

Earnings Persistence in the IT Sector

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Abstract

I analyze the stochastic properties of three measures of profitability for the Information Technology Economic Sector using a balanced panel of disaggregated US Information Technology (IT) firms during the period 1995-2009. I use three measures of profitability, return on assets (*ROA*), return on equity (*ROE*), and return on investment (*ROI*), employing a panel unit-root approach, which assists in identifying competitive outcomes versus non-competitive conditions stemming from new innovation and discriminant pricing practices prevalent in many segments of the IT sector. I disaggregate the sector into five segments and examine the data for cross-sectional dependence. After controlling for cross-sectional dependence, I apply Pesaran (2007) unit root (CIPS test) and find that profitability persists across segments. Our findings do not produce compelling evidence in support of the long-standing “competitive environment” hypothesis originally set forward by Mueller (1977).

JEL classification numbers: C23, D22, L25

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1 Introduction

Competitive environment is the necessary condition of the neoclassical theory of the firm. Free markets are assumed to facilitate efficient allocation of economic resources based on the self-regulating construct of competition through market pricing mechanism. Free market operation fueled by the investors’ desire for higher returns, provides more financial resources to the firms with higher returns. Profitability of the firm is the single most important source of investors’ value. That is, the level of investors’ wealth maximization is closely dependent on the level of firm’s profitability. Firm’s profitability, over an extended period of time, provides the shareholders with the source of additional wealth, i.e., firm’s dividends paying ability and maximization of the market value of the firm.

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According to neoclassical economic theory, firms cannot continuously earn economic rents in a competitive setting. That is, excess earnings are not sustainable over an extended period of time in a competitive environment. Therefore, excess profits are expected to be transitory effects, caused by shocks that dissipate over time and culminate in the reversion of profits to an equilibrium level, i.e., profit series are stationary processes and revert to the mean. However, research findings indicate that firms exhibit heterogeneity. That is, industries display substantial and persistent differences in productivity [42], innovation [21], skill compositions and wages [25], profitability [40], and so on. Persistent differences across firms reflect the characteristics of the industry, such as industry concentration and industry elasticity of demand. Profits persist because significant barriers to entry exist [7].

The persistent profits stem from firm's operational efficiency and dominant market share. Such persistence in profit continues only if sufficient barriers insulate firms from competitive forces. Varian [57] provides an overview of pricing strategies employed by IT firms. He observes that cost structure in technology firms may be characterized with high fixed and low marginal cost. Such a production cost structure can contribute to a significant market power through pricing of the products allowing the firm to differentiate prices based on customer segments. Firms may gain market share using pricing strategies, e.g. penetration pricing, differential pricing, bundling, product line pricing, etc., given the low marginal cost of the product. Conceivably, a firm can generate excess profit in the long-run if the firm is able to retain its dominant share of the market, which seems plausible for IT firms given the lock-in mechanism through the "network effect" and high switching cost. It should be noted that economic rent stemming from the low marginal cost and the market share advantage may dissipate as a result appearance of new and innovative entrants in a rapidly growing market [33].

The remarkable decline in prices of semiconductors since 1994 and significant decline in the cost of memory and logic chips have reduced the marginal production cost of computers and communication equipment. The decline in marginal cost of computers and communication equipment, with the largest application of semiconductor technology, has significantly impacted their utilization of economies of scale as well as the demand for computer and communication hardware. This in turn has stimulated the demand for other information technology segments, i.e., programming and consulting services and application software.

The origin of the U.S. information-technology industry can be dated from the invention of the transistor in 1947. However, the critical core of the industry was shaped in the 1980s with the introduction of personal-computer technology to the mass market. Since the 1980s, historically unprecedented technological innovations have occurred in the information industry that has had an impact across all sectors of the US economy. Jorgenson [31] suggests that the growth of productivity in IT sector and sharp decline in prices provide a powerful incentive for other sectors to substitute IT output for other forms of productive input.

Jorgenson [31] shows that output of the IT sector as a percentage current dollar Gross Domestic Product, has continually increased over the past few decades in spite of declining IT prices. Various segments of the IT sector have realized the benefits of the significant decline in semiconductor technologies. Jorgenson notes that computer output prices have declined less rapidly than prices of semiconductor since logic chips and memory chips account for less than 50 percent of computer cost. Flamm [14] observed a similar decline in the communication equipment to that of computers.

Jorgenson [31] also shows much faster growth in software segment than in computer and communication segments with a similar but smaller price decline than hardware outputs. The demand for software has grown much faster than other segments of IT since the early 1980s and software prices began to decline in 1988, albeit at a much slower rate than that for hardware. An important issue in the literature of persistence of profits is the definition of industry. IT sector may be disaggregated into five segments: hardware, telecommunications and electronic equipment, software, data processing services, and semiconductors.

Packaged software whether sold or licensed for download has very minimal or close to zero marginal cost of production, carrying and ordering cost of inventory, and physical constraint but significant development cost. Other non-standardized software products, specialized use or specific application, whether customized or internally developed, are also costly to create and maintain. The software product characteristics enable the firms to generate excess profits by maintaining their competitive dominance through innovative system design and specifications, high switching costs, network marketing, bundling, versioning and contracting. Computers and communication equipment firms, on the other hand, may not be able to maintain their market shares as easily, given the imitators' accessibility to the physical product and what Christensen [12] calls "disruptive technologies," where a new entrant introduces a lower quality and or lower price substitute or create new technologies that diminishes the excess profits of the dominant firm.

Shumpeter [52] suggestion that "a first success will always produce a cluster" has much relevance to the information technology firms whereby "new combinations of productive means", i.e., existing technologies and innovations, are likely to result in new and or functionally improved software and hardware. Shumpeter and Christensen provide credence to the dynamic view of the "competitive environment" hypothesis as oppose to the static view of competition. The dynamic view, which links to the work of Schumpeter [52], focuses on the characteristics of the firms and their innovative capacities in particular. Innovations create monopoly as firms benefit from their "first mover" advantages (e.g., [54]; [34]) and increase their market power over time [23].

The IT market is characterized by the ease of entry as imitators and innovators, with access to open source for software development and low marginal cost of hardware production, are able to penetrate the market and erode the excess profit of existing firms [57]. Furthermore, many firms in various IT segments are *not* constrained by physical limitations relative to production components, storage, and distribution faced by producers within other economic sectors. This was evidenced in the 1990s "dot com" boom as indicated by the significant increase in the number of IT companies listed on the National Association of Securities Dealers Automated Quotations [57].

However, monopolistic pricing strategies may not be as effective in the long-run as the supply of IT products/service creativity becomes increasingly more elastic and the sector is less subject to regulation or discriminatory policies. As such, the economic rents attributable to initial innovation by the "first mover advantage" is expected to dissipate over time. On the other hand, subsequent creativity or innovations by existing competitors may limit or prevent the success of new entrants.

The "competitive environment" hypothesis characterizes the dynamics of firm profits as a stationary, mean-reverting, stochastic process [40]. In theory, entry and the threat of entry eliminates such abnormally high profits, while firms that make abnormally low profits restructure or exit the industry. Although the process of "creative destruction" should drive all firms' economic profits toward zero, the "first-mover" advantages and other

entry and exit barriers may protect existing firms. As such, the dynamic view is consistent with non-zero economic profits at different points in time [7]. Perhaps the new and unexplored creative aspects of the information technology sector simultaneously brings about new entrants that innovate, as the first mover generates economic rents, while other new entrants imitate and produce lower priced substitute or functionally superior alternative products, hence eroding the market power of the existing firms in the long-run. The existing literature on profit persistence generally follows the mean-reverting view of firm profits. However, if firm profits exhibit random-walk or hysteric behavior (i.e., profits evolve as a unit-root, non-stationary, integrated process), shocks affecting the series exhibit permanent effects, shifting equilibrium profit from one level to another. Evidence on the stochastic properties of profitability also possesses well-defined implications for econometric modeling and forecasting. Failure to reject the dynamics of firm profits as a stationary, mean-reverting, stochastic process potentially implies that profitability exhibits a long-run co-integrating relationship with other firm-level data. The methodology typically applied to analyze persistence of firm profits uses a firm-level first-order autoregressive model.² Cable and Jackson [6] suggest the stability of the AR(1) model parameter should be examined systematically.³

I examine the profitability data for 345 firms within Information Technology sector, Compustat's classification of the Information Technology economy sector 8000 (*ECNSEC*), for the period of 1995-2009. Using Compustat's industry description, I disaggregate the data into five (5) segments and test for cross-sectional independence, and to examine whether return series are stationary and mean-reverting over the study period using Pesaran [47] panel data CD test and CIPS test. Then, I examine the profit series for fifteen different industries within IT sector as identified by compustat's industry codes. A unit-root process imposes no bounds on how a variable moves. If firm profits really conform to random-walk processes, then these profits are also non-predictable. This, however, is problematic for econometric and financial modeling.

The rest of the paper is organized as follows. After a brief review of relevant literature dealing with profit persistent and panel unit-root tests that assume cross-section independence in section 2, I describe the sample and outline some of the conventional testing procedures and describe the approach developed by Pesaran [47] to test for cross-section independence (*CD* test) and to test for panel unit roots with cross-section dependence (*CIPS* test) in Section 3. Section 4 reports the empirical results from the application of the panel data unit-root test proposed by Pesaran [47]. Section 5 reports two sets of robustness checks of segment. First, I consider whether the unit-root results are sensitive to outliers. I examine the winsorized data series to replicate our analysis without the effects of outliers. Second, I consider whether the unit-root test results are sensitive to the selection of the sample period. Recent events may indeed play a crucial role in our

²The AR(1) model incorporates the idea that competitive mechanisms need some time to erode the excess profits generated by short-run rents (Mueller, 1986). Geroski (1990) justifies the autoregressive specification theoretically as a reduced form of a two-equation system, where firm profits depend on the threat of entry into the market, and the threat, in turn, depends on the profits observed in the last period.

³The speed of mean reversion also plays a role. For example, if it takes 50 years for the return to the competitive profit rate, where entry and exit of firms disappears, then as a practical matter the industry does not effectively conform to a competitive environment.

understanding of the dynamics of profits. I construct a “pre-2007” sub-sample and investigate whether the global financial crisis and the Great Recession affected our findings. The conclusions are presented in Section 6.

2 Literature Review

Since the seminal contributions of Mueller [37], many others, such as [15];[53];[13];[41];[29];[44];[50];[33]; [58];[17]; find evidence of persistence of firm profits. Ball, Farshchi, and Grill [3] study examined the competition in the UK construction industry and segmented their sample into Contactors and Homebuilders and suggested that industry characteristics influence the firms’ profitability ratios. Godard and Wilson [18] compare the manufacturing and service segment firms and concluded that service firm profits persistence coefficient is slightly higher than manufacturers. Roberts [49] study suggests that the US Pharmaceutical industry’s persistence of profits is driven by the innovative propensity as well as demand characteristics and effective patent regime.

Lipczynsky and Wilson [35] summarize these studies and their findings. These findings are important because mean reversion assumption of earnings series have profound effect on the forecasting process, since forecasting based on a mean-reverting process proves quite different from forecasting based on a random walk process.

Partial evidence of unit root processes is reported by [32];[19];[22]; among others, using univariate tests, and [59];[5];[48];[1]; and [2] using a panel methodology.

More recent research, such as [23];[24];[55];[11];[38]; and [20]; among others, departs from the *OLS* autoregressive method. Gschwandtner [23], using a state space *AR*(1) model, finds time-varying profit persistence. Gschwandtner and Hauser [24], using a fractional integration method, report evidence of non-stationarity.

In this paper, I depart from the firm-level autoregressive approach and focus on testing for the existence of a unit root in a linear process. By using such tests rather than univariate tests, I combine information from time series with information from cross-section units, improving estimation efficiency and potentially producing more precise parameter estimates. Furthermore, panel unit-root tests possess asymptotically standard normal distributions. This contrasts with conventional time-series unit-root tests, which possess non-standard normal asymptotic distributions.

However, I should point out that the advantages of micro-econometric panels are often overstated, since such data exhibit many cross-section and temporal dependencies. That is, “*NT* correlated observations have less information than *NT* independent observations” [8]. Finally, most previous studies do not consider disaggregating the analysis to the segment levels (using the classification by Standard and Poor’s Compustat) and segmented data within IT sector. Our analysis performs the panel unit-root tests on five IT segments rather than across all firms in IT economic sector.

This paper contributes to the existing profit persistence literature in several ways. First, I deal with the low-power and size-distortion problems [36]; [56]; [46]; of conventional panel unit-root tests by employing the methodology developed by Pesaran [47] to perform a formal test of cross-section independence in panels, and to implement a test which explicitly models and corrects for cross-section dependence. Second, I use a large panel data of public firms in the US from 1995 to 2009 which covers a period of economic crises. Third, I partition the IT sector panel into five segments (Hardware,

Telecommunication and electronics equipment, Software, Service, and Semiconductors) and fifteen industries as suggested by Canarella,*et al.*[9]and examine the stochastic properties of profitability in each segment and industry. By stratifying by segment/industry, our profit persistence tests use the average segment/industry profit as the benchmark rather than economy-wide average profit. In other words, I measure firm profits as a deviation from the average segment/industryprofit. Since each segment, within IT sector, may exhibit a different level of competitive profit, our measure of profit makes it more likely that our tests will support the “competitive environment” hypothesis. Fourth, I measure profitability with three of the most extensively used measures: return on assets (*ROA*), return on equity (*ROE*), and return on investment (*ROI*). Most research in this field uses only data on returns on assets (*ROA*).

3 Data and Analyses

3.1 Data

I use annual data on 345 US firms belonging to all industries in the Information Technology economic sector (*ECNSEC* 8000) of the economy over the period 1995-2009.¹ The total number of firm-years is 5175. The source of the data is the Standard and Poor’s Compustat. Accounting return series are used in the analysis. The sample selection was based on availability of profit measures for the firm during the examination period, 1995-2009. Profitability is measured with three of the most extensively used measures of profitability return on assets (*ROA*), return on equity (*ROE*), and return on investment (*ROI*) [10].⁴*ROA* is calculated as net income divided by total assets, *ROE* as net income divided by common equity, and *ROI* as net income divided by total invested capital. All ratios use net income before extraordinary items in the numerator and are reported in percentages.

The sample is decomposed into five segments and fifteen industries, according to the Compustat classification of the Information Technology sector. I grouped IT industries into five segments to analyze intersegments properties of the earning series. Grouping of industries into segments were based on operational characteristics. As such, IT segments were defined as Computer Hardware, Software, Telecommunication and Electronic Equipment, Data Processing/Consulting/Services, and Semiconductors. Each segment includes 2-4 industries within IT sector. I also used industry classification for IT firms to

⁴These measures are computed as follows: Return on Assets: Income before extraordinary items available for common shareholders (IBCOM[item 237]), which equals income before extraordinary items and discontinued operations less preferred dividend requirements, but before adding savings due to common stock equivalents, divided by total assets (AT[item 6]), which equals the sum of current assets, net property, plant, and equipment, and other noncurrent assets. Return on Equity: Income before extraordinary items available for common shareholders(BCOM[item 237]) divided by common equity as reported (CEQ[item 60]), which equals the common shareholders' interest in the company. Return on Investment: Income before extraordinary items available for common shareholders (IBCOM[item 237]) divided by total invested capital (ICAPT[item 37]), which equals the sum of total long-term debt, preferred stock, minority interest, and total common equity. All returns are multiplied by 100.

complete our analysis of each industry. Segments (industries) and number of firms and the number of observations are shown in Table 1.

Table 1: Information Technology Sector Time Series Data - 1995-2009 Sample

Industry Code	Industry	# of Firms	# of Obs.
	Computer Hardware	32	480
8050	Computer Hardware	11	165
8052	Computer Storage & Peripherals	21	315
	Software	52	780
8110	Internet Software	5	75
8130	Application Software	31	465
8140	Systems Software	13	195
8190	Home Entertainment Software	3	45
	Communication/Electronic Equipment	118	1770
8030	Communication/Electronic Equipment	51	765
8150	Electronic Equipment & Instruments	63	945
8160	Office Electronics	4	60
	Data Processing/Consulting /Services	75	1125
8120	IT Consulting & Services	17	255
8180	Data Processing & Outsourced Services	16	240
8200	Electronic Manufacturing Services	24	360
8210	Technology Distributors	18	270
	Semiconductor	68	1020
8220	Semiconductor Equipment	27	405
8230	Semiconductors	41	615
	Total Information Technology Sector	345	5175

The largest group is the communication and electronic equipment segment with 118 firms and the smallest is the Computer hardware with 32 firms.

The pooled Mean, pooled Median, pooled Standard Deviation, Minimum, Maximum, Skewness, and Kurtosis for each of the three measures of profitability by segment are presented in Table 2. The data show issues related to outliers in the distributions across segments. That is, the median values prove much more stable across segments than do the mean values. Moreover, the standard deviations suggest significant variability in the distributions of profit measures, especially *ROE* and *ROI* for software segment.⁵

⁵All computations use Stata, version 13.

Table 2: Descriptive Statistics – Information Technology Segments

Segment	Mean	Median	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis
Panel A: Return on Assets (ROA)							
Computer Hardware	-4.228	3.825	37.408	-407.78	29.534	-6.127	51.704
Software	-4.279	3.733	48.921	-1165.74	66.497	-17.718	410.462
Communication/Electronic Equipment	-1.470	3.336	24.076	-458.31	41.29	-8.297	127.433
Data Processing / Consulting/ Services	2.759	4.331	12.161	-155.186	31.256	-4.181	37.770
Semiconductors	0.554	3.862	17.121	-154.071	60.213	-2.397	14.922
Panel B: Return on Equity (ROE)							
Computer Hardware	-15.242	6.62	107.536	-1259.87	86.510	-7.096	66.075
Software	-62.875	5.562	1364.312	-38000.00	163.25	-27.623	768.468
Communication/Electronic Equipment	-4.802	5.554	43.874	-608.429	301.867	-5.564	60.425
Data Processing / Consulting/ Services	4.422	9.518	32.094	-471.965	101.973	-6.477	73.964
Semiconductors	-2.560	5.827	45.047	-740.231	168.766	-7.477	96.760
Panel C: Return on Investment (ROI)							
Computer Hardware	-8.294	5.756	73.411	-971.601	76.000	-7.826	83.206
Software	-57.373	5.346	1362.377	-38000.00	143.782	-27.750	773.288
Communication/Electronic Equipment	-2.762	4.68	33.657	-559.35	81.402	-6.796	88.038
Data Processing / Consulting/ Services	4.167	7.441	23.442	-337.461	99.023	-5.787	63.829
Semiconductors	-0.417	4.976	28.148	-388.136	91.728	-4.657	47.616

The standard deviation, skewness and kurtosis for the Software segment are significantly larger than other segments and the mean for all three measures of profitability for this segment is significantly smaller than other segments. The software segment companies are mainly packaged software producers with standardized products and low marginal cost. The only segment with the positive mean and largest median across all three measures is the Data Processing/Consulting/Services segment. This segment provides computer system design and programming as well as computerized professional services and data processing.

Table 2 clearly illustrates the potential problems of aggregating all observations as opposed to partitioning them by segment. Not only do the empirical distributions vary substantially from segment to segment, the largest segment, in terms of number of firms, together with and the most profitable segment in the sample account for approximately 56

percent of the total number of firms. The remaining three may exert little, if any influence, on the results based on the entire sample.

I also examined the distribution of the data for each segment using Doornik-Hansen Normality Test. The results are presented in Table 3. As shown profit series for every segment are not normally distributed.

Table 3: Doornik-Hansen Normality Test χ^2

Information Technology Segments : 1995-2009 Sample			
Segment	ROA	ROE	ROI
Computer Hardware	5483 ***	8258 ***	8774 ***
Software	77735 ***	6.50e+05 ***	7.03e+05 ***
Communication/Electronic Equipment	1765 ***	5865 ***	8635 ***
Data Processing / Consulting/ Services	13364 ***	6608 ***	4209 ***
Semiconductors	587 ***	8058 ***	1694 ***

***. significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

3.2 Analyses

In a competitive environment the firms with new innovation will earn monopoly profits and entry of competitors and imitators will erode the excess profit. In a static competitive environment, the monopoly profits will be eroded and eventually disappear. However, assuming the firm continues with new innovations a permanent profit level that is constant over time may be maintained. Therefore, the profits of firm i for a given time period may be modeled as:

$$\pi_{it} = \pi_i + \mu_{it} \quad (1)$$

where π_{it} is current period profits for firm i , π_i the permanent rate of profit for the firm i and μ_{it} is the deviation of firm's current profit from the competitive profit in any period t .

The methodology typically applied to analyze persistence of firm profits is based on a firm-level first-order autoregressive model.⁶ All studies specify a common empirical model -- a univariate AR(1) process as follows: persistence of firm profits is found in

$$\pi_{it} = \alpha_i + \lambda_i \pi_{it-1} + \varepsilon_{it} \quad (2)$$

⁶The AR(1) model is based on the idea that competitive mechanisms need some time to erode the excess of profits generated by short-run rents (Mueller, 1986). Geroski (1990) justifies the autoregressive specification theoretically as a reduced form of a two-equation system where profits depends on the threat of entry in the market, and the threat in turn depends on the profits observed in the last period.

where π_{it} is the (normalized) profit of firm i in period t , α_i is a firm specific constant, λ_i is the parameter that indicates the speed of convergence of profits to a mean value (equilibrium rate of return), and ε_{it} is an error term assumed $N(0, \sigma^2)$. The AR(1) structure implies that the speed of mean-reversion is maximal at $\lambda_i = 0$. The model is estimated by OLS for each firm i and an estimate of the long-run profit ($\pi_i = \pi_{it} = \pi_{it-1}$) of each firm is obtained as:⁷

$$\pi_i = \frac{\alpha_i}{1-\lambda_i} \quad (3)$$

If all firms earn the competitive rate of profit, then π_i should equalize for all firms (ignoring differences in risk).⁸ This long-run profit captures the static notion of the “competitive environment.” The parameter estimate of λ_i is of particular interest in all these studies. If λ_i is close to zero, this indicates that firm profits displace minimal persistence: profits at time $t-1$ do not have much impact on profits at time t . On the other hand, if λ_i is close to 1, this indicates that firm profits are highly persistent: profits at time $t-1$ have substantial impact on profits at time t . The limitations of this approach, however, are apparent considering that the methodology is appropriate only for stationary processes, since π_i is not defined for unit-root processes where $\lambda_i = 1$, the degenerate case of adjustment dynamics. The first order difference of profit series appears below:

$$\Delta\pi_{it} = \alpha_i + \rho_i\pi_{it-1} + \varepsilon_{it} \quad (4)$$

where $\Delta\pi_{it}$ is $\pi_{it} - \pi_{it-1}$, π_{it} is the (normalized) profit of firm i in period t , α_i is $(1-\lambda_i)\pi_i$, a firm specific constant, ρ_i is (λ_i-1) is the parameter that indicates the speed of convergence of profit to a mean value (equilibrium rate of return), and ε_{it} is an error term distributed $N(0, \sigma^2)$.

I can examine the linear hysteretic hypothesis by means of panel unit-root tests, where the null hypothesis implies a unit root and suggest non-stationarity of profit series. Assume that, for a panel of N firms observed over T time periods, r_{it} exhibits the following augmented Dickey-Fuller (*ADF*) representation:

$$\Delta r_{it} = \alpha_i + \rho_i r_{it-1} + \sum \gamma_{ij} \Delta r_{it-j} + \varepsilon_{it} \quad i = 1, \dots, N; \quad t = 1, \dots, T, j=1 \quad (5)$$

where r_{it} denotes the profit series (*ROA*, *ROE*, or *ROD*), $\Delta r_{it} = r_{it} - r_{it-1}$, α_i is the intercept term that captures the firm-specific effects, P is the lag order in the

⁷The parameter α_i includes a competitive profit and a firm-specific permanent rent over and above the competitive return. See Gschwandtner (2012).

⁸Any firm-specific permanent rent must equal zero.

model, and $\varepsilon_{it} \sim N(0, \sigma_{ij}^2)$. To incorporate the time-specific effects, I add a trend, δ_{it} , component to equation (2) as follows:

$$P$$

$$\Delta r_{it} = \alpha_i + \rho_i r_{it-1} + \delta_{it} + \sum \gamma_{ij} \Delta r_{it-j} + \varepsilon_{it} \quad i = 1, \dots, N; \quad t = 1, \dots, T, j=1 \quad (6)$$

When $\rho_i < 0$, the processes for r_{it} defined by equations (2) and (3) are stationary, and firm profits are mean-reverting. On the other hand, when $\rho_i = 0$, the processes for r_{it} contain a unit root, and firm profits follow a random walk and display path-dependence.⁹

The dynamic notion of the “competitive environment”, however, focuses on the parameter estimate of λ_i . If λ_i is close to zero, then firm profits display minimal persistence: profits at time $t-1$ do not exert much effect on profits at time t . On the other hand, if λ_i is close to 1, then firm profits exhibit high persistence: profits at time $t-1$ substantially affect profits at time t . Conventional panel unit-root tests, such as [26], and [28] receive criticism ([43]; [30]; and [47], among others) for assuming cross-section independence. Cross-section dependence can arise due to unobservable common stochastic trends, unobservable common factors, common macroeconomic shocks, spatial effects, and spillover effects, which are common characteristics of the datasets employed in industry studies.

Pesaran [47] argues that ignoring the presence of cross-section dependence in panel unit-root tests leads to considerable size distortions and can cause adverse effects on the properties of tests, leading to invalid and misleading conclusions. That is, over-rejection of the unit-root null. Pesaran [46] proposes a cross-section dependence (CD) test, which uses the simple average of all pair-wise correlation coefficients. The CD test provides a general test for cross-section dependence, which, as shown in Pesaran [46], applies to a large variety of panel data models, including stationary and non-stationary dynamic heterogeneous and with T small and N large, as is the case for our panel data. The test applies to both balanced and unbalanced panels and is robust to parameter heterogeneity and/or structural breaks, and performs well even in small samples. Under the null hypothesis $H_0 : \rho_{it} = \rho_{jt} = \text{corr}(\varepsilon_{it}, \varepsilon_{jt}) = 0$ for $i \neq j$, ε_{it} is independent and identically distributed over time periods and across cross-section units. Under the alternative hypothesis $H_1 : \rho_{it} = \rho_{jt} \neq 0$ for some $i \neq j$, ε_{it} is correlated across cross-sections, but uncorrelated over time periods. Under the null hypothesis of cross-section independence, the CD test statistics are distributed as standard normal for N sufficiently large.

⁹Madsen (2010) observes that equations (2) and (3) contain two sources of persistence -- the autoregressive mechanism described by ρ_i and the unobserved individual-specific effects described by α_i . A lower ρ_i means that more persistence associates with the autoregressive mechanism and less persistence associates with the unobserved individual-specific effects. The case with $\rho_i = 0$ is the extreme case where all persistence falls on the autoregressive mechanism.

4 Empirical Results

To test whether cross-section independence holds in our data, I employ the CD test proposed by Pesaran [46]. For each of the five segments, the CD test draws on two specifications: residuals from a fixed effects ADF model with intercept and trend and residuals from a fixed effects ADF model with intercept only.¹⁰

The CD test statistic converges asymptotically to the standardized normal distribution. The CD test also applies to unbalanced panels. In this case, I compute the test statistic as follows:

$$CD = \sqrt{\frac{2}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \sqrt{T_{ij}} \text{corr}(\hat{\varepsilon}_i, \hat{\varepsilon}_j) \right) \quad (7)$$

where T_{ij} equals the number of common time-series observations between units i and j and $\hat{\varepsilon}_{it}$ are estimated residuals from the Augmented Dickey-Fuller (ADF) regression equations.

Table 4 shows the findings of the CD test. I reject the null hypothesis of cross-section independence in all cases at the 1-percent level, as the tests clearly indicate; overwhelming evidence of cross-section dependence exists in all segments. This plausible result reflects the high degree of cross-section dependence induced by intra-segments links and common shocks.

Table 4: Pesaran's Cross-Section Independence (CD) Test Results Information
Technology Segments: 1995-2009 Sample

Number of Firms	Segment	ROA	ROE	ROI
32	Computer Hardware	6.24 ***	5.64 ***	5.51 ***
52	Software	11.81 ***	10.19 ***	10.18 ***
118	Communication/Electronic Equipment	41.28 ***	41.73 ***	41.94 ***
75	Data Processing / Consulting/ Services	24.17 ***	21.54 ***	22.36 ***
68	Semiconductors	52.68 ***	47.60 ***	52.50 ***

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

However, since the CD test averages the pair-wise correlation coefficients of the residuals obtained from the individual Augmented Dickey-Fuller (ADF) regression equations, it is possible that the computed correlations alternate in sign, canceling out each other. In such case, the test would fail to reject the null hypothesis in the presence of cross-section dependence. Obviously this is not a concern with the results presented above.

¹⁰These regressions use the raw profitability series that are not adjusted for the mean at each point in time.

The rejection of the hypothesis of cross-section independence implies that using conventional panel unit-root tests, i.e., the *HT* and the *IPS* tests, assume cross-section independence may not be appropriate due to the restrictive nature of these tests which does not discriminate between stationarity with cross-section independence and non-stationarity with cross-section dependence. These tests experience well-known large size distortions when cross-section independence does not hold and may generate contaminated results.

Therefore, I consider the cross-section dependence in our panel unit-root tests. Pesaran [47] proposes a panel unit-root test based on a single common factor specification for the cross-correlation structure. The test augments the *ADF* equations (2) and (3) with the cross-section averages of lagged levels and first-differences of the individual series. This controls for the contemporaneous correlation among r_{it} and filters out the effect of the unobserved common factor. The augmentation of lagged first-differences of the series controls for any residual serial correlation. Then, the cross-section augmented Dickey-Fuller (*CADF*) test equations are as follows:

$$\Delta r_{it} = a_i + \rho_i r_{it-1} + \sum_{j=1}^p \gamma_{ij} \Delta r_{it-j} + b_i \bar{r}_{t-1} + c_i \Delta \bar{r}_t + \sum_{j=1}^p d_{ij} \Delta \bar{r}_{t-j} + \varepsilon_{it}, \quad (8)$$

and

$$\Delta r_{it} = a_i + \rho_i r_{it-1} + \delta_i t + \sum_{j=1}^p \gamma_{ij} \Delta r_{it-j} + b_i \bar{r}_{t-1} + c_i \Delta \bar{r}_t + \sum_{j=1}^p d_{ij} \Delta \bar{r}_{t-j} + \varepsilon_{it} \quad (9)$$

respectively, where $\bar{r}_t = N^{-1} \sum_{i=1}^N r_{it}$ is the cross-section mean of r_{it} , $\Delta \bar{r}_t = N^{-1} \sum_{i=1}^N \Delta r_{it}$, and p is the lag order of the model.

The individual-specific test statistic for the hypothesis $H_0 : \rho_i = 0$ for a given i equals the t -value for $\rho_i = 0$, $t_i(N, T)$, in the *CADF* regressions defined by equations (5) and (6). The panel unit-root test for the hypothesis $H_0 : \rho_i = 0$ for all i against the heterogeneous alternative $H_1 : \rho_i < 0$ for some i equals the average of the individual $t_i(N, T)$ tests. That is,

$$CIPS(N, T) = N^{-1} \sum_{i=1}^N t_i(N, T) \quad (10)$$

In addition, to ensure the existence of the first and second moments of the distribution of $t_i(N, T)$, Pesaran [47] constructs a truncated version of the *CIPS*(N, T) test, denoted $CIPS^*(N, T)$, to avoid using extreme statistics caused by a small number of sample observations.

$$CIPS^*(N, T) = \frac{1}{N} \sum_{i=1}^N t_i^*(N, T), \quad (11)$$

where

$$t_i^*(N, T) = \begin{cases} t_i(N, T) & -K_1 < t_i(N, T) < K_2 \\ -K_1 & t_i(N, T) < K_1 \\ K_2 & t_i(N, T) \geq K_2 \end{cases} \quad (12)$$

K_1 and K_2 depend upon the deterministic component of the models. Pesaran [47] provides values for K_1 and K_2 obtained by simulations for models with intercept and no trend ($K_1 = 6.19$ and $K_2 = 2.61$) and models with intercept and trend ($K_1 = 6.42$ and $K_2 = 1.70$) for various combinations of N and T .¹¹

I also implement the suggestion of Im, *et al.* [27]; [28]. That is, I assume that in addition to a series-specific intercept and/or trend as given in Equations (5) and (6), a time-specific intercept may exist as well. I control for this possibility by removing for each segment the cross-section means from each series. This normalization, by extracting common time-specific or aggregate effects, removes the effect of the business cycle and other macroeconomic shocks.¹² This correction will not remove the potential effect of correlation between the series, but may reduce it considerably [43]; [36].

Table 5 shows the results of the *CIPS** tests.¹³ Panel A of this table presents the results of the intercept only specification, while Panel B presents the results for the intercept and trend specification. In both cases, I augment the *CADF* regressions with 1 lag to account for the possibility of serial correlation.

¹¹Pesaran (2007) investigates the small-sample properties of the tests under various specifications of the *DGP*. The Monte Carlo experiments show that the tests exhibit satisfactory size and power properties even for small time dimensions (e.g., $T = 10$).

¹²This approach differs from the conventional methodology, where researchers normalize profit as a deviation from an economy-wide measure of profitability in year t . Using the economy-wide sample mean may produce misleading implications. That is, the profit of a firm in a given industry may not exhibit abnormal behavior with respect to its own sample average, but may exhibit well above- or below-average behavior with respect to the economy-wide average profit. Table A1 illustrates this point.

¹³The *PESCADF* (version 1.0.3) Stata module (Lewandowski, 2006) computes the test statistics.

Table 5: Pesaran's Unit-root Test (*CIPS**) – Information Technology Segments: 1995-2009 Sample

# of Firms	Segment	ROA	ROE	ROI
Panel A: Intercept Only (Augmented by 1 lag)				
32	Computer Hardware	-1.865	-2.391 ***	2.304 ***
52	Software	-2.124 **	-2.362 ***	-2.283 ***
118	Communication/Electronic Equipment	-2.014 *	-2.336 ***	-2.175 ***
75	Data Processing / Consulting/ Services	-1.763	-1.494	-1.559
68	Semiconductors	-2.276 ***	-2.138 **	-2.325 ***
345	Total Information Technology Sector	-1.954	-2.149 **	-2.047 **
Panel B: Intercept and Trend (Augmented by 1 lag)				
32	Computer Hardware	-2.175	-2.675 ***	-2.666 **
52	Software	-2.969 ***	-3.329 ***	-2.994 ***
118	Communication/Electronic Equipment	-2.479	-2.664 **	-2.549 *
75	Data Processing / Consulting/ Services	-2.226	-1.829	-2.063
68	Semiconductors	-2.352	-2.070	-2.246
345	Total Information Technology Sector	-2.364	-2.602 **	-2.532 *

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

In Panel A, I cannot reject the null hypothesis that *ROA* contains a unit root for the Hardware, the Data Processing/Consulting/Services, and the Semiconductor segments at the any significance level while I reject the null for the Software and the Communication/Electronics Equipment segments at 10 percent and 5 percent, respectively. I reject the null hypothesis that *ROE* and *ROI* contain a unit root at the 1 percent level for three segments, the Hardware, the Software, and the Communication/Electronics Equipment, and at the 5 percent significance level for the Semiconductor. I cannot reject the null hypothesis that *ROE* and *ROI* contains a unit root in the case of the Data Processing/Consulting/Services segment. I cannot reject the null hypothesis that *ROA* contains a unit root for the IT sector while rejecting the null hypothesis that *ROE* and *ROI* contain a unit root for the sector at the 5 percent level.

Panel B presents the results for the intercept and trend specification. I cannot reject the null hypothesis that *ROA* contains a unit root except for the Software segment. I reject the null hypothesis that *ROE* and *ROI* contains a unit root at the 1 percent level for two segments, the Hardware and the Software. I also reject the null hypothesis that *ROE* and *ROI* contains a unit root in the Communication/Electronics Equipment segment at the 5 and 10 percent level, respectively. I cannot reject the null hypothesis that *ROA* contains a unit root for the entire sector, while rejecting the null hypothesis that *ROE* and *ROI* contain a unit root for IT sector at the 5 and 10 percent level, respectively.

In sum, using the *CIPS** test, I find evidence of non-stationary behavior of all three measures of profits consistently for the Data Processing/Consulting/Services segment. I also find evidence of non-stationary behavior of *ROA* profits measure, at 1 percent level, for all segments in Panel A (intercept only specification) and all but Software segment in results as shown in panel B (intercept and trend specification) of Table 5. Clearly, the competitive Environment hypothesis is not supported for every segment within the IT economic sector. More specifically, the Data Processing/Consulting/Services segment does appear to show evidence of persistent profitability.

I then extended our analysis conducted the unit-root test for fifteen industries within the five IT segments as shown in table 6.

Table 6: Pesaran's Unit-root Test (CIPS*) - Information Technology Industries-1995-2009 Sample

Industry Code	Industry	ROA	ROE	ROI
Panel A: Intercept Only (Augmented by 1 lag)				
8050	Computer Hardware	-2.952 ***	-2.969 ***	-2.703 ***
8052	Computer Storage & Peripherals	-2.020	-2.159 **	-1.918
8110	Internet Software & Services	-2.223 *	-4.076 ***	-4.002 ***
8130	Application Software	-2.099 *	-2.350 ***	-2.133 **
8140	Systems Software	-1.536	-1.624	-1.558
8190	Home Entertainment Software	-2.074	-1.654	-1.634
8030	Telecommunications Equipment	-1.947	-2.257 ***	-1.973
8150	Electronic Equipment & Instruments	-2.031 *	-1.941	-1.983
8160	Office Electronics	-0.902	-0.844	-1.217
8120	IT Consulting & Services	-1.261	-1.541	-1.484
8180	Data Processing & Outsourced Services	-1.696	-1.290	-1.308
8200	Electronic Manufacturing Services	-1.116	-1.012	-0.995
8210	Technology Distributors	-1.832	-1.827	-1.664
8220	Semiconductor Equipment	-2.119 *	-2.276 **	-2.057
8230	Semiconductors	-1.402	-1.696	-1.541
8000	Total Sector	-1.705	-1.934 ***	-1.960
Panel B: Intercept and Trend (Augmented by 1 lag)				
8050	Computer Hardware	-2.965 **	-2.514	-2.424
8052	Computer Storage & Peripherals	-2.271	-3.077 ***	-2.268
8110	Internet Software & Services	-2.314	-4.280 ***	-4.333 ***
8130	Application Software	-2.929 ***	-2.916 ***	-2.521
8140	Systems Software	-2.343	-1.875	-2.075
8190	Home Entertainment Software	-2.900 *	-2.693	-2.473
8030	Telecommunications Equipment	-2.707 **	-3.079 ***	-2.915 ***
8150	Electronic Equipment & Instruments	-2.169	-2.126	-2.081
8160	Office Electronics	-2.583	-2.225	-2.901 *
8120	IT Consulting & Services	-1.841	-1.876	-1.990
8180	Data Processing & Outsourced Services	-1.984	-1.452	-1.533
8200	Electronic Manufacturing Services	-1.852	-1.640	-1.843
8210	Technology Distributors	-2.521	-2.346	-2.408
8220	Semiconductor Equipment	-2.576	2.982 ***	-2.671 *
8230	Semiconductors	-1.840	-2.202	-1.888
8000	Total Sector	-2.319	2.433	-2.571 **

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

The results confirm earlier rejection of the null for all four industries, IT Consulting [8120], Data Processing & Outsourced Services [8180], Electronic Manufacturing Services [8200] and Technology Distributors [8210], within the Data Processing/Consulting/Services segment. The findings for Semiconductors [8230] industry (Semiconductors segment) also indicate evidence of non-stationarity. These findings are consistent for both Intercept only and Intercept and Trend models.

As shown in Panel A (Intercept only model), I also find evidence of non-stationarity with respect to *ROA* and *ROI* for Computer Storage and Peripherals [8052] industry (Computer Hardware segment), all three measures for System Software [8140] and Home Entertainment Software [8190] industries (Software segment), *ROA* and *ROI* for Telecommunication Equipment [8030] (Communication/Electronic Equipment segment), *ROE* and *ROI* for Electronic Equipment and Instruments [8150] industry (Communication/Electronic Equipment segment), all three measure of profitability for Office Electronics [8160] industry (Communication/Electronic Equipment segment), *ROI* for Semiconductor Equipment [8220] industry (Semiconductors segment), and all three measures for Semiconductors [8230] industry (Semiconductors segment).

Panel B of Table 6 presents the results for the Intercept and Trend model. I cannot reject the null with respect to *ROE* and *ROI* for Computer Hardware [8050] industry (Computer Hardware segment), *ROA* and *ROI* for Computer Storage and Peripherals [8052] industry (Computer Hardware segment), *ROA* for Internet Software Services [8110] industry (Software segment), *ROI* for Application Software [8130] industry (Software segment), all three measures for System Software [8140] industry (Software segment), *ROE* and *ROI* for Home Entertainment Software [8190] industry (Software segment), all three measures Electronic Equipment and Instruments [8150] industry (Communication/Electronic Equipment segment), *ROA* and *ROE* for Office Electronics [8160] industry (Communication/Electronic Equipment segment), *ROA* for Semiconductor Equipment [8220] industry (Semiconductors segment), and all three measures for Semiconductors [8230] industry (Semiconductors segment).

5 Robustness Checks and Additional Empirical Results

This section considers additional analysis of the IT industries as I further disaggregate our sample and presents two robustness checks that address three particularly important concerns that could understate the strength of the findings in the previous section. First, the descriptive statistics suggest that outliers may create a problem because of their potential effect on statistical inferences. Second, our sample period includes the recent financial crisis. I have to consider the extent of this economic breakdown on our finding. More specifically, to what extent our results are influenced by the structural change caused by the financial crisis.

5.1 Outliers Impact

I winsorize and adjust 20 percent of the observations in our sample: all observations below the 10th percentile are set to the 10th percentile, and all observations above the 90th percentile are set to the 90th percentile. Then, I replicate the analysis for the two-sided winsorized data.

The winsorized data produce more stable means and significantly smaller Standard Deviations, Skewness, and Kurtosis, as expected [4]. I also note that all segments except for Software have a positive winsorized mean. The findings of the *CD* test remain robust to the use of winsorized data that adjusts for outliers in the data series. That is, I find strong evidence of cross-section dependence in each sector for all three measures of profitability for both the intercept only and intercept and trend specifications.

Some of our earlier findings for the *CIPS*^{*} test are sensitive to the winsorization of the data series and produce fewer evidence of stationarity (“competitive environment”) across all three measures of profitability as shown in Table 7. I cannot reject the null hypothesis of a unit root, using the intercept model augmented by one lag, for any of the three measures in any of the five segments except for the *ROE* and *ROI*, at 10 percent level, in the Hardware segment only, as shown in Panel A of Table 7.

Table 7: Pesaran's Unit-root Test (*CIPS*^{*}) Information Technology Segments Winsorized Sample at 10th and 90th percentiles

# of Firms	Segment	ROA	ROE	ROI
Panel A: Intercept Only (Augmented by 1 lag)				
32	Computer Hardware	-1.911	-2.221 **	-2.135 **
52	Software	-1.814	-1.830	-1.770
118	Communication/Electronic Equipment	-1.593	-1.702	-1.569
75	Data Processing / Consulting/ Services	-1.956	-1.828	-1.838
68	Semiconductors	-1.935	-1.934	-1.975
Panel B: Intercept and Trend (Augmented by 1 lag)				
32	Computer Hardware	-2.614 *	-2.792 **	-2.684 **
52	Software	-2.699 **	-2.784 ***	-2.633 **
118	Communication/Electronic Equipment	-2.305	-2.295	-2.304
75	Data Processing / Consulting/ Services	-2.371	-2.128	-2.232
68	Semiconductors	-2.598 *	-2.569 *	-2.656 **

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

The results for the intercept and trend models are presented in Table 7, Panel B. The *CIPS*^{*} test rejects the null hypothesis of a unit root for *ROA* in the Hardware, the Software, and the Semiconductors segments at 10, 5, and 10 percent, respectively. Our findings for *ROE* and *ROI* in Panel B are similar to those for *ROA*. That is, I cannot reject the null hypothesis of a unit root for any of the three measures in the Communication/Electronic Equipment and the Data Processing /Consulting/Services segments. However, using the intercept and trend models, the *CIPS*^{*} test rejects the null hypothesis of a unit root in the Hardware, the Software, and the Semiconductors segments for *ROE* at 5, 1, and 10 percent, and for *ROI* at 5, 5, and 10 percent, respectively.

5.2 Crises and Structural Change

Our sample period also includes the period of financial crisis and Great Recession. Did the structural change caused by the financial crisis and Great Recession impacted our earlier findings? So far, I implicitly have assumed that throughout the sample period the data generating process was not impacted by structural change. If this assumption is not valid, however, the tests can be misleading, since they are biased toward the non-rejection

of the unit-root hypothesis. In the presence of a known structural break, one can intuitively test for a unit root twice, before and after the break. In our case, however, splitting the sample into two is practically impossible. Consequently, I provide a robustness check by applying the same unit-root methodology to a sub-sample that ends in 2006, to avoid confounding effect of financial crisis that is marked by the Lehman bankruptcy filing in September 2008, and the beginning of the Great Recession. This may prove important, since the financial crisis and the Great Recession took a heavy macroeconomic toll on the US industry.

The findings of the *CD* test, instead, remain robust to the sample reduction. That is, I find strong evidence of cross-section dependence in each segment for all three measures of profitability for both the intercept only and intercept and trend specifications.

As shown in table 8, our earlier *CIPS** test results for the full period, are not sensitive to the time period and recent economic crisis. In fact the *CIPS** test results for pre-crisis period are identical to results presented in Table 5 above for either intercept or intercept and trend, model specification.

Table 8: Pesaran's Unit-root Test (*CIPS**) Information Technology Segments: Pre-2007 Sample

# of Firms	Segment	ROA	ROE	ROI
Panel A: Intercept Only (Augmented by 1 lag)				
32	Computer Hardware	-1.865	-2.391 ***	-2.304 ***
52	Software	-2.124 **	-2.362 ***	-2.283 ***
118	Communication/Electronic Equipment	-2.014 *	-2.336 ***	-2.175 ***
75	Data Processing / Consulting/ Services	-1.763	-1.494	-1.559
68	Semiconductors	-2.276 ***	-2.138 **	-2.325 ***
Panel B: Intercept and Trend (Augmented by 1 lag)				
32	Computer Hardware	-2.175	-2.675 **	-2.666 **
52	Software	-2.969 ***	-3.329 ***	-2.994 ***
118	Communication/Electronic Equipment	-2.479	-2.664 **	-2.549 *
75	Data Processing / Consulting/ Services	-2.226	-1.829	-2.063
68	Semiconductors	-2.352	-2.070	-2.246

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

In Table 9, I present the results for the *CIPS** test of winsorized data for pre-economic crisis period. Results are similar to those presented in Table 6 for full period winsorized data. As shown in Table 9, the results provide fewer evidence of stationarity ("competitive environment") across all three measures of profitability for both model specifications. I cannot reject the null hypothesis of a unit root using either the intercept or intercept and trend models for any of the three measures in the Communication/Electronic Equipment and the Data Processing / Consulting/Services segments. Furthermore, I cannot reject the null hypothesis of a unit root using the intercept and trend model (Panel

B) for any of the three measures in the Semiconductors segment. However, I reject the null hypothesis of a unit root using the intercept model (Panel A) for all three measures in the Semiconductors segment at 5 percent significance level, for *ROE* and *ROI* in the Hardware segment at 10 and 5 percent, respectively, and for *ROE* in the Software segment at 10 percent level.

Table 9: Pesaran's Unit-root Test (*CIPS**) Information Technology Segments: Pre 2007
Sample Winsorized Sample at 10th and 90th percentiles

# of Firms	Segment	ROA	ROE	ROI
Panel A: Intercept Only (Augmented by 1 lag)				
32	Computer Hardware	-1.813	-2.046 *	-2.199 **
52	Software	-1.967	-2.016 *	-1.950
118	Communication/Electronic Equipment	-1.813	-1.882	-1.909
75	Data Processing / Consulting/ Services	-1.935	-1.819	-1.825
68	Semiconductors	-2.141 **	-2.126 **	-2.172 **
Panel B: Intercept and Trend (Augmented by 1 lag)				
32	Computer Hardware	-2.657 **	-2.670 **	-2.721 **
52	Software	-2.787 ***	-2.879 ***	-2.746 **
118	Communication/Electronic Equipment	-2.134	-2.102	-2.141
75	Data Processing / Consulting/ Services	-2.132	-1.921	-1.995
68	Semiconductors	-2.304	-2.228	-2.344

*** significance level = 0.01; ** significance level = 0.05; * significance level = 0.1;

6 Conclusions

Firms display pervasive differences in profitability. Some firms earn profits above the equilibrium level while other firms earn profits below the equilibrium level. Do such differences disappear over time? Are such differences transitory or permanent? I assess these questions empirically within the IT sector by applying unit-root tests. If I can reject the unit-root null hypothesis in favor of the alternative hypothesis of non-stationarity, then such differences in firm profit eventually dissipate and the series revert to their equilibrium levels. Conversely, if I cannot reject the unit-root null hypothesis, then such differences in firm profit are permanent and the series never return to their original values. In the standard autoregressive approach, the researcher implicitly assumes that profit (loss) reverts to the mean. It remains to determine how quickly the reversion occurs and whether reversion proceeds to dissipation of the economic profit. That is, the autoregressive model assumes that firms operate in a “competitive environment”, where slow reversion and reversion to a non-zero economic profit implies insufficient competition. Persistent profit can come from two different sources – firm’s operational efficiency and dominant market share. Such persistence in profit continues only if sufficient barriers insulate firms from competitive forces.

Researchers apply conventional methodologies [26] and [27]; [28] for unit roots in panel data. These tests, however, encounter a potential problem, which is now widely recognized in the econometric literature. Thus, assuming cross-section independence proves unrealistic in segment studies. In fact, the *CD* test [46] confirms the existence of cross-section dependence in the original, winsorized, and “pre-2006” data sets.

In contrast to previous research which suggests persistent, but stationary firm profitability, I uncover evidence of hysteretic features in the dynamics of profits in many segments. This is inconsistent with the “competitive environment” hypothesis. Furthermore, the inability to reject the unit-root hypothesis for all segments of the IT Sector indicates that some segments see persistence differences in profitability, where competitive pressures never erode such differences.

In addition, I consider two robustness checks on our findings – winsorized data series to reduce the influence of outliers, using the “pre-2007” sample that excludes the financial crisis and Great Recession at the end of our full sample, and presented our analyses based on an alternative segmentation of the sample. The findings for the winsorized data exhibit fewer evidence of stationary (“competitive environment”) behavior. The results for the “pre-2007” sample do not generate more evidence of stationary (“competitive environment”) behavior. The refinement of the sample segmentation indicates that operational differences may be influential in persistence of profits.

In sum, the “competitive environment” hypothesis becomes, in our findings, a less-compelling concept. Considering the original data set, I strongly reject the “competitive environment” hypothesis in several segments of the IT sectors. Generally, when I winsorize the data series, I find less support for the “competitive environment” hypothesis. That is, I cannot reject the null hypothesis of a unit root only for segments across all three measures of profitability and across the intercept and the intercept and trend models. Finally, when I employ the “pre-2007” data set, our results are the same as those for the full period. That is, the economic crisis did not influence the IT sector’s competitive environment.

This persistence of profits within various segments of IT sector is not surprising. The innovation propensity of the Information Technology sector remains very high and new innovation and disruptive innovation are expected to characterize this sector as evidenced by recent development in the web-services and introduction of the Public Cloud that have the potential to revolutionize the field and significantly impact the competitiveness of hardware, packaged software, programming and consulting services and IT administration and functions within business organization.

Amazon, Microsoft, Google, and IBM, to name a few, are competing for the market share in this new *shared* computing and information processing space. The Cloud technology is available to small and large business with internet access that can share as virtual resources with security and scalability. Organizations and consumers can purchase the shared computing resources and pay based on pay-as-you-go basis through the internet-based service rather than investing in hardware, software personnel, etc.

I can expect a dynamic competitive environment to continue in IT sector. Further research is needed to examine the competitive environment within each segment/industry of IT sector. I suggest that future studies are needed to partition each industry on the basis of firms’ operations and their target markets.

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