The dynamics of superior business performance in the long run
Evidence from the global oil industry

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Abstract

The dynamics of superior business performance over time are of great interest to both practitioners and academics. Empirical evidence and theoretical perspectives on this topic differ. Our longitudinal study (1954-2004) of the global oil industry finds the patterns for different aspects of business performance to fluctuate over time, while the overall trend is downwards. The observed performance cyclicality corresponds to the predictions of Austrian economics. Parallel to the performance cycles, we find a sequence of competitive regimes related with structural changes in the industry. Insight into long-run dynamics of business performance helps managers and investors to form realistic expectations about business performance, develop realistic objectives, and take better decisions.

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1 Superior business performance

Researchers and practitioners in strategic management and economics have long been interested in the measurement of superior business performance, particularly `persistence of profits'. The persistence of profits literature, initiated by Mueller[1], is based on the idea that competitive pressures eliminate positive and negative business rents over time, causing the rate of return on capital for all firms to converge to a competitive level. Different theoretical perspectives within the strategic management and economics literature have different predictions about the emergence of performance patterns. Some perspectives, like neoclassical economics and the hypercompetition model, assume that markets are efficient, which indicates strong competitive convergence leaving no place for persistent superior performance. Other perspectives, like evolutionary economics, industrial organization, and the dynamics capabilities perspective, assume markets to be imperfect and competitive convergence to be weak, which does allow for the persistence of superior performance outcomes.

Also, the empirical evidence on the occurrence of persistence is mixed. Following the review by Wiggins and Ruefli[2], most studies during the period 1974-2003[3] found persistence of superior performance. An exception is Jacobsen[4], who did not find persistence, but used a different data source. Most of these studies used autoregressive techniques; none examined the evolution of persistence through time. A second group of more recent studies did examine the effects of time on persistence, yielding mixed results. McNamara, Vaaler and Devers[5] using auto regression techniques, found cyclicality of

[1] Mueller, Dennis C. 1977. The Persistence of Profits above the Norm. *Economica* **44**(176) 369–380.
[2] Wiggins, Robert R, and Timothy W Ruefli. 2005. Schumpeter's ghost: Is hypercompetition making the best of times shorter? *Strategic Management Journal* **26**(10) 887–911.
[3] See, e.g., Mueller, Dennis C. 1986. *Profits in the long run*. Cambridge University Press; Goddard, J.A., J.O.S. Wilson. 1996. Persistence of profits for UK manufacturing and service sector firms. *The Service Industries Journal* **16**(2) 105–117; and McGahan, Anita M., and Michael E. Porter. 1999. The persistence of shocks to profitability. *Review of Economics and Statistics* **81**(1) 143–153.
[4] Jacobsen, Robert. 1988. The persistence of abnormal returns. *Strategic Management Journal* **9**(5) 415–430.
[5] McNamara, Gerry, Paul M. Vaaler, and Cynthia Devers. 2003. Same as it ever was: The search for evidence of increasing hypercompetition. *Strategic Management Journal* **24** 261–278.

performance, while Wiggins and Ruefli [6] applying non-parametric stratification techniques, found shortening of periods of superior performance.

The present research primarily aims at identifying performance patterns over time, for a particular global industry, and applying various methodologies, including auto regression and non-parametric stratification. We address three related (sets of) research questions.

First, how does the rate of performance convergence develop over time? Secondly, how does the occurrence of superior performance evolve over time? Have incidences of persistent superior performance become less and have superior performance periods shortened during the last decades? Thirdly, how does the migration of firms across performance strata unfold over time? Is there a growing instability or have the performance strata remained relatively stable?

It is not our objective to set up explanations of the causes of performance variations. This would require extensive research of the processes within individual organizations and of the complexity of emerging competitive advantages besides being subject to serious methodological issues[7]. However, we do put the performance patterns into perspective by identifying the main structural changes in the industry that may have affected the performance patterns, thus adding to the growing body of `stylized facts about profitability patterns'[8].

We focus our efforts on one particular group of firms, the global oil industry, 1954-2004. This choice is motivated by various considerations. First, the oil industry reveals considerable structural changes affecting the competitive regime and the competitive order of firms within the industry throughout the research period 1954-2004 (see table 1). The industry has been relatively sensitive to political forces, as illustrated by the nationalization of oil fields by OPEC countries during the 1970s, and is characterized by ongoing globalization. Secondly, the nature of activities in the oil

[6] Wiggins and Ruefli, *op. cit.* (see note 2).

[7] Rouse, M.J. and U.S. Daellenbach. 2002. More thinking on research methods for the resource-based perspective. *Strategic Management Journal* **23**(10) 963–967; Powell, T.C. 2001. Competitive advantage: *Management Journal* **22**(9) 875–888; and Rosenzweig, P. 2007. *The Halo Effect and the Eight Other Business Delusions That Deceive Managers*. The Free Press, New York.

[8] McGahan, Anita M., and Michael E. Porter. 2005. Comment on 'Industry, corporate and business segment effects and business performance: A non-parametric approach' by Ruefli and Wiggins. Strategic Management Journal **26**(9) 873–880.

industry has remained fairly comparable throughout the research period, notwithstanding major structural changes in the industry. This in contrast with the IT industry, for instance, which underwent marked changes in the products and services provided. The stable product image of the oil industry is an attractive property for longitudinal analyses. Thirdly, the main competitors in the oil industry are large, globally-operating corporations, which are mostly present in the Fortune Directories. This practical observation further supports our choice of the Fortune listings. But by emphasizing the global scope of competition, our study also complements existing, predominantly single-country studies, which mostly focus on the United States[9].

Table 1 about here

Our study contributes to prior research in several respects. Firstly, the combination of parametric and non-parametric methods applied to the same set of firms enhances our understanding our understanding of the characteristics of existing methods of analysis. Previous studies largely confined their methodologies to a particular method of analysis, which makes it difficult to disentangle method effects from the observed phenomena. Secondly, our study covers a relatively long time span of 51 years, 1954-2004. Such longer time frames are particularly wanted to identify dynamic performance patterns over time, especially when these patterns are of a cyclical nature, as McNamara et al. assert[10]. Thirdly, we analyze an international sample of firms, which broadens the scope of insights into superior performance persistence from largely US-based firms to worldwide competition.

The remainder of this paper is organized as follows. Section 2 reviews our three research questions from different perspectives in the strategic and economic literature. Section 3 motivates various choices with respect to the data sources used, the industry explored, and the performance measure employed. Moreover, this section outlines the

[9] Chacar, A. and B. Vissa. 2005. Are emerging economies less efficient? Performance persistence and the impact of business group affiliation. Strategic Management Journal **26**(10) 933–946; and Wiggins and Ruefli, *op. cit.* (see note 2).
[10] McNamara, Vaaler and Devers, *Strategic Management Journal*, *op. cit.* (see note 5).

methods of analysis. Section 4 presents the results of the analyses, while section 5 offers a discussion of these results and concludes.

2 Theoretical perspectives

Various patterns of business performance are expected to emerge depending on the theoretical perspectives maintained[11]. To answer our three research questions about the patterns of business performance, we distinguish nine theoretical perspectives. Table 2 applies these perspectives to the three research questions about: (1) the dynamics of performance convergence; (2) the dynamics of superior performance; and (3) the mobility across performance strata over time. First, neoclassical economics, the hypercompetition model, and institutional economics predict that performance convergence is strong, persistence of superior performance is absent, and mobility across performance strata is high. In neoclassical economics, which assumes that markets are efficient, superior performance is perceived as an aberration that will disappear when equilibrium is achieved[12]. Any instances of superior performance will be of a firm-specific, transient kind, and will quickly converge to a competitive level. In institutional economics, institutional isomorphism, e.g. mimetic isomorphism will have performance consequences[13]. Institutional isomorphism will, through competitive convergence, undermine persistent superior performance. Secondly, evolutionary economics and the dynamic capabilities school assume markets to be imperfect implying that competitive convergence may be weak, superior performance may persist, and mobility may be low

[11] Ghemawat, P. 2002. Competition and Business Strategy in Historical Perspective. *Business History Review* **76**(1) 37–74.

[12] See, e.g., Debreu, G. 1959. *The Theory of Value*. Wiley, New York; Jevons, W. Stanley. 1871. *The theory of political economy*. Macmillan, London; and Marshall, A.S. 1890. *Principles of Economics*. 3rd ed. Macmillan, London.

[13] See, e.g., DiMaggio, P.J., and W.W. Powell. 1983. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review* **48**(2) 147–160; Scott,W.R. 1987. The Adolescence of Institutional Theory. *Administrative Science Quarterly* **32**(4) 493–511; North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, New York; and Barreto, I., and C. Baden-Fuller. 2006. To Conform or To Perform? Mimetic Behaviour, Legitimacy-Based Groups and Performance Consequences. *Journal of Management Studies* **43**(7) 1559–1581.

provided that firms succeed in concatenating temporary competitive advantages[14]. Thirdly, the Austrian perspective[15] holds that the rates of convergence, the persistence of superiority, and mobility across strata fluctuate over time due to entrepreneurial innovation and imitation. Schumpeterian rents enable the emergence of persistent superior performance, but eventually competitive imitation will end periods of persistence. The assumption that alternating periods of innovation and imitation alternate, suggests that the observed patterns of superior performance may be expected to evolve cyclically. Finally, the industrial organization literature, the positional school, and the resource-based view suppose weak convergence, persistence of superior performance, and high mobility across performance strata.[16]

Table 2 about here

Though most theories have competition rather than performance as their core subject, it is typically assumed that sustained periods of above-average business performance are the observable manifestations of sustainable competitive advantage[17]. This assumption is not entirely obvious, since value creation and rent appropriation by firms not always

[14] See, e.g., Nelson, R.R., and S.G. Winter. 1982. *An evolutionary theory of economic change*. Harvard University Press, Boston, MA; Winter, S.G. 1987. Knowledge and competence as strategic assets. D.J. Teece, ed., *The Competitive Challenge*. Ballinger Publishing Company, Cambridge, MA, 159–183; Lei, D., M.A. Hitt, and R. Bettis. 1996. Dynamic core competencies through meta-learning and strategic context. *Journal of Management* **22**(4) 549–569; and Teece, D.J., G. Pisano, and A. Shuen. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* **18**(7) 509–533.

[15] See, e.g., Schumpeter, J.A. 1934. *The Theory of Economic Development*. Harvard University Press, Cambridge, Mass.; Schumpeter, J.A. 1942. *Capitalism, Socialism and Democracy*. Harper & Brothers, New York; and Jacobsen, Robert. 1992. The "Austrian" school of strategy. *Academy of Management Review* **17**(4) 782–807.

[16] For industrial organization, see, e.g., Mason, E.S. 1949. The current state of the monopoly problem in the united states. *Harvard Law Review* **62** 1265–1285; and Bain, J.S. 1959. *Industrial Organization*. Wiley, New York. For the positioning school, see e.g., Porter, Michael E. 1980. *Competitive Strategy: Techniques for analyzing industries and competitors*. 14th ed. The Free Press, New York, NY; and Porter, Michael E. 1985. *Competitive advantage: Creating and sustaining superior performance*. The Free Press, New York, NY. For the resource-based view, see. e.g., Wernerfelt, Birger. 1984. A resource-based view of the firm. *Strategic Management Journal* **5**(2) 171–180; Rumelt, Richard P. 1984. Towards a strategic theory of the firm. R. Lamb, ed., *Competitive Strategic Management*. Prentice-Hall, Englewood Cliffs, NJ, 556–570; and Dierickx, I., and K. Cool. 1989. Asset stock accumulation and sustainability of competitive advantage. Management Science **35**(12) 1504–1511.

[17] Porter, *Competitive advantage: Creating and sustaining superior performance*, *op. cit.* (see note 16); Rouse, M.J., and U.S. Daellenbach. 1999. Rethinking research methods for the resource-based perspective: Isolating sources of sustainable competitive advantage. *Strategic Management Journal* **20**(5) 487–494; and Rouse and Daellenbach, *Strategic Management Journal*, *op. cit*. (see note 7);

coincide[18], due to for instance slack or hold-ups and even `serendipity'[19]. Despite these methodological issues, we adhere to common practice to consider persistent superior performance an expression of sustained competitive advantage or a concatenation of temporary advantages.

3 Data and methods

3.1 Data sources

Performance data have been collected from the Fortune Directories, 1954 (first publication) to 2004, enabling us to analyze performance dynamics for a period of more than 50 years. Moreover, this source allows us to do a longitudinal study without a survivor bias, which has been considered an issue in most prior longitudinal research[20]. Our 51 year study period is more than twice the length of samples used in most previous studies having sample periods of 10 to 25 years[21]. Notable exceptions are Thomas and D'Aveni who explore a 52-years period (1950-2002) and Gschwandtner[22] who has a 50-year period. Such long time spans are desirable in light of the objective to explore possibly varying intensities of competition, changing rates of profit convergence, or evolving mobility of firms within industries[23]. For the years following 1989, we used the Fortune Global 500 Directories. For years prior to 1989, when Fortune only offered separate United States and International Directories, we constructed an artificial Global 500 Directory by merging both directories on the basis of the marginal sales revenues.

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[18] See, e.g., Arend, R.J. 2003. Revisiting the logical and research considerations of competitive advantage. *Strategic Management Journal* **24**(3) 279–284; Durand, R. 2002. Competitive advantage exists: A critique of Powell. *Strategic Management Journal* **23**(9) 867–872; Powell, *Management Journal*, *op. cit.* (see note 7); and Ghemawat, P. 1991. *Commitment: the dynamic of strategy*. Free Press, New York.

[19] Williamson, O.E. 1975. *Markets and Hierarchies*. Free Press, New York; Denrell, J., C. Fang, and S.G. Winter. 2003. The economics of strategic opportunity. *Strategic Management Journal* **24**(10) 977–990.

[20] Gschwandtner, Adelina. 2005. Profit persistence in the very long run: Evidence from survivors and exiters. *Applied Economics* **37** 793–806.

[21] Ruefli, Timothy W., and Robert R. Wiggins. 2005. Response to McGahan and Porter's commentary on 'industry, corporate and business-segment effects and business performance: a nonparametric approach'. *Strategic Management Journal* **26**(9) 881–886.

[22] Thomas, L.G., and Richard A. D'Aveni. 2006. The Rise of Hypercompetition in the US Manufacturing Sector, 1950-2002. Working paper, version 3.3, Goizueta Business School, Atlanta, GA; and Gschwandtner, *Applied Economics*, *op. cit.* (see note 20).

[23] See, e.g., Wiggins, Robert R., Timothy W. Ruefli. 2002. Sustained competitive advantage: Temporal dynamics and the incidence and persistence of superior economic performance. *Organization Science* **13**(1) 82–105.

Our analysis is concerned with the oil industry, which includes the Fortune Directories `crude-oil production' (upstream) and `Petroleum refining' (midstream). The data set contains 121 firms. The length of stay of firms in the sample varies from 1 to 51 years with an average duration of 17.11 years. The total number of firm x year observations is 2071.

3.2 Performance measure

In line with previous performance research[24], we measure a company's performance by return on assets (ROA, annual accounting profits after taxes divided by total assets). The use of ROA enhances the comparability of our analysis with previous studies, but also facilitates the compilation of global sample over a relatively long time frame. Clearly, ROA, being based on accounting profitability, has been criticized as a measure of firm performance[25]. But at the same time, many studies report a remarkable consistency in outcomes regardless the use of ROA or market-based indicators, such as Tobin's Q[26]. Besides, stock-market based performance measures, like Tobin's Q, are also not without dispute, as they may confound the actual performance of the firm with investor expectations[27]. More specifically, McGahan and Porter note that `accounting biases are likely to influence levels of effects to a greater extent, however, than the persistence in effects', which further supports the use of ROA in our analysis of long-term performance dynamics[28].

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[24] See, e.g., Mueller, *Profits in the long run*, *op. cit.* (see note 3), Cubbin, J., and P. Geroski. 1987. The convergence of profits in the long run: Inter-firm and interindustry comparisons. *The Journal of Industrial Economics* **35**(4) 427–442; Waring, Geoffrey F. 1996. Industry differences in the persistence of firm-specific returns. *The American Economic Review* **86**(5) 1253–1265; McGahan, Anita M., Michael E. Porter. 2002. What do we know about variance in accounting profitability? *Management Science* **48**(7) 834–851; McGahan, Anita M., and Michael E. Porter. 2003. The emergence and sustainability of abnormal profits. *Strategic Organization* **1**(1) 79–108; and Wiggins and Ruefli, *op. cit.* (see note 2).

[25] See, e.g., Harcourt, C.G. 1965. The accountant in a golden age. *Oxford Economic Papers* **17** 65–80; Fisher, F., and J. McGowan. 1983. On the misuse of accounting rates of return to infer monopoly profits. *American Economic Review* **73**(1) 1504–1511; and Hawawini, G., V. Subramanian, and P. Verdin. 2003. Is performance driven by industry- or firm specific factors? A new look at the evidence. *Strategic Management Journal* **24**(1) 1–16.

[26] See, e.g., Jacobsen, Robert. 1987. The validity of ROI as a measure of business performance. *American Economic Review* **77** 470–478; and McGahan, Anita M. 1999. The performance of US corporations, 1981-1994. *Journal of Industrial Economics* **47**(4) 373–398.

[27] Thomas and D'Aveni, *op. cit.* (see note 22).

[28] McGahan and Porter, *Review of Economics and Statistics*, *op. cit.* (see note 3).

3.3 Methods

Various methods have been applied to evaluate various aspects of superior performance persistence. Below we briefly describe the methods used; a more detailed explanation of the methodology is deferred to appendix A.

Dynamics of performance convergence. The dynamics of business performance convergence our analyzed using Mueller's[29] auto regression model, which specifies a firm's (abnormal) returns as a competitive return common to all firms plus a systematic firm rent and a non-systematic, transient premium. Specifically, the model includes an auto regression parameter λ to reflect the rate of profit convergence, and a parameter π_j to represent the long-term equilibrium level. Values of λ close to zero imply that any short-term rents quickly erode, while values close to one indicate that returns converge relatively slowly to their equilibrium level π. In competitive environments convergence rates will be high and the λ's will be close to zero. We performed the analyses for ROA as well as for ROA in excess of its industry average to correct for a possibly disturbing effect of evolving industry performance[30]. We estimate the model on the pooled set of firms and years as well as on 5-year rolling windows over the sample period 1954-2004.

Dynamics of superior performance. The dynamics of superior business performance are analyzed using the stratification method developed by Ruefli and Wiggins[31]. Their method analyzes performance rankings of firms within industries over five subsequent years to arrive at a stratification of firms into superior, modal and sub modal classes in the sixth year. Firms that maintain a position in the superior stratum for at least six consecutive windows are declared persistently superior performing. Using this stratification method, we analyze the patterns of persistent and transient superiority over time. In a competitive context the fraction of persistently superior performing firms is expected to decrease in favour of the proportion of transiently superior firms towards the end of the sample period. Moreover, we study the duration of superior performance periods τ (in years) for all firms with superior positions for at least one year, using non-

[29] Mueller, *Profits in the long run*, *op. cit.* (see note 3)
[30] See, e.g., Mueller, *Profits in the long run*, *op. cit.* (see note 3); and Waring, *The American Economic Review*, *op. cit.* (see note 24).
[31] Ruefli, Timothy W., Robert R. Wiggins. 2000. Technical note: Longitudinal performance stratification. an iterative Kolmogorov-Smirnov approach. *Management Science* **46**(5) 685–692.

parametric life tables and parametric failure time (hazard) models[32]. If competition is intense, then the estimated expected duration of persistent superior performance τ is expected to decrease.

Stability of performance strata. So far, the discussion of performance stratification has focussed on the persistent behaviour of the superior stratum. However, firms migrate from one stratum to another thus marking performance patterns over time, which go unobserved by the isolated analysis of *SP* periods. This migration process can be conveniently monitored when interpreting annual performance stratifications as realized state distributions of a Markov-chain process. Strategy literature contains but few analyses of this type, despite their early support by Nelson[33].

Various indices have been proposed to measure the mobility of firms in moving from one performance stratum to another, which are all are all derived from the estimated transition matrices. First, the sojourn time S_1 has been used to measure the expected length of stay in the superior performance stratum[34]. The larger S_1, the higher the expected persistence of superior performance positions. If competition intensifies, the migration of firms between strata increases and sojourn times become shorter, particularly for the superior performance stratum. Secondly, we take the estimated equilibrium probability to migrate to the superior performance stratum π_1. The higher this probability, the more competitive the superior stratum, and the more difficult it becomes to maintain superior positions. Low equilibrium probabilities π_1 are expected to go along with longer sojourn times for incumbent firms in the superior stratum. Thirdly, we use the reciprocal of the harmonic mean of sojourn times in all strata M_P to indicate overall mobility[35]. The larger the probability that firms remain in their performance stratum, the closer the index M_P to zero. Low M_P values thus indicate stable performance

[32] See, e.g., Neumann, George R. 1999. Search models and duration data. M. Hashem Pesaran, Peter Schmidt, eds., *Handbook of Applied Econometrics*, vol. II: Microeconomics. Blackwell Publishers Ltd, Oxford, 300–351; Lawless, J.F. 1982. *Statistical Models and Methods for Lifetime Data*. John Wiley & Sons, Inc.

[33] Wiggins and Ruefli, *Organization Science*, *op. cit.* (see note 23); Nelson and Winter, *An evolutionary theory of economic change*, *op. cit.* (see note 14); Fiegenbaum, Avi, Howard Thomas, and Ming-Je Tang. 2001. Linking hypercompetition and strategic group theories: Strategic maneuvering in the US insurance industry. *Managerial and Decision Economics* **22**(4,5) 265.

[34] Prais, S.J. 1955. Measuring social mobility. *Journal of the Royal Statistical Society*. Series A (General) **118**(1) 56–66.

[35] See, e.g., Shorrocks, A.F. 1978. The measurement of mobility. *Econometrica* **46**(5) 1013–1024.

stratifications, whereas high M_P values reflect intensive transition patterns, as typically found in hypercompetitive contexts. Fourthly, we use the second-eigenvalue index M_2 to indicate the changeability of firms across performance strata[36]. If the mobility index M_2 is low, then the transition behaviour converges slowly toward an equilibrium state, and persistent stratifications are more likely to occur. Alternatively, higher index values are indicative of more dynamic performance stratifications, in which superior position are less likely to persist.

The transition matrix summarizing the migration of firms from one stratification to another, has been estimated for the entire observation period as well as for 5-year rolling windows. Moreover, the transition matrix will be defined for performance stratifications based on three states (superior, modal and sub-modal) as well as on four states, including the entering and exiting firms. The latter transition matrix typically has a zero for the fourth diagonal element.

4 Analysis

4.1 Auto regression effects

The main results of the auto regression analyses are summarized in table 3, which gives (average) estimates of the persistence rates λ and long-term returns π (and their standard errors), tests of the absence of autoregressive effects (LR_0) and of the equality of fixed firm effects (F). Various insights into the persistence of profits can be obtained from these results.

Table 3 about here

First, we find that profits in the oil industry do convergence to some mean rate, though at a non-trivial speed. All estimated models reject the assumed absence of an autoregressive structure (the LR_0 test statistics are significant at a 0.1% level), while Dickey-Fuller tests

[36] See, e.g., Geweke, John, Robert C. Marshall, and Gary A. Zarkin. 1986. Mobility indices in continuous time markov chains. *Econometrica* **54**(6) 1407–1423.

systematically reject non-stationarity (λ=1) at the 0.1% level. These results similarly hold for the ROA-figures and for the abnormal return rates.

Secondly, the estimated persistence rates λ of the ROA models appear to be only slightly higher than those of the corresponding abnormal return models, which suggests that inferences about sustained performance are relatively robust against the performance measure used. The differences between corresponding estimated equilibrium rates π, about 4% points, are substantial, but are consistent with the definition of the abnormal return rates as firm performance in excess of industry average ROA. Overall, economy-wide estimated persistence rates are estimated equal to $\lambda = 0.672$, when ROA is used, and $\lambda = 0.660$, when abnormal ROA-figures are used. These estimates indicate fairly slow convergence, which is in line findings reported by Jacobsen and Waring[37].

Thirdly, the estimated persistence rates λ are seen to vary with the restrictions imposed on π and λ. Relaxing the assumption of a common equilibrium return rates, leads to lower (average) estimated λ's in all situations considered: estimated convergence is faster, when firm effects are considered. Likewise, equilibrium profit-rates systematically differ between firms as indicated by the significant *F*-tests in table 3.

Finally, the results suggest that performance patterns over the sample period contain strong firm-specific components. Models with firm-varying persistence rates λ_j are systematically preferred over models that restrict profit convergence to a common industry rate. For instance, examining the abnormal returns results in table 3, we find that the LR_1-tests to compare models with firm-varying and common persistence rates, strongly support the former: $LR_1 = 2281.23$ (=10709.61-8428.38), $df = 172$, $p < 0.001$. Also, Akaike's fit criterion gives the lowest values when estimating the models with firm-specific persistence rates and long-term performance levels (*AIC* = 8920.88 and 8950.38).

Figure 1 about here

In order to further examine the evolution of performance over time, we re-estimate the model for rolling 5-year windows over the entire observation period allowing both long-

[37] Jacobsen, *Strategic Management Journal*, *op. cit.* (see note 4); Waring, *The American Economic Review*, *op. cit.* (see note 24).

term abnormal returns and persistence rates to vary across industries. The estimated long-term abnormal profit rates and estimated persistency rates per time-window are depicted in figure 1.

Estimated long-term abnormal profit rates π are seen to differ substantially over time. Before the 70s, the long-term returns are seen to be negative. Then, at the start of the 70s the equilibrium profits sharply increase and, a few years later, equally sharply decline. In 1978, a second peak can be observed, which sustains about four years, and then drops again. The mid-90s show a small dip, followed by surging profit rates toward the turn of the millennium. The estimated persistence rates λ reveal similar variation. Before the 60s, high persistence rates close to one are observed meaning that abnormal profits hardly converged, consistent with the oligopolistic market structure in this period. During the second half of the 70s, the estimated persistence rates suddenly drops, which seems consistent with the industry changes during this period (see table 1). Considering the 40-year period from the mid 50s to the mid 90s, persistence rates are seen to fluctuate, but with a downward trend. Toward the end of the sample period persistence rates are seen to recover. The observed overall decrease of estimated persistence imply that the erosion of short term rents occurs at an increasing pace for all firms in the oil industry. At the same time, the marked deviations from this general tendency suggest that dynamic forces play a substantial role in the industry.

4.2 Patterns of superior performance

Application of Ruefli and Wiggins' stratification method leads to a classification of all firms into superior, modal and sub modal performing classes for all years in the observation period[38]. Based on this classification, fractions of persistently superior performing (PSP) and temporary superior performing (TSP) firms are determined for each each industry and year, which are depicted in figures 2 together with the number of firms (thick dashed grey line). The following observations are made.

Figure 2 about here

[38] Ruefli and Wiggins, *Management Science*, *op. cit.* (see note 31).

The percentage of persistently superior (PSP) firms gradually decreases from 12% in 1954 to about 2% in 1979 (mentioned years mark the start of 5-year windows). It then increases again to 10% in 1986, after which it declines again. The observed PSP pattern can be partly explained by the development of the total number of oil companies in our sample, which strongly increases during the period 1954-1979 (when the %PSP firms dwindles) and decreases during 1980-1986 (when %PSP firms recovers). After 1986, both the %PSP firms and the total number of firms decrease, which may be considered in support of increased of competition along with consolidation. Furthermore, the percentage of temporarily superior performing (TSP) firms reveals a saw tooth pattern, which oscillates between relatively stable bounds (roughly 0-10%) until 1988. After 1988, the percentage of TSP firm is seen to peak and to become higher than that of PSP firms. The latter may reflect competitive convergence, during which persistent superior performance gives way to temporary superior performance. Eventually, both the %PSP and the %TSP annihilate.

Table 4 about here

In addition, our analysis of the duration of performance superiority shows that the mean duration of superior performance (SP) periods is about 3.48 years (standard deviation 3.41 years). With a median duration of 2 years, the distribution of this duration is skewed to the right: a few firms have relatively sustained periods of superior performance. Tests of association between SP duration and time, measured by the starting year of the window, point at significantly negative dependencies: the Log-rank test ($\chi^2_{LR} = 5.485$, $p = 0.019$) and the Wilcoxon-test ($\chi^2_W = 5.381$, $p = 0.020$) are both strongly significant. Negative rank sums indicate that longer SP duration has become more infrequent in time than expected under independence. This result suggests that it has become more difficult for firms to maintain superior performance positions. It is also consistent with the previously observed downward trended persistence rates.

The results for the accelerated failure time models in table 4 are in line with these results. The significant negative effect of the year indicator (-0.021, $p = 0.007$) suggests that the duration of stays in the superior stratum has decreased over time. In fact, the

expected duration in '99 is found to be about 39% of that in 1954, which seems quite substantial. As this crude approach ignores more delicate performance patterns, we re-estimated the model using dummies for each decade roughly (with `90-`99 as the baseline period). The *Wald*-statistic assessing the effect of time on performance duration is mildly significant in the oil industry (*Wald* χ^2 = 8.468, p = 0.076), where the 90s reveal relatively shorter superior performance periods.

Table 5 about here

4.3 Mobility across performance strata

The dynamics of performance are further analyzed by means of transition matrices associated with the performance stratifications proposed by Ruefli and Wiggins[39]. Table 5 gives the transition matrices for the entire observation period, 1954-2004.

The dominating diagonal elements of the transition matrix indicate relatively high probabilities to remain in the current performance stratum. The related sojourn times are equal to 4.2, 14.6 and 6.8 years for the superior, modal and sub-modal stratum, respectively. The estimated sojourn time for the superior stratum is thus seen to be close to the previously determined mean SP-duration equal to 3.48 years. The probability to enter the superior stratum π_1 is 11.9%.

Figure 3 about here

Figure 4 about here

Estimation of the transition matrices for rolling five year windows gives rise to the following observations.

First, the estimated length of stay in the superior stratum S_1in figure 3 reveals a downward sloping trend with marked periods of sustained performance periods just before the 60s and towards the end of the 70s. Since the 80s, the sojourn times in the

[39] Ruefli and Wiggins, *Management Science*, *op. cit.* (see note 31).

superior stratum have decreased continuously. Secondly, the long-term probability to enter the superior performance stratum π_1 shows a wave-like pattern, which largely conforms the pattern of sojourn times. The general impression is that the unconditional probability to enter the top performance stratum peaks just before 1960, after which it becomes relatively low until the mid 70s. It increases again during the second half of the 70s, then decreases and ends with a relatively low peak in the second half of the 90s. Thirdly, the inverse mean length of stay in any stratum M_P points at slowly increasing mobility until a sudden drop during the mid 70s, after which mobility continues its gradual increase. Fourthly, the inverse convergence speed M_2 reveals a more evolving pattern. Mobility M_2 was low and decreasing until the end of the 60s, after which it suddenly increased until the first half of the 70s. During the late 70s mobility is again seen to sharply increase until the mid 80s, after which it fluctuates around a downward trend. Apart from a two-year period in the 80s, M_2 is everywhere below 0.2 suggesting relatively low rates of convergence and stable stratifications. In all, different indices reveal different mobility patterns over time, but all are fluctuating. The sojourn time S_1 and the long-term probability to enter the superior stratum π_1 reveal a similar downward trend and deviations thereof. The inverse mean sojourn time for all strata M_P shows a clear upward trend (overall sojourn times have shortened), while the convergence index M_2 reveals a cyclical pattern.

5 Discussion

5.1 Main findings

In this study, we have examined the long-run dynamics of business performance in the oil industry for a comparatively long period, 1954-2004. Our study of the dynamics of performance convergence, superior performance persistence, and stability of performance strata has generated various results that support and complement theoretical perspectives and previous empirical studies. We shall briefly discuss these findings along the three sets of research questions.

Firstly, our longitudinal analysis of profit persistence shows that the persistence rate fluctuates over time with a marked drop during the second half of the 70s and a

declining overall trend. The long-term (abnormal) profit rates evolve more gradually showing peaks during the first half of the 70s and 80s. A similar fluctuation of persistence rates has been found by McNamara et al., while declining persistence rates have been reported by Thomas and D'Aveni[40]. The latter show that the decline is mostly concentrated in the 1970s with relatively stable persistence rates before 1970 and moderate decreases after 1980.

Secondly, exploring the persistence of superior performance over time, we find that the (average) percentage of firms achieving persistent superior performance fluctuates over the research period. Overall, the percentage of firms achieving persistent superior performance decreases from 12% in '54 to 2% in '79 and 0% in '93. During the late 80s this percentage is seen to increase to about 10%. The percentage of firms achieving temporarily superior performance fluctuates throughout the sample period. Our finding that the duration of superior performance periods shortens is in line with Wiggins and Ruefli[41].

Thirdly, our analysis of the mobility of firms across performance strata points at a trended increase of mobility. Mild evidence of such trends can be observed for the sojourn time in the superior performance stratum, the probability to enter the superior stratum and somewhat stronger evidence for the inverse mean stratum residence. But for the convergence toward equilibrium, periods of decreasing mobility are separated by periods of high convergence speeds. In addition, the mobility of firms across performance strata is seen to fluctuate over time, confirming Gimeno and Woo and McNamara et al.[42].

Although different methods of analysis are used, yielding a variety of detailed results, there seems to be conformity with respect to the main features of long-term performance dynamics: business performance evolves over time through phases of increase and decrease with an overall downward trend. The cyclicality of superior performance, which has previously been found in auto regression analyses[43], thus also can be observed in the mobility patterns of firms across performance stratifications. The

[40] McNamara, Vaaler and Devers, *Strategic Management Journal*, *op. cit.* (see note 5); and Thomas and D'Aveni, *op. cit.* (see note 22).
[41] Wiggins and Ruefli, *op. cit.* (see note 2).
[42] Gimeno, J., and C.Y. Woo. 1996. Hypercompetition in a Multimarket Environment: The Role of Strategic Similarity and Multimarket Contact in Competitive De-Escalation. *Organization Science* **7**(3) 322–341; and McNamara, Vaaler and Devers, *Strategic Management Journal*, *op. cit.* (see note 5).
[43] McNamara, Vaaler and Devers, *Strategic Management Journal*, *op. cit.* (see note 5).

shortening of superior performance periods[44] is found to have a parallel in the downward trended persistence rates from auto regression approaches. The observed fluctuation of performance patterns seems generally consistent with the cyclical dynamics asserted by the Austrian school of economics[45]. But in the Austrian perspective such fluctuation is ascribed to innovation and imitation. In the oil industry, cyclicality also is politically induced, which seems more consonant with institutional economics and industrial organization.

5.2 Interpretation

Parallel to the cyclicality of business performance we observe different structural changes taking place in the industry (see table 1), inducing changes in competitive regimes favouring different firms. Firstly, the nationalization of crude oil reserves of international oil companies in the 70s illustrates an important structural change in the global oil industry, ending the era of the oligopoly of the 'Seven Sisters.' This nationalization ended the periods of persistent superior performance of 'Seven Sister' companies like Chevron and Texaco. Because of the possession of crude oil reserves, various newly established national oil companies were able to achieve persistent superior performance, for example, Petrobras and PDVSA. As crude oil reserves constitute a key competitive advantage, the transfer of these resources from international oil companies to national oil companies, meant a revolution in competitive positions. Secondly, structural changes, through their impact on oil price, have influenced the critical success factors for oil companies. High oil prices induce exploration of new reserves, while low prices force firms to focus on efficient exploitation of current reserves. Low prices discourage exploration of new fields and encourage industry consolidation. The discovery of large fields (outside OPEC territory) in the high price era of the 1970s was another main structural change in the oil industry during the research period. For instance, discoveries in the North Sea and Alaska marked the beginning of new periods of persistent superior performance for respectively the international oil companies Petrofina and AMOCO. Thirdly, industry consolidation in terms of mergers and acquisition waves among international oil companies may have had a negative impact on superior performance. For instance, the wave of 'mega mergers'

[44] Wiggins and Ruefli, *op. cit.* (see note 2).
[45] See, e.g., Jacobsen, *Academy of Management Review*, *op. cit.* (see note 15).

starting in 1998 coincided with the decimation of the superior performance stratum and the elimination of persistent superior performance.

5.3 Limitations and suggestions for future research

Our study may be criticized for several limitations. Firstly, our sample is limited to Fortune Global 500 firms from the global oil industry. This has the advantage of a long sample period and more in-depth analysis, but at the same time it limits the extent to which our findings can be generalized. Secondly, we have used ROA as our performance measure, which exclusively relies on accounting profits. This has been motivated by data considerations and has numerous antecedents in the literature, but it clearly also affects the robustness of our findings. Future research exploiting even more extensive data sources should include alternative value-based measures, like Tobin's Q or economic profit per dollar capital employed[46], to broaden insight into the dynamics of business performance. Thirdly, in our analyses we have applied existing parametric methods (such as auto regression) and non-parametric methods (such as the IKS approach) to assess the long-term dynamics of business performance. These methods have been subject of extensive debate between McGahan and Porter and Ruefli and Wiggins[47]. Although the simultaneous application of these methods in a single study allows one to compare the empirical results obtained with each of them, there clearly is a need for research into the theoretical relations between these methods and maybe even for entirely new approaches as suggested by McGahan and Porter[48]. Fourthly, this study is biased towards superior performing firms, although the mobility analyses are concerned with all performance strata including entering and exiting firms. Future research may extend to the performance patterns of low performing firms and exiters[49]. Fifthly, although we have examined the dynamics of performance, we did not analyze the causal mechanisms underlying the dynamics of performance.

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[46] See, e.g., McGahan, *Journal of Industrial Economics*, *op. cit.* (see note 26); Wiggins and Ruefli, *Organization Science*, *op. cit.* (see note 23); and Hawawini, Subramanian, and Verdin, *Strategic Management Journal*, *op. cit.* (see note 25).

[47] Ruefli and Wiggins, *Strategic Management Journal*, *op. cit.* (see note 21); and McGahan and Porter, *Strategic Management Journal*, *op. cit.* (see note 8);

[48] McGahan and Porter, *Strategic Management Journal*, *op. cit.* (see note 8);

[49] McGahan and Porter, *Strategic Organization*, *op. cit.* (see note 24); Gschwandtner, *Applied Economics*, *op. cit.* (see note 20)

Appendix A: Methods

This appendix provides detail about the methodologies applied.

Dynamics of performance convergence. Performance convergence is analyzed with Mueller's[50] auto regression model, which specifies firm *j*'s (abnormal) returns r'_{tj} in year *t* as: $r'_{tj} = \mu + \nu_j + \varepsilon_{tj}$, where μ is the competitive return common to all firms, ν_j a systematic firm rent, and ε_{tj} a non-systematic, transient premium, $\varepsilon_{tj} = \lambda_j \varepsilon_{t-1,j} + \eta_{tj}$ with $\eta_{tj} \sim \text{iid}(0,\sigma^2)$. The auto regression parameter λ_j reflects the rate of profit convergence and π_1 the long-term equilibrium level. The model is estimated on the pooled set of all firms and years in the sample period 1954-2004, as well as on rolling 6-year windows. Firms with less than 6 years of ROA-information are excluded from the analysis in order to have sufficient information to estimate firm λ_j's. All models are estimated by maximum likelihood, rather than OLS, to preserve the initial observations of each firm's ROA-series and to obtain efficient estimates of λ_j and π_j. Specification tests include a Dickey-Fuller[51] single mean test of stationarity (λ_j=1), Likelihood-Ratio (LR_0) tests of the appropriateness of the autoregressive assumption (λ_j=0, $\varepsilon_{tj} = \eta_{tj}$, the so-called null model), Likelihood Ratio (*LR*)-tests of other restrictions on the persistence rate (needed, for instance, when evaluating the assumption that all competitors within industries share a common rate of convergence), and multiple *F*-tests to evaluate the contribution of fixed firm and industry effects. Denominator degrees of freedom of the F- and t-statistics are based on a correction proposed by Satterthwaite[52].

Dynamics of superior performance. The analysis of performance superiority is based on a stratification methods developed by Ruefli and Wiggins[53], which yields a classification of firms into superior, modal and sub modal. Firms remaining in the superior stratum for at least six consecutive windows are declared persistently superior. The fraction of superior performing firms in the industry is used to explore the evolution of persistent superior performance over time. Moreover, the duration of superior

[50] Mueller, *Profits in the long run*, *op. cit.* (see note 3).
[51] Dickey, David A., and Wayne A. Fuller. 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* **74**(366) 427–431.
[52] Satterthwaite, F.E. 1946. An approximate distribution of estimates of variance components. *Biometrics Bulletin* **2**(6) 110–114; Giesbrecht, F.G., and J.C. Burns. 1985. Two-stage analysis based on a mixed model: Large-sample asymptotic theory and small-sample simulation results. *Biometrics* **41**(2) 477–486.
[53] Ruefli and Wiggins, *Management Science*, *op. cit.* (see note 31).

performance periods, denoted τ_j, is analyzed with non-parametric life tables and parametric failure time (hazard) models[54], for all firms with a superior position for at least one year. Non-parametric log-rank and Wilcoxon tests are performed to examine whether duration patterns are homogeneously distributed across industries. Accelerated failure time models are applied to obtain parametric estimates of the distribution of superior performance duration assuming duration τ_j log-normally distributed. The log-normal distribution gave a better fit than the often-used Weibull, and behaved slightly better than the more general gamma distribution. Differences with the log-logistic distribution were small, and the consequences for the results are negligible. All models are estimated by maximum likelihood. Censored observations consisting of unfinished periods of superior performance at the closure of the observation period, have been taken into account.

Stability of performance strata. The stability of performance strata is analyzed with mobility indices based on the properties of strata transition matrices. Let $\mathbf{x}_t = (x_{1t}, \ldots, x_{s,t})'$ summarize the distribution of the number of firms over *s* performance strata in any year *t*, then the next period's performance stratification $\mathbf{x}_{t+1}$ is obtained as $\mathbf{x}'_{t+1} = \mathbf{x}'_t\mathbf{P}$. The s *x* s transition matrix **P** summarizes the conditional probabilities p_{ij} of moving from stratum *i* to stratum *j*; $\Sigma_j\, p_{ij} = 1$ for all originating strata *i*. Future behaviour of the process is completely determined by this one-period transition matrix. Assuming convergence, the long-run equilibrium stratification follows as $\boldsymbol{\pi}' = \lim_{n\to\infty} \mathbf{x}'_{t+n} = \mathbf{x}'_t \lim_{n\to\infty} \mathbf{P}^n = \mathbf{x}'_t\, \boldsymbol{\Pi}$, with $\boldsymbol{\Pi} = \boldsymbol{\iota}\, \boldsymbol{\pi}'$, a transition matrix with rows equal to the equilibrium distribution. In equilibrium, $\boldsymbol{\pi}' = \boldsymbol{\pi}'\, \mathbf{P}$ implying perfect mobility. The transition matrix **P** has been estimated using the observed transitions for the entire observation period and for 5-year rolling windows. Moreover, the transition matrix has been defined for performance stratifications based on three states (superior, modal and sub-modal); including a fourth state to cope with entering and exiting firms gives very similar results and has therefore not been covered in this paper.

Various mobility indices can be derived from the estimated transition matrix and the associated equilibrium stratification. The properties of these indices have been

[54] See, e.g., Neumann, Search models and duration data, *Handbook of Applied Econometrics*, *op. cit.* (see note 32); and Lawless, *Statistical Models and Methods for Lifetime Data*, *op. cit.* (see note 32).

explored by Geweke, Prais, and Shorrocks[55]. We briefly define the indices mentioned in the text: (1) sojourn time in the superior stratum $S_1 = 1/(1-p_{11})$; (2) the probability to migrate to the superior stratum in equilibrium π_1; (3) the reciprocal of the harmonic mean of sojourn times in all strata $M_P = (s - \Sigma_i p_{ii})/(s-1)$; and (4) the second-eigenvalue index $M_2 = 1 - |\lambda_2|$, where λ_2, the second eigenvalue of **P**, indicates the speed of convergence of **P** to the equilibrium π. Other mobility indices have not been included: the unconditional probability of leaving the current performance stratum M_U, and Bartholomew's index M_B indicating the expected number of strata passed when moving from a particular state; the eigenvalue index M_E, which is identical to M_P when eigenvalues are all real and non-negative; and the determinant index M_D which is not practical when eigenvalues can be zero. Also, the entropy-like measure $M_R = \Sigma_i \Sigma_j\ p_{ij} \ln p_{ij} / s \ln s$ proposed by Ruefli and Wilson and Collins and Ruefli has not been included[56].

[55] Geweke, Marshall and Zarkin, *Econometrica*, *op. cit.* (see note 36); Prais, *Journal of the Royal Statistical Society*, *op. cit.* (see note 34); and Shorrocks, *Econometrica*, *op. cit.* (see note 35).

[56] Ruefli, TimothyW., Chester L.Wilson. 1987. Ordinal time series methodology for industry and competitive analysis. *Management Science* **33**(5) 640–661; and Collins, James M., and Timothy W. Ruefli. 1992. Strategic risk: An ordinal approach. *Management Science* **38**(12) 1707–1731.

Table 1. Main structural changes affecting the competitive regime in the oil industry

Period	*Main structural changes*	*Regime*
50s - 60s	Oil producing countries found OPEC in 1960. Organization subsequently expands. Relatively low crude oil prices	Oligopoly of vertically integrated international oil companies (IOCs): Exxon, Royal Dutch Shell, Texaco, Gulf, Mobil, Chevron, BP (Seven Sisters) dominates by privileged access to crude oil reserves.
70s	OPEC oil producing countries (OPEC) nationalize crude oil reserves and establish national oil companies (e.g. Saudi-Aramco, Petrobras); OPEC oil embargo leads to first oil crises '73; IOCs diversify into non-oil businesses and explore new sources outside OPEC territory (e.g., North Sea and Alaska); Iranian revolution causes second crisis in `78; both oil crises lead to sharp rise of crude oil price	OPEC dominates. Increase of competition from national oil companies and new entrants. Focus on exploration of new crude oil reserves, outside OPEC. Also diversification outside oil industry.
First half 80s	Increased supply from non-OPEC sources leads to crude price decrease from 1980; M&A's among international oil companies (e.g., 1984 takeovers of Getty Oil by Texaco, and Gulf by Chevron); mid 1980s: sharp fall of crude price	OPEC under pressure. Industry consolidation among international oil companies
Second half 80s - late 90s	Collapse OPEC quota system in '86; era of low prices; international oil companies focus on cost reductions and exploit existing reserves	Focus on exploitation / efficiency
Late 90s - early 2000	Downward pressure on price causes another consolidation wave among international oil companies (e.g., 1998: BP acquires AMOCO, Exxon acquires Mobil, 2000 Chevron merges with Texaco); after price nadir in 1998 sharp rise due to increased demand from emerging counties, China and India, and from recovering US and Japanese economies; oil supplies increasingly constrained	Consolidation. Focus on exploration.

Table 2. Summary of main theoretical perspectives on the research questions

Theoretical perspective	*Dynamics of convergence*	*Dynamics of superior performance*	*Mobility across performance strata*
Neoclassical economics	Strong convergence	PSP not feasible	High mobility
Hypercompetition model	Strong convergence	PSP not feasible, only temporary competitive advantages	High mobility
Institutional economics	Strong convergence	PSP not feasible, institutional isomorphism	High mobility
Evolutionary economics	Convergence weak if concatenation of temporary competitive advantages based on routines	PSP feasible if concatenation	Low mobility if concatenation
Dynamic capabilities perspective	Convergence weak if concatenation of temporary competitive advantages based on dynamic capabilities	PSP feasible if concatenation	Low mobility if concatenation
Austrian school of economics	Cyclical convergence: convergence rate fluctuates over time due to entrepreneurial innovation and imitation	PSP feasible, Schumpeterian rents	Mobility fluctuates over time
Industrial organization economics	Weak convergence	PSP feasible; monopoly rents, sustainable competitive advantage	Low mobility
Positioning school of strategic management	Weak convergence	PSP feasible; monopoly rents, sustainable competitive advantage	Low mobility
Resource based view of the firm	Weak convergence	PSP feasible; Ricardian rents, inimitable and non-substitutable resources	Low mobility

Table 3. Overall auto regression results (*n*=1973)

Levels of random and fixed effects		Overall likelihood fit results		LR_0-test results for equality random effects			F-test results for equality fixed effects				Means of estimates and S.E.'s of π and λ			
Random, λ_j	Fixed, π_j	-2ln *L*	*Aic*	χ^2	*df*	sig.	*F*	df_1	df_2	sig.	Avg π	S.E. π	Avg λ	S.E. λ
Estimation results for models based on ROA														
Pooled	*Pooled*	11074.33	11080.33	1180.401	1	0.000	342.176	1	242.3	0.000	4.623	0.250	0.672	0.016
Pooled	*Firm*	10838.25	11016.25	584.069	1	0.000	13.155	87	353.2	0.000	4.325	1.738	0.509	0.019
Firm	*Pooled*	8886.07	9236.07	2265.593	174	0.000	1492.802	1	4.8	0.000	2.019	0.052	0.659	0.153
Firm	*Firm*	8398.88	8920.88	3023.441	173	0.000	61.549	87	2.5	0.007	4.346	1.124	0.339	0.230
Estimation results for models based on ROAPI														
Pooled	*Pooled*	10942.54	10948.54	1127.065	1	0.000	0.272	1	250.7	0.603	-0.122	0.234	0.660	0.016
Pooled	*Firm*	10709.61	10887.61	549.695	1	0.000	4.099	87	360.3	0.000	-0.325	1.646	0.497	0.019
Firm	*Pooled*	8791.47	9141.47	1322.647	174	0.000	180.997	1	3.7	0.000	-0.776	0.058	0.642	0.163
Firm	*Firm*	8428.38	8950.38	2830.926	173	0.000	22.739	87	2.3	0.030	-0.315	1.091	0.349	0.237

Table 4. Analysis of superior performance duration*

	Time via start year	*Time via decades*
Intercept	41.522	0.231
	(0.006)	(0.435)
Start year	-0.021	-
	(0.007)	
Period '54-'59		0.967
		(0.010)
Period '60-'69		0.863
		(0.019)
Period '70-'79		0.843
		(0.027)
Period '80-'89		0.569
		(0.092)
Scale	0.732	0.725
N	56	56
Censored	0	0
Log Likelihood	-61.977	-61.453
Wald's χ^2 ($df = 4$)		8.468
		(0.076)

* Significance levels between parentheses
** Wald's χ^2 tests the equality of decade effects; '90-'99 is the baseline period.

Table 5. Transition matrix and mobility indices, entire sample period 1954-2004

	To stratum		
From stratum	*High*	*Mid*	*Low*
High	0.760	0.213	0.027
Mid	0.036	0.931	0.033
Low	0.019	0.127	0.854
	Associated mobility indices		
π_i	0.119	0.702	0.179
S_i	4.159	14.585	6.848
M_P	0.228		
M_2	0.178		

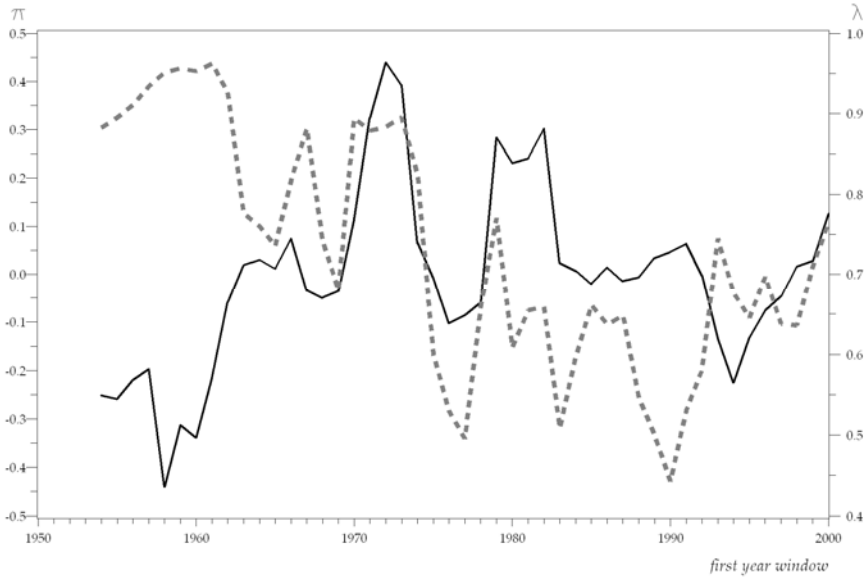

Figure 1. Estimated π (solid) and λ (dashed) for rolling 5-year windows

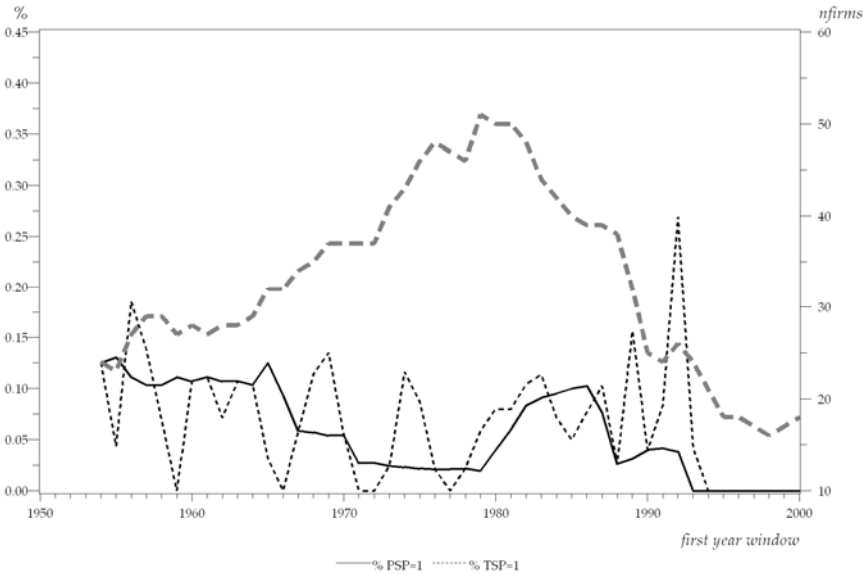

Figure 2. Fractions of PSP and TSP firms for rolling 5-year windows

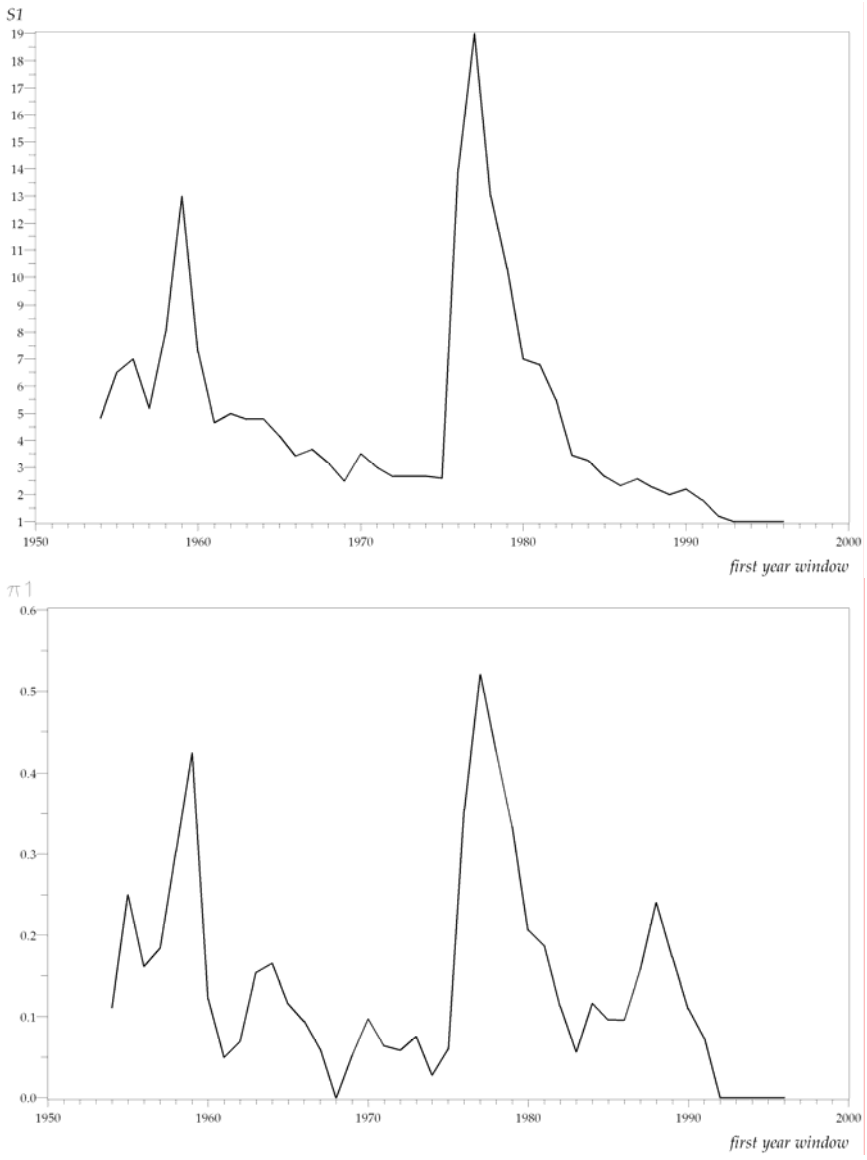

Figure 3. Mobility indices S_1 and π_1 through time for rolling 5-year windows

Figure 4. Mobility indices M_P and M_2 through time for rolling 5-year windows