data from the 1990s were mixed.[22] On the one hand, some found that mergers produce no improvement in banks' cost efficiency, especially when the deals involve very large banks.[23] It was also showed that on average, smaller banking institutions tend to exhibit larger variations in X-inefficiencies than larger institutions.[24] This may be due to the organisational diseconomies of operating larger firms in

[17] Ayadi (2007).

[18] According to AT Kearney (1999): "58% of the M&A announced and completed are unfortunately a failure. Indeed, the stock market value of the merged entity two years after the operation is lower than the sum of both separated partners three months before". Similarly, a KPMG survey in 2001 has shown that: "30% of the M&A have increased the shareholders' value, 39% haven't brought any considerable change and almost 31% have destroyed value". In other words, 70% of mergers were unsuccessful in producing any business benefit as regards shareholder value. Finally, according to a Merrill Lynch study in 2003, not only do most mergers fail to deliver their promised value, but large deals have tended to perform worse than smaller ones. And at least 50% of major mergers since 1990 have eroded shareholder returns.

[19] Ayadi (2007).

[20] Houston and Ryngaert (1997).

[21] Berger and Humphrey (1992), Srinivasan (1992) and Pilloff (1996).

[22] One limitation applies to this litterature, indeed, the efficiency gains or losses associated to M&A activity may take a very long period to materialise, but these studies only focus on a short period of time before and after each M&A, Berger (2003).

[23] Peristiani (1997), Berger (1998) and Rhoades (1998). Akhavein and al. (1997) and Berger (2000).

24 X- inefficiencies have been broadly investigated in the US but without giving a final answer. Indeed, the first cause is linked to the size, on average, operating costs of larger banks are found to be closer to the optimal frontier curve than those of smaller banks to their respective cost frontier (Kwan and Eisenbeis (1996)). This could be explained by the fact that larger banks which operate in metropolitan markets are more likely to face stronger competition than smaller banks which are more likely to operate in suburban or rural areas. The second reason is linked to risk taking, inefficient institutions are found to take in a higher level of risk (Gorten and Rosen (1995). It is indeed very likely that managers of inefficient banks are more inclined to compensate the operating inefficiency by taking on more risk which may reward them with a higher yield. Finally, the third reason is the financial condition which is linked to the percentage of problem loans and other illiquid positions in the balance and off balance sheets. The correlation between poor asset quality and inefficiency may be an indication of poor management.

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relation to disruptions from the M&A process, which may offset most potential efficiency gains. And on the other hand, other studies found cost reductions also for very large US banks.[25]

The evidence for European banks is broadly consistent with the US results. Domestic mergers among banks of equal size seem to improve cost efficiency, but these results do not hold for all countries and all banks.[26]Consistent with these findings, Ayadi (2007) while applying the Activity/Geography matrix, she shows that banking M&A focussing activities and geographies are more likely to cut costs. Nationally, studies on Italian banks or UK building societies found significant cost efficiency gains following an M&A.[27] Moreover, simulation evidence suggests that a cross-border acquisition may be associated with a reduction in the costs of the target, while little effect is found for domestic M&A.[28] On the contrary Vander Vennet (2002b) and Ayadi (2007) found no tangible gains in terms of cost efficiency in cross-border M&A. The difficulties in improving cost efficiency for domestic transactions may be related to the obstacles often encountered, especially in continental Europe, in reducing a bank's labour force. In fact, personnel reduction, one of the main sources of savings, is hardly an option in countries with rigid labour markets.[29] For cross-border transactions, the difficulties to improve cost efficiency stem from the obstacles yet existing in the European financial market.[30]

Studies on *profit efficiency* of US banks more often found gains from M&A. The fact that cost efficiency is, on average, little improved as a result of a bank merger, does not necessarily mean that there is no improvement in profits. Profit efficiency incorporates both cost as well as revenue efficiency. Revenue efficiency can be improved by simply raising prices as market power expanded through the merger process itself. Or revenues may rise because the merged institution restructures its assets mix.[31]

Two studies in particular have attempted to determine the profit effects of mergers. Akhavein et al. (1997) found little change in cost efficiency but an improvement in profit efficiency of large US banks from 1980-90 following M&A, especially when both merger participants were relatively inefficient prior to the merger.[32] Also, after merging, banks tended to shift their portfolios to take on more loans and fewer securities. They attribute gains in profit efficiency to the benefits of risk diversification: larger banks have more diversified loan portfolios and lower equity-asset ratios. But their measure of profit efficiency does not account for changes in risk likely to result from such a portfolio switch. Berger (1998) found similar results in a study that includes all US bank mergers, both large and small, from 1990 to 1995.

In Europe, Vander Vennet (1996) found that domestic mergers of equals in European countries have a positive impact on profitability, mainly driven by improvements in operational efficiency. In line with these findings, Ayadi (2007) found that M&A transactions that concentrate activities in the same local area may raise anti-competitive concerns since the improvement of profit efficiency is shown to be driven by an increase in revenues suggestive of a pricing policy change rather than an improvement of cost efficiency. As regards cross-border M&A, Vander Vennet (1996) only found a partial profit efficiency improvement that may be caused by changes in the pricing behaviour of the acquired banks.[33]

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25 Houston and al. (2001).

26 Vander Vennet (1996).

27 Resti (1998). Haynes and Thompson (1999).

28 Altunbas and al. (1997).

29 Focarelli and al. (2002).

30 Ayadi (2007).

31 Many studies of market structure, price conduct and profit performance found that higher bank concentration is significantly associated with lower prices for deposits, but the relationship between higher concentration and higher profits is often mixed, being sometimes significant and sometimes not. Berger and Hannan, (1998) found that cost efficiency tends to be lower in markets where concentration is higher. Indeed, higher concentration (market power) may lead to higher prices and revenues but, with less competition, the incentive to reduce costs to their minimum levels is blunted. So, the higher revenues are largely absorbed in higher costs rather than contributing fully to expanded profits. From this perspective, market concentration seems to have a greater negative effect on cost efficiency than it does on prices.

32 Other relevant studies include Berger (1993 and 1996), Berger and Mester (1997), Clark and Siems (1997), Cummins and al. (1999) and Berger (2000).

33 Vander Vennet (2002b), Arnaboldi (2004), Ayadi and Pujals (2005), Ayadi (2007).

Focarelli et al. (2002) found that Italian deals that consist of the purchase of a majority (but not all) of the voting shares of the target appear to result in significant improvements, mainly due to a decrease in bad loans. For full mergers, they observe that Italian banks aim to change their business focus towards providing a broader range of financial services and thus increase their non-interest income, rather than to obtain efficiency gains. After the merger, they observe an increase in profitability in the long run that is also related to a more efficient use of capital.

3. Analyzing catching-up or convergence process of productivity in banking industry with directional distance function

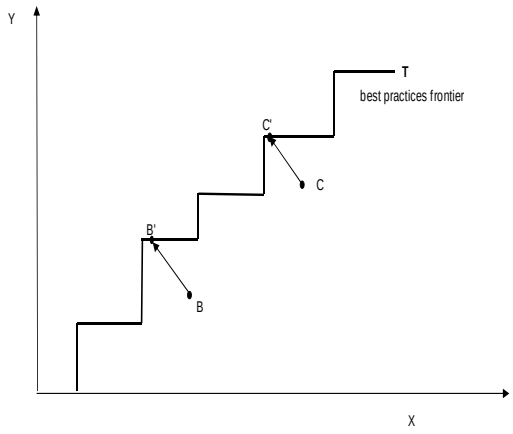
The objectives of the model is both to gauge a catching-up effect of technical efficiency levels and to evaluate a convergence process of input/output mixes among banking institutions. While the former depends on managerial capabilities to adopt the best available technology, the latter encompasses the heterogeneity of input/output mixes across the individual banks involved in a same M&A operation. This type of efficiency can be viewed as an indicator of complementarities among lines of work from each bank component within a consolidated banking group.

3.1. Technological catching up process and productivity convergence

Traditionally, the applied literature about technological adoption compares Total Factor Productivity levels (TFP) across decision making units (DMUs) and tests an inverse relationship between growth TFP rates and their initial levels[34]. Convergence in productivity levels turns out if DMUs with the lowest initial TFP have the highest growth rates: the followers catch up the leaders.

Figure 1 illustrates the technical inefficiency of two DMUs (B and C) situated in the interior of the production set and their relative benchmark onto the frontier of best practices (B' and C'). The distance between B and C and the frontier is a measure of their inefficiency. Thus, a decrease with time in distances between banks B and C and their respective benchmarks onto the production frontier denotes such a catching-up process to the maximal feasible productivity levels. We will latter introduce the directional distance function to formally measure the distance of any production plan to the production frontier.

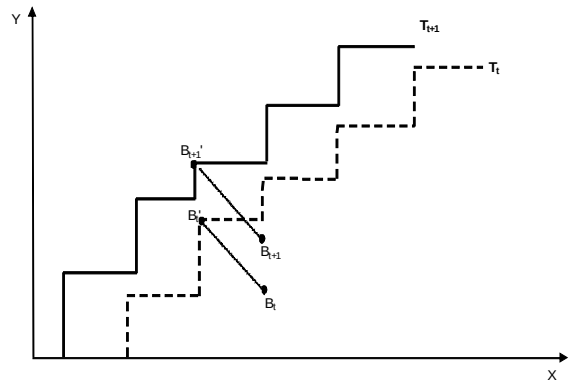
Figure 1 Technical efficiency measure as distance to a best practice



In our approach, the technological catching-up process is independent from the usual technical change definition since we compare the observed levels of TFP to their current technological benchmark. Comparisons are therefore done within the same period and not across time. While shifts of the production frontier modify productivity levels, they do not interfere with our technological catching-up measure since technical progress affect uniformly any bank and its benchmark onto the frontier. This is illustrated by Figure 2. While there is technical progress over the two periods, distances to the frontiers have not changed implying no technological catching-up.

[34] That is usually named β convergence.

Figure 2 Efficiency catching-up and technological progress



The efficiency catching-up or convergence process can be defined as the tendency of the least productive bank to catch up with the more efficient ones. Identifying the DMUs having adopted the best practices (i.e., banks forming the production frontier), the gaps of the other banks to this frontier measure their relative efficiencies. If these distances decrease over time, they reveal an efficiency convergence or catching-up process. In other words, the least productive DMUs align themselves gradually to the more efficient ones if there is a significant negative correlation between the initial level of efficiency and its growth rate.

Therefore, for a bank n, we assume that its efficiency growth rate at period t depends on the initial level of efficiency:

$$\ln(\lambda_{n,t}) - \ln(\lambda_{n,t-1}) = \alpha + \beta.\ln\left(\lambda_{n,t-1}\right) + u_n \quad (1)$$

where $\lambda_{n,t}$ is the observed level of efficiency of bank n, u_n is an error term with mean zero. A negative and significant coefficient β for the initial technological gap would signal that banks with a higher gap at the beginning of the periods have grown faster, so that they have caught up the more efficient ones. This model is compatible with technical catching-up in the case of technical efficiency and input/output mixes convergence in the case of structural efficiency. The both processes may lead to productivity convergence or technological diffusion with overall efficiency.

From this definition, we investigate the process of efficiency convergence across banks with a two-step procedure. In the first step, the above distance functions are used to measure the efficiency change index component (technical or structural) for each individual bank of the two sub-samples (respectively M&A and the matched group) over the period of the merger or acquisition. Hence, the efficiency gap is then defined as the distance between each bank and the frontier. In a second step, Eq. (1) is estimated with cross-section ordinary least squares which allow testing for absolute convergence or complete efficiency catching-up. Then statistical tests on slopes comparisons between M&A and matched banks can reveal or not significant differences on technical catching-up and structural convergence of output/input mixes among the two sub samples.

3.2. Structural inefficiency and convergence of input/output-mixes

We further illustrate the structural inefficiency effect in a multiple outputs-inputs case as a subtle source of inefficiency due to heterogeneity in output and input shares among individual banks. Assume that two

banks involved in a same M&A operation are technically efficient and also price efficient in the sense of Farrell (1957). Therefore no inefficiencies arise at the individual level. However, if banks face different price systems, it is clear that a kind of inefficiency prevails within the banking group in line with the second welfare theorem. This market inefficiency is captured by a structural inefficiency component as shown in Figures 3 and 4. Let us consider two banks production plans (A and B) which are represented respectively in the input and output spaces. While A and B are both technically and price efficient, there is still inefficiency at the aggregate level. This structural inefficiency is coming from differences in relative output or/and input allocations among the two individual component of the M&A operation. Indeed, in a perfect competition market, only one input/output price vector has to coordinate the two banks and this structural effect computes the inefficient market allocation in the spirit of the Debreu (1951) coefficient of resource utilization.

Figure 3 Structural inefficiency in the input space

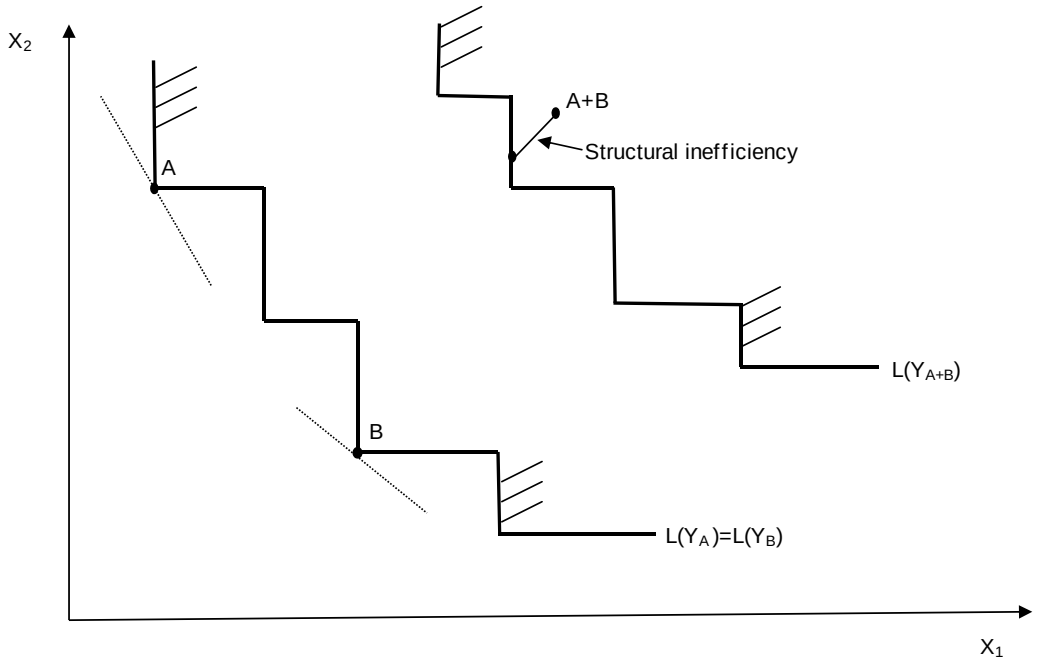
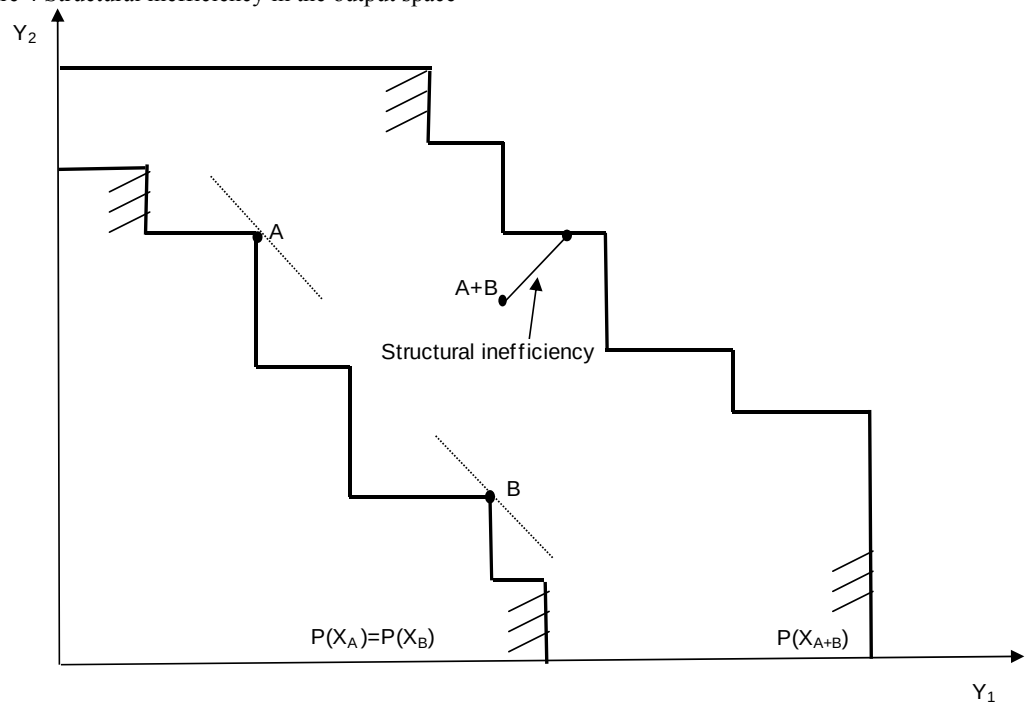


Figure 4 Structural inefficiency in the output space



Before turning to a formal presentation of the model we use to gauge the technical, scale and structural effects defined above, we briefly highlight the implications of these concepts about the productivity convergence process among banks. First, a decrease of technical inefficiency with time appears as a technological catching-up effect. Second, the greater the structural inefficiency, the more heterogeneity we have in the input/output mixes between each individual bank involved within a same M&A operation. Therefore, a decrease of structural inefficiency of the consolidated banking group over time reveals that the M&A operation has strengthened complementarity among lines of work from each individual component.

3.3 Measuring overall, technical and structural inefficiencies

Formally, let $x \in R_+^I$ denote the vector of inputs and $y \in R_+^O$ the vector of outputs for a DMU. All the K banks are assumed to face the same technology represented by its production possibility set T:

$$T = \{(x, y) : x \text{ can produce } y\} \qquad (2)$$

For estimation purposes, we employ non-parametric frontier estimation by specifying an operational definition of T based on a set of observed banks and a set of axioms which add some structure to the definition of T in (1). We opt for the model introduced by Green and Cook (2004) (called Free Aggregation Hull – FAH) which appears relevant for our analysis. Since we aim to compare the efficiency of a M&A bank to its constituents additivity is required but not necessarily convexity. We therefore reject the DEA family models where convexity is assumed and where an evaluated bank is compared to an unobserved linear combination of other banks. In the Green and Cook approach, an evaluated bank is compared to an observed bank of the same size. With the additivity, only free disposability of inputs/outputs is assumed which together lead to an operational definition of the production set that relies on very weak assumptions. The FAH technology denotes T_{FAH} can be represented by its production possibility set:

$$T_{FAH} = \left\{ (x,y) : \sum_{k=1}^{K} y_o^k z^k \geq y_o, o = 1,...,O, \sum_{k=1}^{K} x_i^k z^k \leq x_i, i = 1,...,I, z^k \in \{0;1\} \, \forall k \right\} \qquad (3)$$

The M&A operation (M) is composed of M individual banks $(m = 1,...M)$. The aggregate technology at the group level inherits its properties from the individual bank technology. Formally, we define the group technology T^M as the sum of the individual bank technologies:

$$T^M = \sum_{m=1}^{M} T \qquad (4)$$

We now turn to the definition of the directional distance function which measures distances between observed production plans and the boundary of the technology. These distances are interpreted as gaps between observed TFP levels and their maximal feasible or desired levels of TFP. The function $D_T : (R_+^O \times R_+^I) \times (-R_+^O) \times R_+^I \longrightarrow R_+$ defined by:

$$\vec{D}_T(x,y;g_x;g_y) = \sup_{\lambda} \left\{ \lambda \in \Re_+ : (x - \lambda \cdot g_x, y + \lambda \cdot g_y) \in T \right\}, \qquad (5)$$

is called the directional distance function where $(g_x; g_y)$ is a nonzero vector that determines the direction in which $\vec{D}_T(\cdot)$ is defined. An analysis of the properties of directional distance functions can be found in Chambers et al. (1996). Note that $(x,y) \in T \Longleftrightarrow \vec{D}_T(x,y;g_x;g_y) \geq 0$. Thus, it is possible to characterize the production set from the directional distance function. Concerning the directional distance function, we use the group output vector of the M&A operation to construct the direction of translation; i.e. $(g_x, g_y) = \left(\sum_{m \in M} x^m, \sum_{m \in M} y^m \right)$. Therefore, technical inefficiency are computed as percentages of the aggregated output or input of the total group of banks involved in the same M&A operation (Dervaux et al., 2004).

The distance functions computed by the following binary programs (P1) and (P2) respectively measure overall efficiency which is evaluated at the aggregated level of the M banks involved in a same M&A operation and technical efficiency of each individual bank within the group:

$$\begin{aligned}
&\vec{D}_{T_{FAH}}\left(\sum_{m=1}^{M} y^m, \sum_{m=1}^{M} x^m; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m\right) = \max_{z,\lambda} \ \lambda \\
s.t. \ &\sum_{k=1}^{K} z_k y_o^k \geq \sum_{m=1}^{M} y_o^m + \lambda \sum_{m=1}^{M} y_o^m \quad \forall o = 1,\cdots,O \\
&\sum_{k=1}^{K} z_k x_i^k \leq \sum_{m=1}^{M} x_i^m - \lambda \sum_{m=1}^{M} x_i^m \quad \forall i = 1,\cdots,I \qquad (P1) \\
&\sum_{k=1}^{K} z_k = M \\
&z_k \geq 0 \quad \forall k = 1,...,K
\end{aligned}$$

$$\begin{aligned}
&\vec{D}_{T_{FAH}}\left(x^{m'}, y^{m'}; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m\right) = \max_{z,\lambda} \ \lambda \\
s.t. \ &\sum_{k=1}^{K} z_k y_o^k \geq y_o^{m'} + \lambda \sum_{m=1}^{M} y_o^m \quad \forall o = 1,\cdots,O \\
&\sum_{k=1}^{K} z_k x_i^k \leq x_i^{m'} - \lambda \sum_{m=1}^{M} x_i^m \quad \forall i = 1,\cdots,I \qquad (P2) \\
&\sum_{k=1}^{K} z_k = 1 \\
&z_k \geq 0 \quad \forall k = 1,...,K
\end{aligned}$$

Therefore, the structural efficiency part of the productivity gap is defined at the group level and is based on the difference between the technical inefficiency evaluated at the aggregated level (overall inefficiency) and the sum of individual technical efficiencies. Finally we obtain the following definitions and decompositions of the efficiencies of a M&A:

- Overall Efficiency: $\vec{D}_{T_{FAH}}(\sum_{m=1}^{M} y^m, \sum_{m=1}^{M} x^m; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m)$ (6) calculated by P1
- Technical Efficiency: $\sum_{m'=1}^{M} \vec{D}_{T_{FAH}}(x^{m'}, y^{m'}; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m)$ (7) calculated by P2
- Structural Efficiency: $\vec{D}_{T_{FAH}}(\sum_{m=1}^{M} y^m, \sum_{m=1}^{M} x^m; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m) - \sum_{m'=1}^{M} \vec{D}_{T_{FAH}}(x^{m'}, y^{m'}; \sum_{m=1}^{M} y^m; \sum_{m=1}^{M} x^m)$ (8)

4 Sample and Results

To specify the banking technology we adopt the intermediation approach and retain two outputs (loans and investment assets) and three inputs (labor approximated by wages plus social taxes, physical capital and borrowed funds).

4.1 Sample

All the data used in the empirical analysis are derived from Bankscope, a FitchRatings/Bureau Van Dijk international database, which provides annual income and balance sheet data for banks. These institutions are mainly commercial, cooperative and savings banks. All data are expressed in millions of constants euros (base year 2003).

Additional information concerning M&As were obtained from the Thomson Financial Securities, M&A SDC database and press coverage. They concern 42 completed M&As executed by banks headquartered in the EU15 plus Norway over the period 1996-2003. As measures of technical and structural efficiency require detailed statistics on each bank component of M&As, the decomposition of overall efficiency into its two components was restricted to only 22 M&A operations.

The referent technology T is based on a control group composed of 587 non-merging or majority-acquired European banking institutions that meet the same selection criteria as the M&A sample. Foreign branches and subsidiaries that have their parent institution outside the EU15 or Norway and institutions that were involved in a merger or a majority acquisition are excluded.

Finally to obtain more robust conclusions, each bank of the M&A sample is matched to another similar bank of the control group. This matching enables us to conclude if significant differences exist among the two sub samples (namely M&A banks and matched banks) concerning their respective efficiency scores.

Descriptive statistics of the variables used to provide efficiency measures are detailed in Table 1. On average, the matched and M&A banks are nearly twice bigger than the others of the control group. But the sample contains some heterogeneity in size for all variables. The coefficients of variation are quite large (larger than one) especially for the control group. Over the period, the annual growth rates of the two outputs were higher for the matched and control groups than for the M&A sample.

Table 1: Descriptive statistics of the variables
means over the total period 1996-2003

	M&A Banks	Matched Banks	Control Group
Loans			
Mean	13 700	17 189	8 116
Std. Dev.	24 081	39 303	27 811
Average growth rate	-0.8%	11.7%	11.2%
Other Earning Assets			
Mean	16 120	14 745	7 465

Std. Dev.	31 987	28 090	27 150
Average growth rate	5.2%	9.1%	12.1%
Personnel Expenses			
Mean	303	342	151
Std. Dev.	555	782	600
Total Fixed Assets			
Mean	286	392	159
Std. Dev.	548	1 407	830
All borrowed funding			
Mean	28 125	29 888	14 573
Std. Dev.	51 023	60 325	49 425

All figures are in millions of constant euros (base year 2003)

4.2 Results

4.2.1 Best practices frontier estimation and efficiency scores

First annual production frontiers are calculated by program P2 associated to its respective directional distance function allowing the evaluation of overall efficiency of the 42 completed M&As. Second considering the only 22 M&A operations for which detailed statistics on each institution component are available, technical efficiency scores of each individual bank are calculated thank to program P1. Then we can derivate technical and structural efficiency scores for each M&A operation.

Table 2 resumes the average score of overall efficiency for the 42 completed consolidated banking group before and after the M&A operations. Compared to the matched sub sample, the M&A banks seem to be more efficient. If all of these banks were aligned on the observable best practices, the potential gains in productivity would be about 22% and 27% for M&A and matched banks respectively. However, over the observation period, efficiency score growths seem very similar among the two groups (around 5%).

Table 2: Scores of overall efficiency in %
(average of 42 consolidated banking group)

	Before M&A	After M&A
M&A banks	74.0	79.0
Matched banks	68.3	73.1

Decomposition of overall efficiency into its technical and structural components for the 22 detailed M&A operations and their matched institutions are presented in table 3. For the both groups of banks, technical efficiency increases while structural efficiency does not move meaning that input/output mixes of M&A banking activities have not changed before and after M&A operations.

Table 3: Scores of technical and structural efficiency in %
(average of 22 banking groups)

		Technical Efficiency		Structural Efficiency	
		Before M&A	After M&A	Before M&A	After M&A
M&A banks	average	72.9	77.1	94.6	94.6
	std	11.7	9.8	3.4	3.3
Matched banks	average	74.2	77.2	95.6	95.8
	std	14.0	12.3	3.1	3.2

However, the simple observation of these average results does not enable to clearly conclude on the catching-up or convergence hypothesis for overall efficiency as well for its two components. Therefore, a statistical test procedure is performed on these three effects.

4.2.2 Econometric estimations of convergence

For the three types of efficiencies (namely overall, technical and structural), the results of the catching-up regressions are plotted in figures 5 to 7. As we can note, significant overall efficiency and technical

catching up effects are found for both M&A and Matched bank groups. Nevertheless, according to statistical tests on slopes differences between M&A and matched banks (table 1), these effects are not significantly different between these two groups. Therefore, we can conclude that M&A operations do not seem to support the argument concerning total factor productivity and technical efficiency improvements

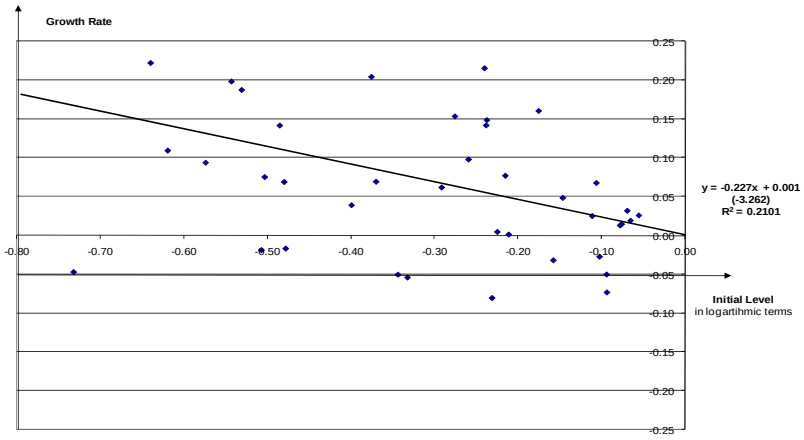
Table 4: Statistical tests on slopes differences between M&A and matched banks

	Estimated F	N	critical F
Overall Efficiency	0.87	42	4.10
Technical Efficiency	0.13	22	4.41
Structural Efficiency	6.14	22	4.41

Furthermore, statistically significant differences on structural convergence of output/input mixes are established in favour of the M&A bank sample (table 4). As a preliminary conclusion, over the period 1996-2003, M&A operations in the European banking industry appeared to be essentially motivated by an objective of improving complementarity among lines of work from each bank component of M&As.

Figure 5 Overall Efficiency Catching-up

M&A Banks



Matched Banks

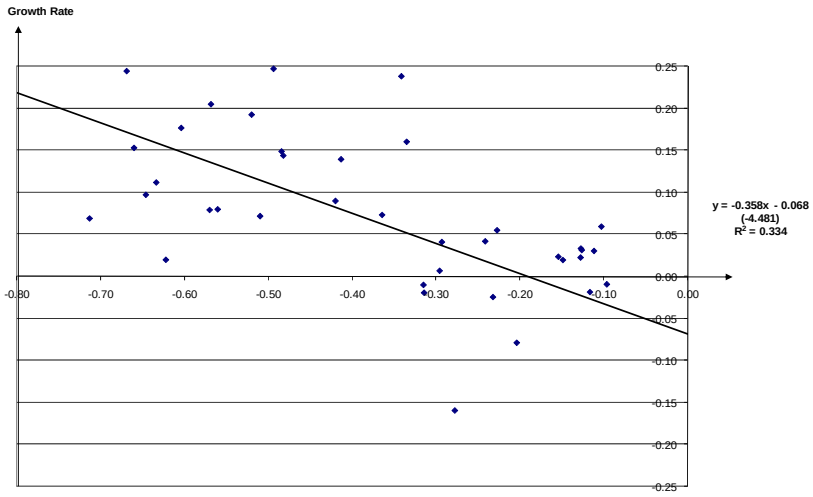
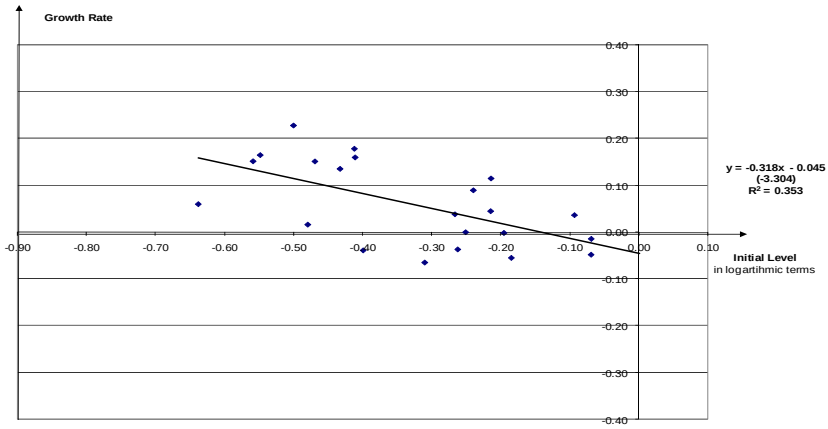


Figure 6 Technical Efficiency Catching-up

M&A Banks



Matched Banks

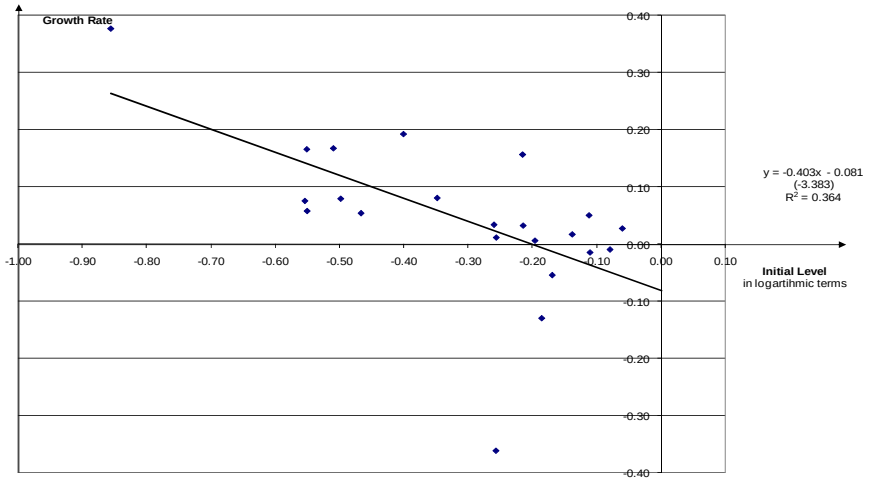
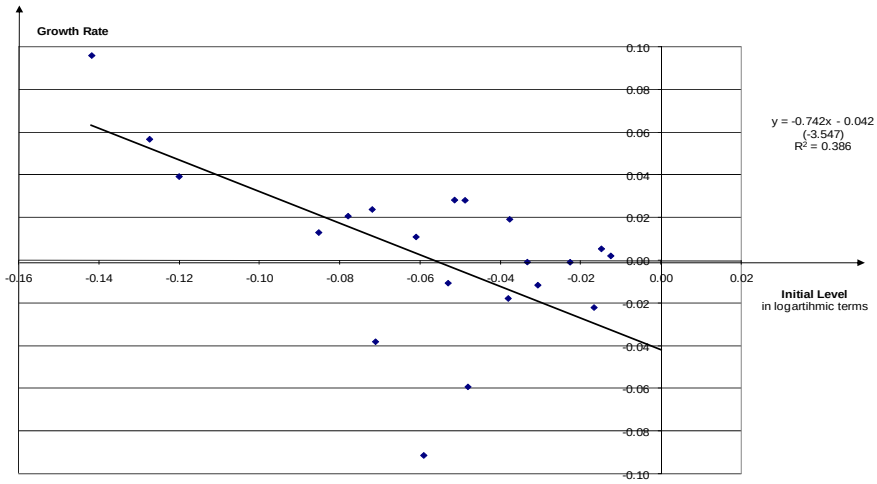
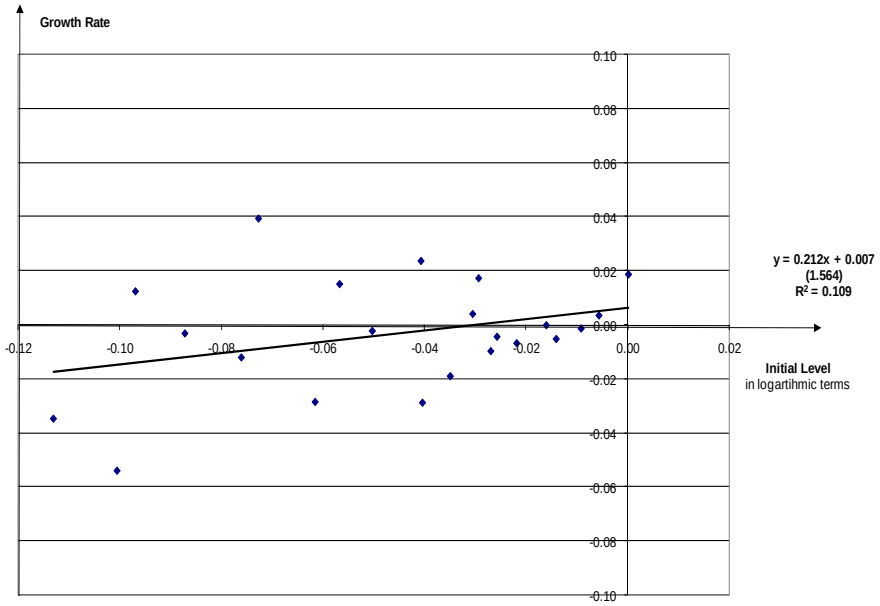


Figure 7 Structural Efficiency Catching-up

M&A Banks



Matched Banks



5. Conclusions

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