University of Alberta

Product Innovation, Competitor Imitation and the Persistence of Firm-Level Profitability in the U.S. Pharmaceutical Industry

by

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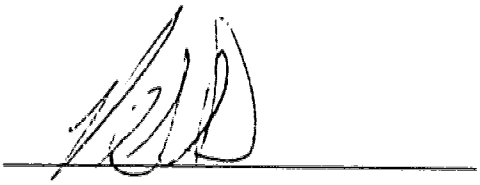

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Product Innovation, Competitor Imitation and the Persistence of Firm-Level Profitability in the U.S. Pharmaceutical Industry* submitted by Peter William Roberts in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Organizational Analysis.

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DEDICATION

This dissertation is dedicated to my wife, Tania Herbert, and my two sons, Ellis and Oliver.

ABSTRACT

In increasingly turbulent economic environments, firm managers and public policy makers struggle to understand the causes of, and the effects of, firm-level innovation and the subsequent imitation by competing firms. In response, economists and business policy scholars alike are turning to more dynamic theories of competition which incorporate elements of Schumpeter's classic writings on the process of 'creative destruction'. By moving beyond the static approaches that have dominated in the past, these new models view competition as the process by which new products are developed and introduced by innovating firms, proven successful, and subsequently imitated by competing firms.

These dynamic models of competition address the question: What are the factors that allow some firms to earn persistently high profits? While successful innovations are supposed to yield high returns around the time the innovation is introduced, the imitative forces inherent in a competitive economy should, all else equal, ensure that these high profits are eroded over time. Within such a framework, two generic explanations surface to explain persistently high profits. First, sustained high profits may result when a firm repeatedly introduces valuable innovations that service previously unmet consumer demands. While the value to the firm of each innovation erodes over time, the pattern of continual innovation ensures that, in aggregate, the firm maintains its high performance position. Second, sustained high performance might also accrue to firms that innovate less often, but are able to thwart the imitative forces that otherwise erode high returns.

The empirical component of this research is aimed at uncovering the determinants of sustained high profits in the U.S. pharmaceutical industry over the 1977 to 1993 period. By modeling pharmaceutical firms as evolving bundles of drug products that have been innovated at discrete points in time and subsequently exposed to varying levels of competition from imitating products, the analysis ascertains the extent to which sustained high firm profits are due to superior innovation records, as opposed to an ability to protect products from the threats imposed by imitator products.

ACKNOWLEDGMENT

As anyone who has undertaken the task of writing a PhD dissertation will attest, it is a vain individual who takes full credit for its completion. And although mention of their names on this page is insufficient acknowledgment for the contributions they have made, it seems the best that I can do for now. First and foremost, I must acknowledge the huge impact that this process has had on my family and, as such, will thank Tania, Ellis and Oliver for their patience, and Tania specifically for the extra burden that she has shouldered over the last four years.

The next obvious note of gratitude goes to my supervisor, John L. Brown, whose guidance, both in terms of content and process, has been invaluable. For similar reasons, I thank the remaining members of my dissertation committee - Royston Greenwood, David Jobson and David Parkinson - for their valuable comments and suggestions. And although they had no direct influence on this dissertation process, I must also thank Mukesh Bhargava, Paul Ingram and Danny Miller for their contributions, and especially for their well-placed words of encouragement.

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CHAPTER 1: INTRODUCTION

> do companies live eternally and *do they pay dividends forever*? Certainly there are such, but broadly only two groups of them. First, there are branches of industry ... which have, *if not perpetual, yet an assured monopoly for a long time* ... then there are kinds of enterprises which by nature and programme are *continually doing new things and are really nothing but forms for continual new enterprises* (Schumpeter, 1934:208, emphasis added)

The observation that some firms experience relatively high profitability over prolonged periods of time is of great interest to both scholars and practitioners. Strategic managers and strategy scholars strive to understand the factors that allow some firms (but not others) to attain and sustain relatively high profit levels (Hunt & Morgan, 1995; Jacobson, 1988; Porter, 1985; Varadarajan & Ramanujam, 1986). At the same time, public policy practitioners and the associated set of industrial organization (IO) economists are concerned about the extent to which competitive markets are able to efficiently allocate resources among competing uses. The theories adhered to by this latter group suggest that, unless otherwise impeded, competitive forces should drive abnormally high and low profits toward more normal levels (Cubbin & Geroski, 1990; Geroski, 1990; Mueller, 1977, 1986).

Recently, Schumpeterian (1934, 1950) logic has been called upon to ground

academic thinking about persistent profitability (Jacobson, 1992; Mueller, 1990). According to a typical interpretation of Schumpeter's work, innovation may yield transitory, although not necessarily persistent, above-normal profits:

> the process of 'creative destruction' proceeds: innovation creating monopoly, monopoly creating profits, profits creating imitators until a state of normalcy returns, only to be followed by new innovations and a repeat of the cycle (Mueller, 1990:3).

This type of thinking implies that Schumpeter's arguments have *direct* implications for the dynamics of firm profitability. An innovating firm is expected to attain relatively high profitability at a point in time. However, competitor imitation is expected to ensure that such high profitability is a transitory, and not a persistent, phenomenon.

The problem is that one does observe examples of firm-level persistent profitability. Empirical research undertaken by industrial organization (IO) economists demonstrates that, while it is normal for a firm's abnormal profits to diminish over time, there are documented exceptions to this norm (this literature is reviewed in Chapter 2). Stated differently, researchers observe considerable firm-to-firm variance in the extent to which profits persist over time (see also Hunt & Morgan, 1995). Following these observations, the task for the researcher is one of developing a conceptual framework which explains the general tendency for firms to achieve relatively high profitability which subsequently falls back to normal levels, as well as the firm-level factors which account for the variance in persistent profitability.

If Schumpeterian logic is applied directly at the firm level, it is quite natural to look toward those factors that slow the rate of competitor imitation as the drivers of firm-level

profit persistence. The review of the persistent profitability literature in Chapter 2 attests that this is precisely what has happened. The aim of this research is to extend and refine the Schumpeterian explanation of firm-level persistent profitability. At a conceptual level, two contributions are made. First, the two dynamic processes to which Schumpeter alludes in his writing are explicitly recognized: *innovation*, which tends to generate high profits, and *imitation*, which tends to drive high profits down toward more normal levels. Second, scholars are reminded that these two processes operate at a sub-firm level of analysis. Products, and not firms, are innovated and subsequently imitated during Schumpeter's process of creative destruction.[1] More importantly, multiple innovations may be introduced within the same firm; a fact that is explicitly recognized in the Schumpeterian (1950) hypothesis relating innovative propensity to firm size and confirmed with reference to any number of real-world examples.

This latter fact mandates that firms be conceived of as (at least potentially) evolving *portfolios* of products - each product introduced and subsequently imitated at different points in time. Relating this to the persistent profitability question, the task becomes one of understanding how a firm's product portfolio development affects the dynamics of its overall profitability. Note the correspondence between this perspective and that of Hunt and Morgan (1995:2, emphasis added), who observe that:

> across and within industries, firms differ radically ... *some produce hundreds of products and others sell only one*; ... some are profitable and

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[1] Although Schumpeter (1934, 1950) alludes to several types of innovation - including new production processes, new organizational forms, new sources of supply, and the introduction of existing goods to new markets, this research focuses exclusively on product innovations.

> others are unprofitable; and *some consistently maintain relatively high profits and others "fall back into the pack"*.

The prospect of serial product innovation mandates that one use caution in assessing the firm-level implications of Schumpeter's innovation and imitation dynamics. For example, it is reasonable to expect *firm-level* persistent profitability in spite of intense imitative competition *at the product level* in those cases where firms successfully generate streams of profitable innovations.

Once this is recognized, the door is opened to two competing explanations for firm-level persistent profitability. A *monopoly argument* currently dominates the IO economics literature. It suggests that persistently-high profitability accrues to firms that are exposed to relatively low rates of competitor imitation. Such a conjecture is epitomized in the following passage from Scherer and Ross (1990:442, emphasis in original):

> a properly formulated dynamic theory indicates that one should indeed expect to see especially profitable firms' returns decline *unless* entry barriers are sufficiently high.

A competing explanation emphasizes innovation and is likely more sympathetic to the orientation of strategy scholars. An *innovation argument* suggests that imitative forces may be sufficiently intense to make the high profits associated with specific innovations transitory phenomena. However, firms vary in their propensity to generate streams of valuable innovations over time, and the firms generating valuable innovations on a more regular basis may be the ones displaying more persistent profitability. Finally, while these two explanations are juxtaposed for analytical purposes, it is possible that both are

operational to varying degrees. That is, firms may differ both in their ability to generate streams of innovations, as well as in the intensity of the imitative pressures to which each innovation is exposed. It becomes the goal of empirical analysis to shed light on how each explanation contributes to the determination of firm-level persistent profitability.

After developing the theoretical premises, the research turns to an empirical analysis of the dynamic interrelationships between product innovation, competitor imitation and firm-level persistent profitability in the U.S. pharmaceutical industry. For several reasons, the pharmaceutical industry provides an ideal site for this research. The review of the pharmaceutical economics literature in Chapter 4 illustrates how questions about the sources of above-normal profitability have dominated academic debates (Comanor, 1986). Moreover, discussion about pharmaceutical industry competition inevitably points to the inadequacy of static conceptualizations of price competition and to the need for analysis to be grounded in dynamic notions of product competition (Cocks, 1975; Comanor, 1964, 1979, 1986; Hill & Hansen, 1991; Jadlow, 1979). Finally, Henderson (1994) argues that, given the pivotal role that innovation has always played in the pharmaceutical industry, pharmaceutical firms should serve as models for firms in other industries who must compete in increasingly dynamic competitive environments (see also Schnee, 1979:364).

Chapter 5 empirically validates several key features of the Schumpeterian framework on firm-level persistent profitability. First, seventeen years of profit data across a sample of nineteen pharmaceutical firms are analyzed to determine whether, on average, above-normal profits persist, and whether the degree of persistence varies significantly across firms. This exercise confirms that the phenomenon of interest -

variable firm-level persistent profitability - is present in the pharmaceutical industry. The firm-level profit data are then combined with product-level sales data to demonstrate that there is an inverse relationship between the relative profitability of a firm and the level of competition that its products face in their respective markets. The product-level sales data are also used to analyze of the relationship between changes in the level of competition that products face and the passage of time. This analysis shows that, for innovative products, the level of competition faced increases with the length of time that they have been on the market. The same analysis also shows that the sampled firms face different rates of competitor imitation. Finally, the product-level data are analyzed in order to demonstrate that the sampled firms are differentially inclined to introduce innovative new products to the market.

These analyses confirm that innovative new products (which, by definition, are introduced to low levels of competition) initially earn relatively high profits. These high profits create the incentive for competitor imitation which, over time, increases the level of competition faced by the products. This increased competition erodes the high profits. Finally, the analyses show that firms vary in the two key dimensions which may affect firm-level persistent profitability - innovative propensity and the rate of competitor imitation. Taken together, these findings increase confidence in a Schumpeterian explanation of firm-level profit persistence.

The analysis in Chapter 6 is comprised of two parts. The first examines whether, on average, innovative propensity and/or the rate of competitor imitation have an impact on firm-level profit dynamics. The results of this analysis indicate that both of these proposed covariates of profit persistence operate in the expected fashion. That is, above-

normal profits tend to persist when firms are more innovative and when competitor imitation is, relatively speaking, absent. The second part of Chapter 6 moves the analysis to the firm level in order to ascertain whether the observed inter-firm variance in innovative propensity and competitor imitation rates explains any of the inter-firm differences in profit persistence. Here, the analysis seeks to understand whether those firms displaying the greatest degree of profit persistence tend to be those that are either more innovative or less likely to have their products imitated. Once again, the analysis confirms the expectations derived from the Schumpeterian framework. Persistently profitable firms tend to be those generating more of their sales from recently-innovated products and/or those facing relatively less intense competitor imitation.

The balance of this dissertation is structured as follows. Chapter 2 summarizes the current research into persistent profitability in the IO economics and strategy literatures. The first section of Chapter 3 develops Schumpeter's ideas in some detail, stressing his views on profit dynamics. The section closes by noting the product-level applicability of Schumpeter's dynamics. The second section in Chapter 3 describes how a coherent firm-level profitability analysis may be grounded in Schumpeterian logic as long as one recognizes that firms represent evolving, and not fixed, portfolios of products. It also indicates how firm variability in the propensity to innovate and the rate of competitor imitation combine to explain why some (but not all) firms experience persistent profitability. Chapter 4 briefly reviews the pharmaceutical economics literature in order to draw connections between the current approach and previous studies of competition and profitability in the pharmaceutical industry. The chapter closes by discussing data sources, as well as issues relating to the measurement of firm profitability.

After Chapter 4, the discussion turns to empirical issues. Chapter 5 validates several key features of the Schumpeterian framework by showing that (a) persistent profitability is observed and varies across the sampled firms, (b) there is an inverse relationship between the level of competition faced and relative profitability, and (c) there is a positive relationship between the level of competition faced and the passage of time (at least for innovative products). Chapter 6 quantifies the impact of product innovation and competitor imitation on firm-level profit dynamics. Finally, Chapter 7 concludes the dissertation by summarizing its main findings and implications and by pointing out avenues for further research.

CHAPTER 2: FIRM-LEVEL PERSISTENT PROFITABILITY

Economists and strategy scholars are beginning to explore issues related to the dynamics of firm profitability. Such interest is due in large part to a dissatisfaction with the static, cross-sectional approaches that tend to dominate both fields (Geroski, 1990; Hunt & Morgan, 1995; Jacobson, 1992; Porter, 1991). In this chapter, the research that characterizes the study of profitability dynamics is summarized. Section 2.1 reviews the research that is conducted under the heading of *persistent profitability analysis*. This research, found almost exclusively within the IO economics literature, provides considerable evidence suggesting that, on average, abnormal profits tend to dissipate over time. At the same time, there is also evidence that some firms resist this tendency and demonstrate persistent abnormal profitability. The standard interpretation of this latter finding is that these firms have been able to thwart the otherwise smooth functioning of the competitive mechanisms. Section 2.2 summarizes a more recent strand of literature; that relating to the study of sustained superior performance. This research, which tends to be more conceptual in nature, traces the path from firm strategy through sustainable competitive advantage to sustained superior performance.

2.1 Persistent Profitability Analysis

While strategy scholars are beginning to address the dynamic aspects of competition and their implications for firm-level profitability, the majority of the work on

profitability dynamics is found within the IO economics literature. IO economists have been studying the dynamics of firm and industry profitability since the early 1970s (e.g., Brozen, 1970; Mueller, 1977). Two motivations for moving beyond cross-sectional analyses of firm and industry profitability are put forth by Geroski (1990). The first recognizes that economic theory posits relationships between various elements of industry structure and economic performance in equilibrium. However, the data analyzed in cross-sectional analysis are almost invariably disequilibrium in nature. To the extent that various elements of market structure may covary with the equilibrium status of industries, results from cross-sectional analysis may provide biased indicators of the true equilibrium relationships (Brozen, 1970).

More importantly for current purposes, cross-sectional analysis does not provide insights into the dynamic processes that characterize competition. This is seen clearly by distinguishing questions regarding the existence of abnormal profits from those regarding their persistence (Mueller, 1986). It is not particularly problematic from an economic efficiency perspective that above-normal profits are generated by firms since "markets have inbuilt error correction mechanisms that function to bid away excess profits (Geroski, 1990:19)."[2] However, when such mechanisms are malfunctioning (or are pre-empted), abnormal profits may persist, perhaps indefinitely. It is this latter phenomenon that interests persistent profitability scholars. Their world view is captured by Mueller (1986:1, emphasis added), who suggests that "the second assumption about the

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2 Additional commentary on the anticipated effects of competitive forces on the persistence of abnormal profits is found in Cubbin and Geroski (1987:429), Mueller (1977:369) and Schohl (1990:385).

competitive process is that ... profits (and losses) *cannot persist*, even when transitory market conditions sometimes allow them to *exist*." Whereas cross-sectional research can only answer questions about the existence of abnormal profits, dynamic analysis addresses the extent to which they persist over time.

Early empirical research into the persistent profitability question was conducted at the industry level of analysis (e.g., Brozen, 1970; Qualls, 1974). These studies were motivated by a concern about the public policy prescriptions that were flowing from observed cross-sectional correlations between industry concentration levels and industry profitability. As Brozen (1970) reports, these observed correlations tend to be weak. More importantly, they tend to disappear when industry profitability is re-examined several years later on. More closely related to the present research are the studies that examine firm-level profit dynamics. Using a pair of empirical techniques, Mueller (1977) analyzes the dynamic behavior of after-tax return on assets (ROA) for 472 firms over a 24-year period.[3] While he finds some evidence of profit erosion, he also observes a tendency for highly profitable firms to retain their above-normal profit positions for prolonged periods of time. In a more recent project, Mueller (1986) examines ROA over a 22-year period for firms that were among the 1000 largest U.S. firms in either 1950 or 1972. Using time-series methods, he concludes that:

> although the general pattern of results ... is consistent with an overriding tendency for profits to regress back onto some normal, competitive level, the regression is not complete either in the sense that all firms exhibit such a regression, or that those that do experience a complete return to the

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3 The methods used in persistent profitability research are summarized in Chapter 5.

competitive level (Mueller, 1986:27).

The results from these two studies depict a dynamic competitive process wherein abnormal firm profits appear and disappear with some regularity. However, it is not uncommon for some firms' abnormal profits to persist for some time, if not indefinitely.

Following Mueller's (1977, 1986) seminal work, other researchers have turned their attention to the persistent profitability question, each using slightly different methods and/or different samples. Cubbin and Geroski (1987), for example, use a more complex research design in their study of the dynamics of firm-level profitability in a sample of 217 large U.K. firms over the 1951 to 1977 period. Based on their findings, the authors conclude that whereas dynamic forces typically drive returns toward normal levels, "there were firms in the sample whose profits persistently exceeded 'the norm' for long periods of time (Cubbin & Geroski, 1987:436)." Jacobson (1988) examines the autoregressive properties of profit time series using two separate data bases, one firm-level and one business-unit level. In each case, his results suggest that abnormal profits eventually converge on a common long-run level. However, the rate of convergence is not common across firms and is influenced by several factors. Examples of the factors which influence the autoregression process are a firm's market share, the extent to which it is vertically integrated, and the intensity of its marketing expenditures. Still other researchers compare firm-level profit dynamics across different countries (see Mueller, 1990). Odagiri and Yamawaki (1986) and Yamawaki (1989) compare the profit dynamics demonstrated by samples of Japanese versus U.S. firms. Geroski and Jacquemin (1988) compare French, German and U.K. samples to assess whether inter-country differences in profit dynamics are observed. Finally, Schohl (1990) analyzes the profit dynamics demonstrated by a

sample of German firms.

It is always difficult to distill consistent themes from such a diverse range of empirical studies. However, for the purposes of this research, the overall impression from the above studies is that of a general convergence-of-returns process with several notable exceptions. In other words, there is considerable empirical evidence suggesting that it is typical for high firm-level profits to erode over time. However, the evidence also points to several firms which have been shielded from the imitative competition which would otherwise erode their high profit positions, thereby earning relatively high profits over prolonged periods of time. These exceptional firms motivate the interest in understanding the causes of firm-level persistent profitability. And whereas IO economists tend to invoke monopoly-type arguments in an attempt to understand firm-level persistent profitability, researchers studying sustained superior performance would argue for a broader explanation; one which is couched in an understanding of the idiosyncratic nature of firm competition.

2.2 Sustained Superior Performance Analysis

Within the strategy literature, a focused, theory-based dialogue on the sustained superior performance question is a relatively recent phenomenon. Moreover, it has tended to be more conceptual than empirical (Conner, 1991; Robins & Wiersema, 1995). The most obvious example of such a discussion is the ongoing exposition of the resource-based view of the firm, in which sustained superior performance is related to the nature of

the resources and capabilities possessed by firms.[4] While resource-based theory is in its conceptual-development phase, the basic premise is that firms are heterogeneous with respect to the resources and capabilities that they possess and/or control. In a cross-section, firms differ in their respective performance outcomes to the extent that their resources are differentially rare and valuable; the more rare and more valuable resources yielding superior performance. Moreover, such differences may persist over time. Firms sustain superior performance if their rare and valuable resources are also inimitable, non-substitutable and appropriable (Barney, 1991; Grant, 1991).

Although resource-based theory addresses sustained superior performance, it is not immediately obvious how it captures issues related to the Schumpeterian thinking that grounds this research. A review of the resource-based literature finds numerous references to Schumpeter (Amit & Schoemaker, 1993; Barney, 1991; Conner, 1991; Grant, 1991; Mahoney & Pandian, 1992; Rumelt, 1984, 1987). For the most part, these citations link resource-base theory with Schumpeter's process of creative destruction:

> a resource-based view embraces Schumpeter's notion of a dynamic process of creative destruction, in which firms can make stunning gains in (or experience equally stunning losses of) competitive position (Conner, 1991:144)

However, resource-based scholars do not tend to *formally* describe the sources of above-normal profitability in Schumpeterian terms. Nor do they *explicitly* address the imitative

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[4] Discussions of sustained superior performance that are not explicitly resource-based are found in Porter (1985) and Varadarajan and Ramanujam (1986).

competition that ultimately ensures its erosion.[5] Rather, the tendency is to use Schumpeter's creative destruction to illuminate the turbulent environments that foster the creation and ultimate destruction of sustainable competitive advantages. Notable exceptions in this regard are found in Conner (1991) and Rumelt (1987).

Conner (1991:133) suggests the following similarities between resource-based theory and Schumpeterian-type competition: both suggest that above-normal returns result from new ways of competing; both place entrepreneurial vision at the heart of the firm; and both recognize the potential for competitor imitation. In commenting on the differences between the two approaches, Conner (1991) suggests that resource-based theory, moreso that Schumpeter, recognizes that competitors may be constrained in their ability to imitate. However, as shown in Chapter 3, Schumpeter very much recognizes that some innovations are easier to imitate than others. Conner (1991) also suggests that resource-based theory, but not Schumpeter, allows abnormal profits to come from less-than-revolutionary innovations. This difference may be due to differences in the primary level of analysis. Schumpeter examines competitive dynamics from the perspective of a macroeconomist and tends to emphasize the revolutionary innovations that reshape whole industries. Resource-based theorists, on the other hand, are more interested in firm-level phenomena and are more sensitive to less-revolutionary innovations.

Similarly, Rumelt (1987) builds on Schumpeter's ideas by explicitly placing entrepreneurial vision at the heart of a firm's ability to generate abnormal profits, or

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5 There are many references within resource based theory to the issue of inimitability. However, these references tend to apply to the imitability of a firm's resources and capabilities, and not to its specific products or services (see Chapter 7).

entrepreneurial rents. Entrepreneurial rents are " the difference between a venture's *ex post* value ... and the *ex ante* cost of the resources combined to form the venture (Rumelt, 1987: 143)." Rumelt (1987:138) also stresses the importance of isolating mechanisms (or impediments to imitation), which protect the high profits associated with entrepreneurial discovery, by stating that "if competition is swift and frictionless, entrepreneurs can expect only zero profits if projects succeed."

Given the potential correspondence between resource-based theory and Schumpeterian logic (which is developed in detail in Chapter 3), there is an obligation to demonstrate how the proposed Schumpeterian framework fits in with the emerging resource-based perspective. This discussion is saved for Chapter 7, wherein it is argued that a more detailed understanding of Schumpeter's competitive dynamics provides a coherent foundation for further resource-based theory development. For now, it suffices to note that the primary difference between this project and a typical resource-based analysis lies in the current emphasis on the product markets in which firms compete, and not the input markets in which they acquire the resources needed to compete.

Having said this, it is necessary to reconcile an apparent inconsistency between the current approach and that offered by resource-based theory. While "a defining characteristic of the resource-based perspective is the emphasis upon resources as a fundamental determinant of firm performance (Schultze, 1994:130), the current approach locates causality in the evolving composition of a firm' product profile. However, a closer examination of resource-based logic suggests that resources lead to sustainable competitive advantage which, in turn, yields sustained superior performance. And, competitive advantage manifests itself within product markets (Coyne, 1985; Peteraf,

1993). That is, competitive advantage implies an ability to deliver products that have either a differentiation or a cost advantage relative to competing products (Bharadwaj, Varadarajan & Fahy, 1993; Grant, 1991; Porter, 1980). In either case, products must generate revenues for the firm that exceed their total costs of production; they must deliver abnormally high profits.

In all cases, a firm's competitive advantage may be traced to an innovation on the part of the firm. With a differentiation advantage, the firm has introduced some product that is superior to previously-available alternatives; its above-normal profits are the result of a product innovation. In the case of a cost advantage, the firm has uncovered some way to deliver the same product at lower cost. Its above-normal profits result from some other form of innovation; i.e., new production processes, new organizational forms, or lower-cost sources of supply. Finally, these advantages are maintained only as long as competitors are unable to imitate the innovations.[6]

The resource-based link between resources and competitive advantage justifies an examination of the relationship between product innovation and sustained superior performance. As suggested, a more complete exposition of the complementarity between the current Schumpeterian approach and the resource-based explanation for persistent profitability is found in Chapter 7.

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6 Note that because this research focuses exclusively on product innovations (see Note 1), it is explicitly concerned with understanding the implications of differentially sustainable differentiation advantages.

CHAPTER 3: A SCHUMPETERIAN FRAMEWORK

Schumpeterian thinking has grounded diverse attempts to understand the dynamics of innovation, competition and profitability. As suggested above, Mueller (1990) makes explicit reference to Schumpeter in discussing the persistence of firm-level profitability. And, resource-based theorists (e.g., Conner, 1991; Rumelt, 1987) have made several references to Schumpeter's process of creative destruction in trying to understand how sustainable competitive advantage may be built and destroyed within dynamic environments (see also Barney, 1986a). Elsewhere, Nelson and Winter (1982) frame their evolutionary theory of economic change in Schumpeterian terms. Finally, an impressive volume of empirical research has addressed the twin Schumpeterian hypotheses concerning the relationship between innovation and firm size and market structure (Cohen & Levin, 1989; Kamien & Schwartz, 1982).

This chapter argues that a valid understanding of persistent profitability must come to terms with two related questions: Where do relatively-high profits come from? and What factors operate in favor of (and against) their persistence (Mueller, 1986)? Schumpeter provides answers to both of these questions:

> Schumpeter's analysis of how the capitalist engine works recognizes ... the lure and reward for innovation in the quasi rents from a private temporary monopoly. However, in Schumpeter's analysis, the monopoly normally is limited and temporary. Sooner or later, competitors will be able to imitate, or even invent around, or develop a better version of, the initial innovation

(Nelson, 1986:186).

This chapter integrates Schumpeter's insights about product-level competitive and profit dynamics into a coherent firm-level framework on persistent profitability. Section 3.1 summarizes Schumpeter's theorizing about profit dynamics as it relates to innovation (which tends to generate high profitability) and imitation (which tends to drive these high profits onto more normal levels). Although brief, such a discussion establishes the foundation for a Schumpeterian framework on firm-level profit dynamics.

Such a framework is developed in Section 3.2, which explicitly recognizes that these innovation and imitation dynamics operate at a sub-firm level of analysis. It also recognizes that firms may differ in their propensity to introduce streams of valuable innovations, as well as in the intensity of the imitative pressures to which each innovation is exposed. These inter-firm differences are hypothesized to be at the heart of the inter-firm variability in persistent profitability (see Chapter 2). That is, following Schumpeterian logic, firms that are better at innovation and/or face less intense competitor imitation are expected to be those which demonstrate persistent profitability.

3.1 Schumpeter's Profit Dynamics

As suggested above, Schumpeter's writings span a broad spectrum of issues, most of which are beyond the scope of this research. The element of his writings that has caught the attention of strategy scholars and IO economists alike is that relating to the dynamics of competition, which is usually referred to under the heading of 'the process of creative destruction' (Schumpeter, 1950). In very general terms, Schumpeter (1934) set

out to distinguish static economic theory from that which is inherently dynamic. The static component, which has been over-emphasized in both economic and strategy research, entails analyzing the economics of the 'circular flow', wherein managers (as opposed to entrepreneurs) marshal available resources according to known opportunity sets, or established production functions. The price competition that prevails in the circular flow ensures that, given sufficient time, an equilibrium results wherein all resources are paid according to their respective marginal productivities. It is important to stress, as Schumpeter (1934:76) did, that "there is no profit in the circular flow."

Schumpeter and Innovation. To Schumpeter, the emphasis on price competition that dominates static economic theory misses a decidedly more important type of competition:

> it is not [price competition] which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization ... competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and very lives (Schumpeter, 1950:84).

In this more dynamic type of competition, entrepreneurs (as opposed to managers) introduce innovations, or new combinations, into the existing circular flow. In doing so, they upset the prevailing pattern of exchange, moving the economy out of an equilibrium, and into a disequilibrium position. Although the emphasis of this research is on product innovations, Schumpeter's entrepreneur is responsible for innovations found in any of the following categories: new goods, new methods of production, new markets for existing

products, and new forms of organization. In Schumpeter's terms, it is only important that one distinguishes the creative response of the entrepreneur from the adaptive responses that characterize economic decision-making in the circular flow (Schumpeter, 1951).

For a discussion of profitability implications of innovation, the crucial factor is that "the carrying out of new combinations means ... simply the different employment of the economic system's existing supplies of productive means (Schumpeter, 1934:68)." In order to carry out a new combination, the entrepreneur obtains productive factors at prices that correspond to values in the existing circular flow. If successful, the re-deployment of these factors in novel endeavors generates returns that exceed factor costs. This differential between revenues and costs represents the profit to the entrepreneur; "the surplus, to which no liability corresponds, is an entrepreneurial profit (Schumpeter, 1934:132; see also Rumelt, 1987:143)." By responding to perceived opportunities, successful entrepreneurs earn profits.

While Schumpeter's views on innovation could be discussed at much greater depth, it is necessary for current purposes only to recognize that innovation generates above-normal profitability. In support of this point, Geroski, Machin and Van Reenen (1993), who examine the relationship between innovation and firm profitability, find that innovators tend to enjoy higher profits than non-innovators. More specifically, they look at major innovations in sample of 539 U.K. firms and find that each innovation raises the margins of innovating firms by some 16.5% relative to the sample mean.

Schumpeter and Imitation. A second, equally important, dynamic is found in Schumpeter's writing, namely an imitative dynamic:

> [the entrepreneur] also leads in the sense that he draws other producers in his branch after him ... they are his competitors, who first reduce and then annihilate his profit (Schumpeter, 1934:89).

As this suggests, the economic system does not react passively to above-normal profits. Rather, unless otherwise deterred, imitators arise to compete away the profits earned by the innovator:

> the ruling principles are always that the economic process, if unobstructed, first does not tolerate value surpluses in the case of individual products, and secondly always forces the values of the means of production up to those of the products (Schumpeter, 1934:150).

In the extreme, such imitation is immediate and the profit earned by the entrepreneur vanishes almost as soon as it arises; high profits never persist. However, Schumpeter alludes to two factors that might sustain the profits associated with innovation: friction in the competitive mechanisms and the establishment of monopoly positions.

In the abstract, competitor imitation operates independent of time. However, "in practice competition does not act promptly and hence enterprises remain in possession of surpluses for considerable periods of time (Schumpeter, 1934:209)". As such, even when the entrepreneur does not establish an outright monopoly position for the innovation in question, above-normal profitability will persist "until other firms copy his method (Schumpeter, 1951:222)." Based on this insight, the firm-level framework developed in the next section recognizes the general tendency for innovative new products to attract imitation. It also recognizes that the intensity of this imitative process may vary because imitation is more difficult and/or costly for some innovations than for others (Levin *et al.*,

1987; Mansfield, Schwartz & Wagner, 1981; Williams, 1992).

In the extreme, imitation of an innovation is prohibitively costly. In such cases, entrepreneurs have created monopoly positions for their innovations. Schumpeter admits to this possibility, although he clearly makes a conceptual distinction between entrepreneurial profits and the returns to monopoly positions (Schumpeter, 1934:152).[7] For current purposes, it is sufficient to characterize the imitative process as follows. The above-normal profits that are generated as a result of a successful innovation provide an incentive for imitation. To varying degrees, this imitation increases competition levels which erode the profits accruing to the innovator. At one extreme, imitation is unimpeded and the above-normal profits vanish almost instantly. At the other extreme, an innovation is virtually inimitable, generating monopoly returns for the innovator that persist indefinitely.

Summary. Schumpeter hypothesizes the following dynamic relationship between product

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[7] While it is useful to make an analytical distinction between entrepreneurial and monopoly rents, it is not clear-cut at which point entrepreneurial rents become monopoly profits. This is seen most clearly from an Austrian economic perspective, as espoused by Kirzner (1973). From a long-run perspective, all rents may be classified as entrepreneurial rents, even those associated with monopoly resource positions. To the extent that the act of attaining a monopoly resource position was undertaken with no constraints on entrepreneurial activity, such rents are a natural part of the competitive process. It is only when these rents are viewed in the context of established means-ends frameworks (i.e., ignoring the act of innovation that generated the profit opportunity) does one differentiate between the two classes of rents. In the remainder of this research, we sidestep this issue and focus on above-average profitability, which is associated with entrepreneurial and/or monopoly rents (Peteraf, 1994).

innovation, competitor imitation and profitability at the product level. Innovative new products tend to face low competition at the time of their introduction, and therefore tend to earn relatively high profits. These relatively high profits attract imitation, which increases the level of competition faced by the innovative product as time passes. Finally, this increased competition translates into reduced profits for the firm producing the product. This Schumpeterian line of reasoning supports the following pair of hypotheses (H1 and H2), each of which is tested in Chapter 5:

H1: There is an inverse relationship between the level of competition to which a product is exposed and the profits that it earns.

H2: The level of competition faced by innovative new products tends to increase as time passes from the point of introduction.

3.2 A Schumpeterian Framework On Firm-Level Persistent Profitability

An understanding of firm-level persistent profitability which is consistent with Schumpeterian logic must address the fact that these innovative and imitative dynamics do not operate on firms *per se*, but rather on the individual products that are embodied in them. Schumpeter suggests that the returns to a product (or any other type of) innovation will be high in the initial stages of its competitive cycle, but will eventually fall off as competition from imitators intensifies. However, his approach does not *necessarily* suggest that the profit profile of a firm must follow the same course; such would only be the case if all firms were single-product firms. The direct connection between Schumpeter's competitive dynamics and firm-level profitability is severed once one allows

for multiproduct firms. This point is especially important given that even casual observation confirms that few, if any, of the firms typically studied by economists and strategic management scholars are usefully classified as single-product firms.[8] Moreover, Schumpeter's (1950) own writing locates a high proportion of observed innovations in larger, as opposed to smaller firms.

In the latter respect, Schumpeter (1950) argues that large firms are responsible for a disproportionate share of innovative activity and output. Following Schumpeter (1950), a positive relationship between size and innovativeness is expected as large firms have preferential access to the finances required to conduct large-scale research and development (R&D) projects, can take advantage of technological economies of scale in the R&D process, can spread the costs of R&D across a larger sales base, and can capitalize on complementarities between the R&D function and other areas such as marketing and distribution (Cohen & Levin, 1989). On the other hand, large firms may also suffer from the inefficiencies and rigidities that tend to be associated with bureaucratic structures. Schumpeter's (1950) conjecture has spawned a large volume of empirical research, the results of which are mixed (see Cohen & Levin, 1989; Kamien & Schwartz, 1982; Scherer, 1992; Schwartzman, 1976). So much so, in fact, that in their review of the empirical research conducted in this area, Cohen and Levin (1989:1069) conclude that "the most notable feature of this considerable body of empirical research on the relationship between firm size and innovation is its inconclusiveness."

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8 A firm may be multiproduct even if it is not diversified across several industries. As such, our usage of multiproduct is distinct from that of for example, Teece (1982), wherein a multiproduct firm is one which competes simultaneously in several different industries.

Therefore, there is no solid evidence that large firms are more innovative than their smaller counterparts. However, what is important for current purposes is not whether larger or smaller firms are more innovative *per se*, but merely the recognition that multiple innovations may be embodied within a single firm. Extending this, one would expect that firms may introduce innovations at several different points in their respective histories and that a firm's profitability at any point in time is related to all of the innovations that have been introduced, each of which might be at a different stage of its competitive life cycle. Those that have been introduced recently may still be in relative monopoly positions while older products may be exposed to much greater levels of imitative competition.

To substantiate this image of multiproduct firms, one need only look at examples of how the pattern of product innovation within firms determines the composition of its product profile at any point in time. Table 1 summarizes the product portfolios of the three largest pharmaceutical firms in terms of their 1993 U.S. pharmaceutical sales (Merck, Bristol Myers Squibb, and Glaxo). It shows that each firm frequently brings new products to the market; at a rate of roughly three per year in the case of Bristol Myers Squibb. Therefore, even if one ignores the non-pharmaceutical operations for these firms, their 1993 profitability must be linked to all of the up to 166 different products produced in that year (Comanor, 1986). And these products have been on the market for as little as two years and as many as 44 years. It is therefore likely that each is exposed to varying levels of imitative competition, implying different profit contributions for the firms that produce them (Cocks, 1975). On average, recently-innovated products (i.e., *Zocor* for Merck and *Cefzil* for Bristol Myers Squibb) stand a greater chance of earning relatively high profits than do those introduced in the 1940s.

Table 1
Multiproduct Pharmaceutical Firms

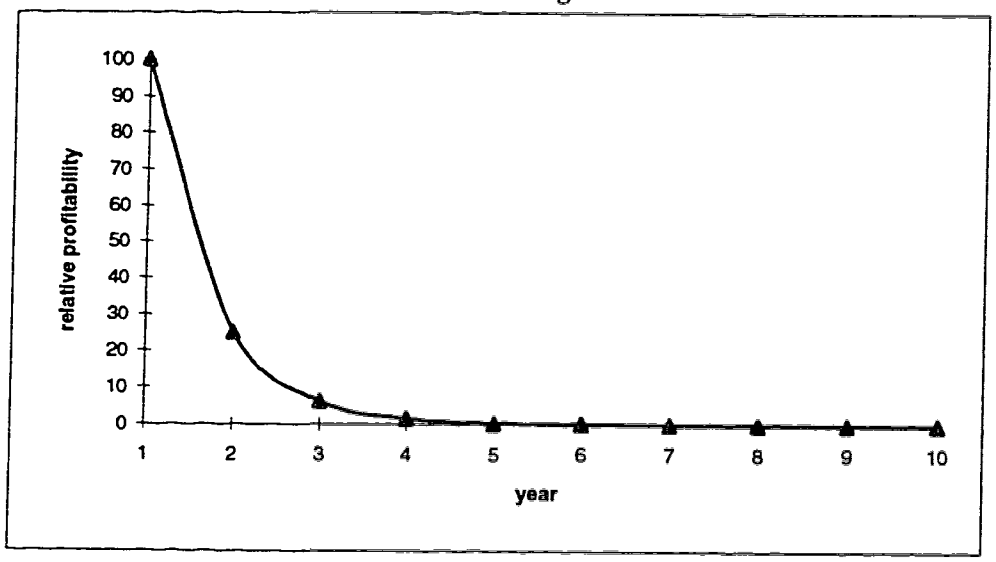
Merck	Bristol Myers Squibb	Glaxo
Mevacor (1987)	Capoten (1981)	Beclovent (1979)
Vasotec (1986)	Buspar (1986)	Ventolin (1981)
Prilosec (1990)	Pravachol (1991)	Beconase (1981)
Pepcid (1986)	Duricef (1978)	Ventolin A (1981)
Zocor (1992)	Cefzil (1992)	Ventolin B (1981)
Prinivil (1987)	Vepesid (1983)	Ventolin C (1981)
Timoptic (1978)	Taxol (1992)	Zantac (1983)
Primaxin IV (1985)	Corgard (1979)	Zinacef (1983)
Mefoxin (1978)	Paraplatin (1989)	Zantac IV (1984)
Proscar (1992)	Platinol AQ (1989)	Trandate (1984)
Vaseretic (1987)	Azactam (1987)	Trandate IV (1984)
Noroxin (1986)	Ifex/Mesnex (1989)	Fortaz (1985)
Plendil (1991)	Estrace (1975)	Temovate (1986)
Recombivax HB (1987)	Excedrin Ex Str (?)	Aclovate (1987)
Flexeril (1975)	Questran Light (1989)	Ceftin (1988)
Total Products=59[b]	Total Products=166[b]	Total Products=25[b]
Earliest Intro=1941	Earliest Intro=1942	Earliest Intro=1979

Source: IMS America
[a] year of introduction in parentheses
[b] achieving annual sales of at least $2 million during the 1977-1993 period

Therefore, researchers interested in firm-level persistent profitability are forced to confront a significant level of analysis issue; they need an approach that allows them to go inside the firm. The following comments introduce a dynamic approach which recognizes that firms differ in their propensity to generate streams of valuable innovations, as well as their ability to shield those innovations from the imitative pressures that erode above-normal profits. Stated differently, firms may be heterogeneous with respect to both of Schumpeter's dynamic processes, and such heterogeneity may explain the observed pattern of firm-level persistent profitability.

Consider the example in Figure 1. In this example (which is intendedly abstract), it is assumed that an innovative product earns profits that are one hundred percent above

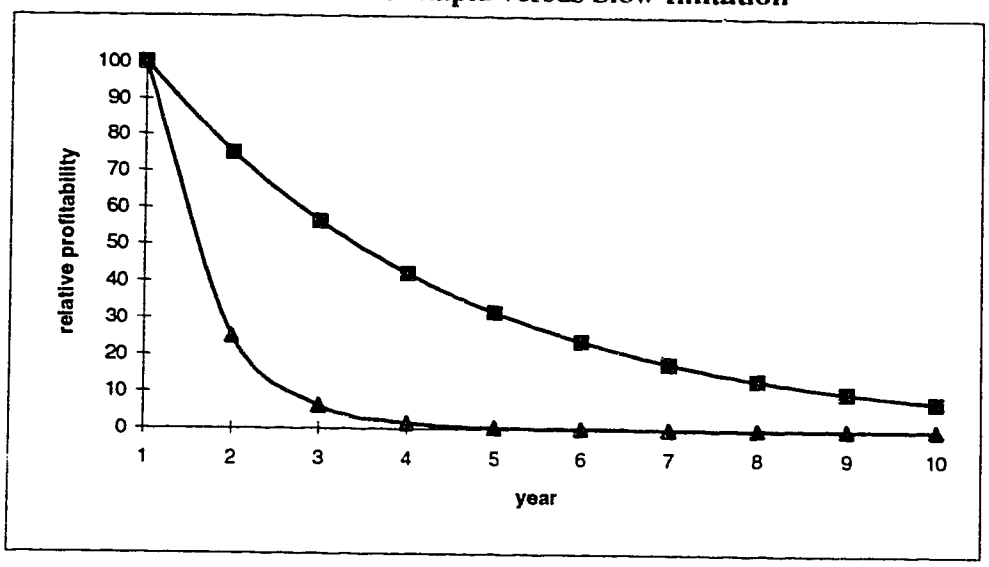
Figure 1
Profit Profile of Single Product



normal in its first year, but that competitive imitation ensures that 75 percent of above-normal profits are eroded away each year. Accordingly, the high profits generated by the innovative product in year one all but disappear by year five. Although abstract, such an example is consistent with the Schumpeterian logic outlined in Section 3.1 as it embodies relatively high profits in the period directly following the product's introduction and rapid convergence toward more normal profits as imitative pressures intensify.

Figures 2 and 3 demonstrate the firm-level profit streams that might arise under different scenarios. Figure 2 compares two single-product firms. The 'rapid-imitation' firm's only product is that represented in Figure 1 and, correspondingly, its above-normal profitability all but vanishes by the end of year five. On the other hand, the product produced and sold by the 'slow-imitation' firm faces less severe imitative competition; its excess profits erode at a rate of only 25 percent per year. As shown in Figure 2, this second single-product firm, because it is more effective at shielding its product from the

Figure 2
Profit Profiles: Rapid versus Slow Imitation

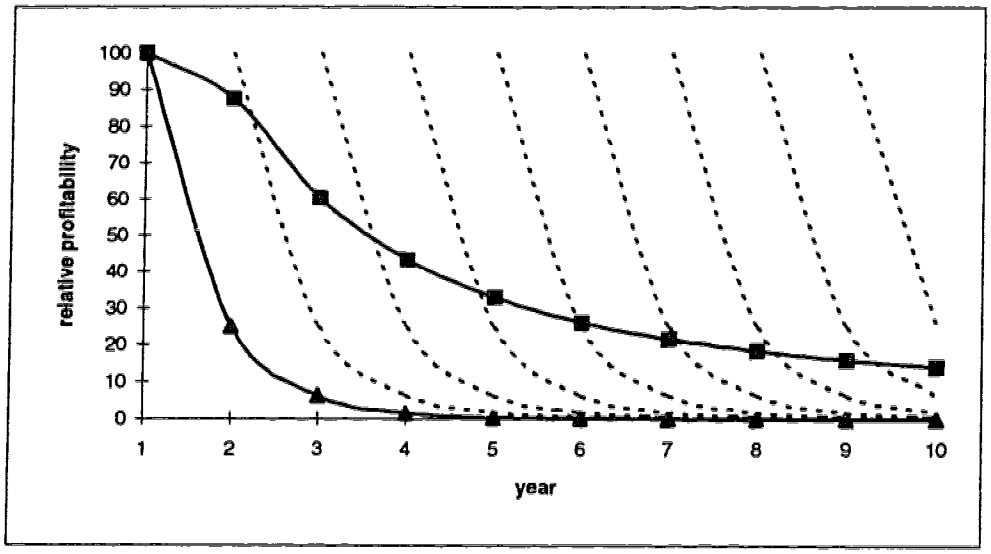


▲ Single-Product, Rapid Imitation
■ Single Product, Slow Imitation

erosive effects of competitor imitation, sees its relatively high profits persist for a longer period of time. By the end of year five, the slow-imitation firm is still earning profits that are roughly thirty percent above the norm. In fact, the firm is still relatively profitable at the end of year ten. It is critical to stress that *the only difference* between the two firms in Figure 2 is the differential rates of profit erosion experienced by their respective single products. As such, this comparison illustrates that one explanation of firm-level persistent profitability may be traced to variability in the rate of competitor imitation which erodes the above-average profits earned by its innovative products.

Figure 3 compares a single-product firm with a multiproduct firm. Once again, the single-product firm's only product is that represented in Figure 1. Because it is a single-product firm, Schumpeter's dynamics apply directly at the firm level, and the firm's profit profile is identical to that depicted in Figure 1. Relatively high profitability is

Figure 3
Profit Profiles: Single versus Multiproduct Firms



▲ Single-Product Firm
■ Multiproduct Firm

attained as a result of the innovation, but imitative competition ensures that it does not persist for long. On the other hand, the multiproduct firm embodies a series of product innovations. Here, it is assumed that the firm introduces an innovative new product to the market in each of the ten years depicted. It is also assumed that (as in Figure 1) each innovate product initially earns profits that are one hundred percent above normal and that above-normal profits erode at a rate of 75 percent per year. Finally, the overall output of the multiproduct firm in any year is assumed to be equally distributed across all products.[9] Now, although the profit profile corresponding to each product is identical to that depicted in Figure 1, the multiproduct firm experiences persistent profitability as a direct result of its innovative propensity. Figure 3 shows that, even when the potency of the

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[9] The comparison would be even more stark if the firm adjusted its output to produce and sell a higher proportion of the more recently-innovated (and higher-profit) products.

Table 2
Three Explanations for Firm-Level Persistent Profitability

Explanation	Relatively-High Profitability	Innovations Generated	Imitation Process
Base Case	Transitory	Few	Rapid
Monopoly-Based	Persistent	Few	Slow
Innovation-Based	Persistent	Many	Rapid
Hybrid	Persistent	Many	Slow

imitative process is held constant, persistent profitability may observed when a firm is able to introduce a series of valuable new products to the market. This suggests that a second explanation of firm-level persistent profitability may be traced to firms' differential abilities with respect to product innovation.

The discussion of Figures 1 through 3 formalizes our Schumpeterian framework on firm-level persistent profitability. Its implications may be summarized as follows. Relatively high profits flow from innovations (see Section 3.1). Therefore, it makes sense to trace above-normal profitability to some innovation on the part of a firm. Once attained, high profits at the firm level may persist in one of three ways (see Table 2). Firm-level persistent profitability may be explained with reference to a *monopoly-based* explanation, an *innovation-based* explanation, or a *hybrid* (monopoly-innovation) explanation.

The Monopoly-Based Explanation. Either by chance or by design, a firm may introduce an innovative product (or group of products) that is buffered from the imitation that

would otherwise erode the high profits associated with its introduction. This monopoly-based explanation is consistent with the position taken by the persistent profitability researchers (see Geroski & Jacquemin, 1988:379) whereby persistent profitability is thought to imply anti-competitive behavior on the part of firms. It is also consistent with observations made by Williams (1992), who notes that products can range from low to high imitability based on the types of resources which underly their production. At one extreme, some products depend on 'slow-cycle' resources and are therefore isolated from the erosive effects of imitation for longer periods of time.

The monopoly-based explanation assumes that firms are differentially shielded from the competitor imitation which erodes high profitability. As such, in terms of conducting empirical research, one seeks evidence in support of the following hypothesis:

H3: The relationship between changes in the level of competition faced by products and elapsed time (see Hypothesis H2) differs across firms.

The Innovation-Based Explanation. The innovation-based explanation recognizes that relatively high profits may persist at the firm level even though competitor imitation is fairly intense. In such a case, the excess profits associated with any single innovation are indeed transitory, but firms successfully introduce multiple product innovations over time. Whereas in the former case, persistent profitability accrues to firms with unchanging product portfolios, these latter firms sustain above-average profitability with rapidly changing product portfolios. Again, note that the innovation argument rests on the assumption that firms are differentially able to introduce a series of innovative new products to the market. As such, the following hypothesis must be tested:

H4: Firms differ in the rate at which they introduce innovative new products to the market.

Finally, a 'hybrid' explanation recognizes that the monopoly and innovation arguments are not mutually exclusive. That is, firms may be moderately capable product innovators, generating a few valuable innovations. At the same time, each of their innovations may be subjected to only a moderate level of competitor imitation. The combination of these two moderate capabilities might ensure the persistence of above-average profitability at the firm level.

This completes the development of a Schumpeterian perspective on firm-level persistent profitability. The primary insight gained relates to placing the innovation-based and hybrid explanations of profit persistence alongside the monopoly-based explanation that is typically invoked by persistent profitability researchers. Although these scholars have tended to recognize innovation as the source of above-normal profits, they rely exclusively on imperfect competition as the cause of its persistence. In the course of developing this framework, several hypotheses have been put forth, which are to be tested in Chapter 5 using data from the U.S. pharmaceutical industry.

CHAPTER 4: THE PHARMACEUTICAL INDUSTRY

> the leading firms in the drug industry are likely to earn high profits and do so persistently because of the importance of innovation in this industry. The innovators are the largest firms and their relatively high profits will persist as long as they *continue to innovate* and their new products are *protected against imitation* (Schwartzman, 1976:153, emphasis added)

In the introduction, two goals were established for this research, one that is quite general and one that is more applied. At a general level, the aim is to understand the relationship between Schumpeterian dynamics at the product level and persistent profitability at the firm level. Toward this end, the previous chapter outlined the dynamic Schumpeterian framework that is adopted in this research, while Chapters 5 and will discuss the proposed research methods and findings. The more applied goal is to employ the framework in an effort to understand the dynamics of firm profitability in the U.S. pharmaceutical industry. Because pharmaceutical industry competition and profitability have been discussed at great length within the pharmaceutical economics literature, it is imperative that the current project be located within such debates.

The pharmaceutical economics literature addresses three major issues, each of which is consistent with a Schumpeterian perspective. First, pharmaceutical firms are in a constant struggle to introduce innovative new products to the market. Second, these firms (some more than others) also engage in imitative R&D in an attempt to produce

imitator, or 'me-too' drugs, which are close substitutes to successful innovative products. These, in conjunction with the generic substitutes that appear upon expiration of patents, increase the level of competition to which products are exposed as time passes. Finally, the financial performance of pharmaceutical firms is strongly influenced by both of these innovation and imitation dynamics.

4.1 Profitability In The Pharmaceutical Industry

The pharmaceutical industry is well-suited to an analysis of persistent profitability. The industry as a whole is under constant attack because of its persistent above-normal profitability. Schwartzman (1976) reports that between 1968 and 1972, pharmaceutical industry return on equity (ROE) was, on average, 7.5 percentage points higher than the corresponding rate for all manufacturing industries. Similarly, Campbell and Smith (1978) find that average pharmaceutical return on investment (ROI) exceeded that for all manufacturing by 63 percent over the 1958 to 1975 period. More recently, Menga and Mueller (1991) show that the ROA for leading pharmaceutical firms averaged roughly fifteen percent between 1975 and 1985, a rate that far exceeded the corresponding estimates for all manufacturing firms.

Moreover, a close examination of Mueller's (1986) findings reveals that sustained above-normal pharmaceutical profitability is also a firm-level phenomenon. Of the 50 large U.S. firms found to experience long-run profitability at least 50 percent above average, nine were pharmaceutical firms (see Table 3). For the current purposes, this latter phenomenon is of greater interest because it indicates that several, but not all,

Table 3
Pharmaceutical Firms with Above-Normal Long-Run Profits

Firm	% Above the Norm
SmithKline & French Labs	218
Merck	212
American Home Products	171
Eli Lilly	161
Bristol-Myers	151
Upjohn	143
Sterling Drugs	134
Warner-Lambert	130
Schering-Plough	117

Source: Mueller, D. 1986. *Profits in the Long Run*. Cambridge: Cambridge University Press

pharmaceutical firms have been able to attain and sustain above-average profitability. This point is corroborated in Menga and Mueller (1991) who find 1975-1985 average pharmaceutical firm ROA ranged from negative ten percent to positive twenty percent. Based observations such as these, a considerable amount of commentary is devoted to explaining high pharmaceutical firm profitability (Comanor, 1986). At a general level, such discussions mirror the basic premises underlying this research in that they have recognized two sources of profitability: monopoly and innovation. However, whereas the current framework allows both arguments to operate (to varying degrees) simultaneously, the pharmaceutical economics literature tends to pit one explanation against the other.

Consistent with the orientation of orthodox economists, the initial reaction to pharmaceutical firm profits is to invoke a monopoly explanation. Ayanian (1975:81), for example, comments that:

> one sees persistently high profit rates year after year, giving rise to the view that there exists a monopoly problem here that has not been dealt with by

market forces.

In response, several pharmaceutical economists argue that the accounting rates of return measures that are typically examined are poor indicators of monopoly profits (e.g., Ayanian, 1975; Brownlee, 1979; Clarkson, 1979; Schwartzman, 1975). This issue is revisited in Chapter 5. For now, it is illustrative to note that Schwartzman (1976) accounts for the entire 7.5 percentage point differential between pharmaceutical and economy-wide ROE (over the 1968 to 1972 period) with reference to differential R&D expenditures, risk and sales growth.

For those less content to explain away the profit differentials, the tendency is to critique the static orientation of the orthodox monopoly arguments. In this respect, Schwartzman (1976) notes that although concentration ratios within therapeutic markets are high at any one time (implying the possibility of oligopolistic pricing behavior), there is considerable turnover as innovative new products supplant dominant therapies. For example, five products accounted for roughly 74 percent of broad and medium-spectrum antibiotic sales in 1960. However, these same five products accounted for less than 13 percent of class sales in 1973. At the same time, the top five selling drugs in 1973 accounted for over 50 percent of total class sales in that year. Similar examples are given for several other therapeutic classes (see Schwartzman, 1976:129-130), each of which suggests that the standard static monopoly arguments do not adequately capture the dynamic nature of pharmaceutical industry competition and the dynamic sources of firm profitability. Monopoly (or oligopoly) arguments fail if the firm dominance that is implied by high cross-sectional concentration figures quickly vanishes with the introduction of innovative new products (Schwartzman, 1976).

As the following discussion attests, alternative explanations of firm profitability have (either explicitly or implicitly) alluded to Schumpeter's innovation and imitation dynamics. This is not to say that the monopoly explanation is completely dislodged. As Schumpeter recognized, innovation generates monopoly positions, while imitation *tends to* ensure that such positions are transitory. As such, persistent profitability may be explained with reference to the standard monopoly argument in those cases where imitative competition is demonstrably absent for prolonged periods of time. However, a Schumpeterian framework also allows for the fact that highly innovative firms translate a series of transitory product-level monopolies into firm-level persistent profitability. The next section demonstrates how the pharmaceutical economics literature has portrayed pharmaceutical industry competition in a manner that is consistent with a Schumpeterian framework. This completes the justification for employing such a framework to analyze pharmaceutical firm-level persistent profitability.

4.2 Competition In The Pharmaceutical Industry

The current approach is founded on the premise that a firm's profitability is inextricably linked to the portfolio of products that it sells at any given time. The competitive status of each firm's portfolio evolves as firms introduce valuable product innovations at different points in time and as competing firms introduce substitute products to the market. Product portfolios that are dominated by recent innovations tend to be, relatively speaking, sheltered from the impacts of imitative competition and therefore associated with higher profitability at the firm level. On the other hand,

portfolios that are devoid of recent innovations tend to be subject to higher levels of imitative competition and are associated with less exceptional profitability.

The image of the competitive process that emerges is one wherein firms struggle to develop and introduce valuable innovations, all the while aware that imitative forces may eventually erode any above-normal profits that are associated with them. This is precisely the image portrayed in analyses of competition within the pharmaceutical industry. Comanor (1986:1193), for example, notes that:

> new drugs are a major determinant of industry profits. The picture that emerges is that major pharmaceutical firms earn normal profits on their older products but quite high returns on newer ones.

The following comments find specific support for each of Schumpeter's dynamics, as well as the fact that such dynamics operate within firms, necessitating a view of pharmaceutical firms as evolving portfolios of drug products.

Allusions to the innovative and imitative processes that characterize drug markets are implied in the various distinctions made between radical innovations on the one hand and incremental innovations on the other (e.g., Achilladelis, 1993). Kemp (1975), for example, distinguishes between breakthrough and follow-on drugs. The former group represents truly innovative new products while the latter encompasses those drugs that are either close or perfect substitutes for existing therapies. In similar fashion, other studies have differentiated new chemical entities (NCEs) from follow-on (including new chemical combinations and new dosage forms) and generic drugs (Comanor, 1964; Office of Technology Assessment, 1993; Schnee, 1979). The observed flow of radical or breakthrough drugs attests to the fact that pharmaceutical firms seek the above-normal

profits associated with innovative product introductions. At the same time, the introduction of follow-on and generic drugs is evidence that those above-normal profits provide the impetus for the introduction of imitator products.

Some researchers clearly recognize that high profits flow from the development of innovative new drugs and that pharmaceutical firms are primarily interested in developing breakthrough drugs (Schwartzman, 1976; Taggart, 1993). Cocks (1975:232) makes the point that:

> when a firm demonstrates that it has been successful in introducing significant new products, its *ex post* profit can be expected to be relatively higher than that of firms which are less successful with their R&D investments.

Similar remarks are made by Comanor (1964:374), who notes that "completely new chemical entities [are] the most desirable type of new product," and by Grabowski and Vernon (1979).

Once introduced, drugs are protected by a patent system which, according to Levin *et al.* (1987) and Mansfield, Schwartz and Wagner (1981) is relatively effective in mitigating competitor imitation. However, the patent system only temporarily stops competitors from introducing products that are identical to pioneering drugs. It does not stop them from engaging in imitative R&D in an attempt to develop follow-on drugs which capture some of the returns accruing to successful innovations (Weston, 1979). Such a prospect encourages firms "to introduce new products that may have only slight advantages over, or even duplicate, existing therapy (Cocks, 1975:227)." At an extreme, some researchers argue that such activity is the principal source of new product

introductions in the industry (Jadlow, 1979). However, Schnee and Caglarian (1978) and Schwartzman (1976) document how the vast majority of drugs that are prescribed in any one year would have been unknown as little as ten years prior, attesting to the prevalence of an innovative, as well as an imitative process. Given the large number of breakthrough drugs that have been introduced, it is more appropriate to view pharmaceutical firms as engaging in R&D in order to develop both radical innovations as well as imitator drugs (Kemp, 1975).

The above discussion locates references to each of Schumpeter's innovation and imitation processes within the pharmaceutical economics literature. In closing this section, note that several researchers also allude to the fact that these processes operate at the sub-firm level and that pharmaceutical firms should be modeled as evolving portfolios of products. In the words of Comanor (1986:1182):

> major drug firms produce and distribute large numbers of products, and the margins realized for individual products may not be typical of the firm as a whole.

More concretely, Cocks (1975:228) describes the multiproduct pharmaceutical firm in the following way:

> the market positions of a firm's various products range from strong "market power" to pure market competition. This appears to be a realistic assumption for the drug industry. Newly patented drugs may have "market power" positions depending on their therapeutic uniqueness. As drugs mature commercially and substitutes become available, markets move closer to pure competition (Cocks, 1975:228).

4.3 Data Sources

As the above discussion implies, empirical analysis requires data from two different levels of analysis: the firm level and the product level. At the firm level, annual profit and sales data are required across a sample of pharmaceutical firms over several consecutive years. At the product level, annual data describing several aspects of the drug product offerings for each sampled firm are required, including product sales, therapeutic class membership, therapeutic class sales and year of introduction. Annual accounting data (including income, assets and sales data) describing a large number of pharmaceutical firms are available from the Compustat data base for each of the most recent twenty years (1974 to 1993). Additionally, Intercontinental Medical Statistics (IMS) America has been collecting pharmaceutical product data (for the U.S. market) for at least the past twenty years. The most recent seventeen years (1977 to 1993) of data were obtained for this analysis. The IMS America data includes annual product sales data, therapeutic class membership, and year of product introduction. In addition, IMS America reports annual data on total therapeutic class sales. Selected information from these two data bases have been combined to input into the following analysis.

The Product-Level Data File. Initially, each of the largest 35 firms (according to 1993 U.S. pharmaceutical sales) was considered for analysis. However, several firms were dropped for different reasons. Most of the excluded firms (e.g., Ciba Geigy, Roche, Sandoz, and Miles) are based in Europe and are not covered in the Compustat data base. As such, reliable firm-level profit and sales data could not be easily obtained. In the case

Table 4
Sampled Pharmaceutical Firms

1. Merck	11. Upjohn
2. Bristol Myers Squibb	13. Marion Merrell Dow
3. Glaxo	14. Warner-Lambert
4. American Home Products	17. Syntex
5. Johnson & Johnson	22. Rhone Poulenc Rorer
6. Lilly	23. Searle
7. SmithKline Beecham	24. American Cyanamid
8. Pfizer	28. Sterling
9. Abbott	33. Carter-Wallace
10. Schering-Plough	

Numbers indicate 1993 U.S. pharmaceutical sales ranking

of Procter & Gamble, U.S. pharmaceutical operations accounted for an extremely low percentage (i.e., less than four percent) of overall sales. The final sample, consisting of nineteen firms, is described in Table 4. As Table 5 indicates, the pharmaceutical sales of these nineteen firms account for roughly 60 percent of total U.S. sales in any one year.

Consistent with the conceptual underpinnings of this analysis, in any year, a large pharmaceutical company produces and sells upwards of one hundred different products (see Table 1). Moreover, the firms' portfolios of products change from one year to the next. In order to keep the project manageable, it is necessary to extract a subset of these products for inclusion in the analysis. A decision was made that only those products achieving at least $2 million in sales at some point during the sample period would be included. A total of 1,628 products surpassed the $2 million threshold in at least one year between 1977 and 1993 and were produced and sold by one of the nineteen sampled firms at some point during the sample period. Although a large number of smaller products are not included in the product-level data file, Table 6 indicates that the sampled products account for an average of 93 percent of each firm's total U.S. pharmaceutical sales in any one year.

Table 5
U.S. Pharmaceutical Sales
(in Sample and Total)

Year	Sales In Sample ($M)	Total Sales	Percent in Sample
1993	37,419	58,600	63.9
1992	33,023	50,643	65.2
1991	30,908	47,597	64.9
1990	27,099	41,877	64.7
1989	23,263	37,418	62.2
1988	20,792	32,882	63.2
1987	17,507	28,844	60.7
1986	15,346	25,153	61.0
1985	13,654	22,657	60.3
1984	12,584	20,623	61.0
1983	11,192	18,159	61.6
1982	9,638	15,852	60.8
1981	8,346	13,962	59.8
1980	7,043	12,114	58.1
1979	6,226	10,677	58.3
1978	5,515	9,579	57.6
1977	5,069	8,797	57.6

This section closes by summarizing the content of the product-level data file. As suggested above, it contains annual data describing 1,628 different drug products. Because the sample period covers seventeen years, there are potentially 27,676 different product-year observations. However, many of the product-year combinations contain missing data. Some products were introduced after 1977, while in other cases, the product was removed from the market prior to 1993. For each valid product-year combination, the data file contains information describing (1) the firm producing the product, (2) the year in which the product was introduced, (3) the sales of the product in U.S. dollars, (4) the therapeutic class and sub-class which contain the product, and (5) the total sales of the therapeutic class and sub-class. As one proceeds though the following, descriptions are provided of how modified versions of this product-level data file are used

Table 6
Percent of Firms' Total Pharmaceutical Sales in Sample (1977-1993)

	Avg.	Min.	Max.
Merck	97.4	92.3	99.5
Bristol Myers Squibb	93.7	88.0	98.5
Glaxo	84.6	52.0	100.0
American Home Products	94.9	87.0	97.6
Johnson & Johnson	95.0	83.3	98.0
Lilly	94.7	90.2	99.5
SmithKline Beecham	95.7	87.9	99.0
Pfizer	93.8	66.6	98.7
Abbott	92.7	85.8	96.8
Schering-Plough	93.7	90.6	97.5
Upjohn	96.0	89.9	99.1
Marion Merrell Dow	94.3	85.8	99.6
Warner-Lambert	91.7	83.1	96.2
Syntex	95.6	86.4	99.7
Rhone Poulenc Rorer	92.7	86.7	96.9
Searle	96.0	83.0	98.8
American Cyanamid	86.6	73.3	95.1
Sterling	89.1	79.2	94.5
Carter-Wallace	89.1	70.9	96.0
All Firms	93.0	52.0	100.0

as inputs into the various analyses.

CHAPTER 5: MODEL VALIDATION

In Chapter 3, Schumpeterian logic was employed to develop a framework which explains firm-level persistent profitability. Chapter 4 alluded to the correspondence between this framework and current thinking on product innovation, imitation and persistent profitability in the pharmaceutical industry. In this chapter (and in Chapter 6), such correspondence is demonstrated by undertaking an empirical analysis of firm-level profit dynamics in the U.S. pharmaceutical industry. More specifically, Chapter 6 presents analyses which demonstrate the impacts of innovative propensity and competitor imitation on firm-level persistent profitability. Prior to such an analysis, however, it is important to first validate several features of the Schumpeterian framework.

Sections 5.2 through 5.4 describe the methods employed to test the hypotheses (H1 through H4) that were set out in Chapter 3, as well as the results that are attained from an analysis of the data summarized in Section 4.3. First, however, Section 5.1 shows that the sampled pharmaceutical firms experience persistent profitability to differing degrees. Section 5.2 then presents evidence suggesting that the highest profits tend to come from the sales of those products which are exposed to the lowest levels of competition (H1). Section 5.3 shows that, on average, innovative (as opposed to imitator) new products are exposed to increasing levels of competition the longer they are on the market (H2). It also confirms that firms vary in their propensity to protect their innovative product offerings from competitor imitation (H3). Finally, Section 5.4 presents data showing that firms are differentially successful in bringing innovative new products to

market (H4).

5.1 Persistent Profitability in the U.S. Pharmaceutical Industry

The impetus for this research stems from a desire to understand the relationship between product innovation, competitor imitation and the *dynamics of* firm-level profitability. It is therefore necessary to move away from cross-sectional methods and towards a method that captures the inter-temporal behavior of firm profitability. As noted in Chapter 2, such a movement has already occurred within the IO economics literature, spurred by scholars interested in the persistent profitability question (e.g., Mueller, 1977, 1986, 1990). Section 2.1 outlined the conclusions that may be drawn based on this research. This section describes the methods used to examine firm-level persistent profitability before describing the inter-temporal behavior of firm profitability among the nineteen sampled pharmaceutical firms.

Method. Researchers have employed different approaches to analyze profit dynamics. Much of the early work was conducted at an industry level of analysis (Brozen, 1970; Qualls, 1974). However, from a methodological standpoint, such studies are of minor concern to us because our interest is with firm-level (and sub-firm level) profit dynamics. At the firm level, Mueller's (1977) seminal article examines the probabilities that firms within eight different profitability groups (ranging from very high to very low) at one point in time retain their initial profitability status as time passes. The null (or competitive markets) hypothesis is that all abnormally high and low profit outcomes eventually

dissipate. As such, the probability of eventually occupying a particular profitability group should be independent of the group occupied in the initial period.

In the same analysis, Mueller (1977) regresses *normalized* firm-level profits on the reciprocal of elapsed time (t):

$$\pi_{it} = \alpha_i + \beta_i * (1/t) + \varepsilon_{it} \qquad 5.11$$

where π_{it} is an indicator of the relative profitability of firm i in year t:

$$\pi_{it} = \frac{\left(\Pi_{it} - \Pi_{avg,t}\right)}{\Pi_{avg,t}}$$

Π_{it} being the realized profitability of firm i in year t and $\Pi_{avg,t}$ being a measure of the average profitability across all i firms in year t. In equation 5.11, as t becomes larger, 1/t approaches zero. As such, α_i provides an indication of the abnormal returns that remain *in the long run*. It is not significantly different from zero when profits eventually converge on normal levels. At the same time, β_i reflects the rate at which such convergence occurs. In more recent work, Mueller (1986) recognizes that the first-order specification of equation 5.11 arbitrarily forces convergence on the model. That is, regardless of the estimate of β_i, β_i *(1/t) approaches zero as t becomes progressively large. To overcome this limitation, he proposes a model which includes squared and cubed expressions of 1/t:

Mueller (1986) also suggests that the dynamic behavior of firm profits might be examined by estimating the autoregressive properties of the profit time series:

$$\pi_{it} = \alpha_i + \beta_i * \pi_{it-1} + \varepsilon_{it} \qquad 5.12$$

In equation 5.12, α_i and β_i are two parameters which jointly describe the dynamics of firm-level profitability.[10] The β_i estimate indicates the rate at which relatively high and low profits converge on the estimated average levels. A β_i estimate that is not significantly different from one indicates a complete forestalling of the erosion-of-returns process. In such cases, abnormal returns persist indefinitely. More generally, the higher is the β_i estimate, the more persistent are the abnormal profit outcomes. Additionally, the α_i and the β_i estimates combine to produce an indicator of the level upon which firm profits converge in the long run. If one considers the long run as the point at which period-to-period changes in profitability cease, then an estimate of the long-run rate of return (π_{ilr}) may be attained by setting π_{it} equal to π_{it-1} (see Scholl, 1990:391):

$$\pi_{ilr} = \alpha_i / (1 - \beta_i)$$

An π_{ilr} estimate that is not significantly different from zero indicates that relatively high and low profits tend to converge upon average levels in the long run. An estimate that is significantly different from zero indicates that a firm is earning relatively high (or low) profits, even in the long run.

Equation 5.12 has become the modal one taken by persistent profitability

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10 Geroski (1990) discusses the approaches in equations 5.11 and 5.12 in greater detail and describes how equation 5.12 is actually a reduced-form representation of a dynamic model of competitive entry.

researchers (Geroski, 1990; Geroski & Jacquemin, 1988; Levy, 1987; Mueller, 1986; Odagiri & Yamawaki, 1986; Schohl, 1990; Yamawaki, 1989), and will be the one used in the following. In this section, both industry-wide (i.e., pooled, cross-sectional) and firm-specific regressions are estimated. In the industry-wide regression, the α_i and β_i coefficients are forced to be the same across firms. Estimation uses the information contained in all firms' profit time-series to characterize average industry dynamics. The industry-level results are complemented by examining profit dynamics in firm-specific regressions. Here, the α_i and β_i estimates are allowed to vary across the nineteen sampled firms. Estimation of firm-specific regressions identifies those firms for which long-run profit levels are significantly different from average, as well as those with significantly higher or lower rates of convergence toward long-run levels.

As stated, equation 5.12 examines the path of convergence followed by *all* firm-level profit outcomes which deviate from the industry average, including those that are below, as well as above the average. However, the Schumpeterian framework outlined in Chapter 3 explicitly models the persistence of *above-average* profit outcomes. It says nothing about expectations *vis-à-vis* the dynamic path taken by abnormally-low profits.[11] For the purpose of analyzing *persistently-high* profitability, it is useful to run separate versions of equation 5.12, one that covers all observations, and another that covers only those observations for which π_{it} is greater than zero. Before proceeding with the estimation of these models, the twin issues of measuring firm-level profitability and operationalizing average profitability must first be addressed.

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[11] This is not to say that the persistence of below-normal returns is not an interesting topic of study.

Measuring Firm-Level Profitability. Debates about performance measurement are found in the strategy literature (Blaine, 1993; Chakravarthy, 1986; Varadarajan & Ramanujam, 1990; Venkatraman & Ramanujam, 1986), the economics literature (Jacobson, 1987; Menga & Mueller, 1991; Mueller, 1986:105-110, 1990:8-14; Scherer & Ross, 1990:415-426), and especially the pharmaceutical economics literature (Ayanian, 1975; Brownlee, 1979; Campbell & Smith, 1978; Clarkson, 1979; Cooper & Parker, 1968; Mund, 1969; Schwartzman, 1975, 1976). While recognizing the importance of such debates, the primary aim of the following paragraphs is to provide support for after-tax return on assets (ROA) as a measure of firm-level profitability.

According to Scherer and Ross (1990:416), "profit is the surplus of revenue over cost, including the cost of attracting capital from other uses." Although ideal measures are difficult to attain, they suggest three 'second-best' profitability measures: accounting rates of return (including ROA), Tobin's q ratio, and the price-cost margin. The correlations between accounting rates of return and Tobin's q are typically quite high and "neither measure is innately superior to the other in detecting supra-competitive profits (Scherer & Ross, 1990:417)." Mueller (1990) agrees, suggesting that the primary difference between the two is that Tobin's q tends to capture future economic returns, while ROA measures only current returns. The goal of this analysis is to analyze the period-to-period dynamics of current profitability that are attributable to product innovation and changes in competitor imitation. As such, it is not desirable to have current and future returns confounded in the same profit measure. ROA is therefore the

preferred measure of firm profitability. It is defined in the following manner:[12]

$$\Pi_{it} = \frac{\text{Net Income} + \text{Interest Payments}}{\text{Total Assets}}$$

In support of this decision, accounting rates of return are used extensively by scholars examining the dynamics of firm profitability. For example, Cubbin and Geroski (1987), Geroski and Jacquemin (1988), and Mueller (1977, 1986) all use ROA, while Branch (1980) and Jacobson (1988) use ROI.[13]

At least three concerns about the use of accounting measures to indicate firm profitability have been expressed. First, several pharmaceutical economists argue that the economic rate of return, which discounts all future costs and revenues to the point at which an initial investment decision is made is the appropriate measure of excess profitability (e.g., Schwartzman, 1976, 1979). Others argue that accounting rates of return may overstate the true profitability of pharmaceutical firms because advertising and R&D expenditures are expensed and not capitalized. Finally, Scherer and Ross (1990) express concern about the use of firm-level rates of return in industry-specific analyses given that most large firms are active in several industries.

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12 Modifications to this specification were also explored, including Net Income over Total Assets, Net Income over Total Assets less Cumulative Depreciation, and Net Income plus Interest Payments over Total Assets less Cumulative Depreciation. However, the correlation between any two variants is extremely high; in all cases in excess of 0.90.

13 Scherer and Ross (1990:416) note that "the correlations among alternative rate of return measures are generally quite high."

Although a thorough response to these three concerns is beyond the scope of this paper, a few comments are warranted. With respect to the economic rate of return, one need only note that it captures a different dimension of profitability than that examined in this research. While it is important to understand whether the present value of a stream of future revenues is sufficient to justify a given investment (Mund, 1969; Schwartzman, 1975, 1976), it is quite another issue to understand the period-to-period dynamics of realized rates of return. Therefore, in the same way that Tobin's q was rejected because it confounded current and future profitability, the economic rate of return is also rejected because it collapses all future profits into a one-shot measure of firm profitability.

Much of the concern about using accounting rates of returns to indicate economic profitability relates to accountants' decisions to expense, rather than capitalize R&D and advertising expenditures (Ayanian, 1975; Brownlee, 1979; Clarkson, 1979; Scherer & Ross, 1990). Because these expenditures contribute to the development of a firm's intangible asset base, the argument is that they should be capitalized and subsequently expensed according to an appropriate depreciation schedule. This issue is critical to the measurement of pharmaceutical firm profitability because R&D and advertising outlays represent a very large component of overall expenditures. Those attempting to revise reported rates of return in accordance with this concern explain away a great portion of the pharmaceutical industry's abnormally high profits (e.g., Schwartzman, 1976).

There are several responses to this concern. First, the ability to explain away inter-industry profit differentials is not universal. Menga and Mueller (1991), for example, find that considerable differences remain even after accounting for differential R&D and advertising propensities. Second, the assumptions made about the economic lives of R&D

and advertising investments and about their depreciation profiles are, to a large degree, arbitrary (Clarkson, 1979:119). This suggests that although revised rates of return may be different than those reported in firms' financial statements, they are not necessarily more accurate in any absolute sense. Third, most of the discussion on this issue has been in the context of inter-industry profitability comparisons. The current interest, however, is in intra-industry profit comparisons. To the extent that the firm-to-firm variance in R&D and advertising propensities is likely lower within, as opposed to across, industries, the above concerns are not as significant.[14]

Finally, Scherer and Ross (1990) note that firm-level accounting returns may be inappropriate in industry-specific studies because large firms are increasingly diversified across several industries. In the current context, this implies that the overall rate of return reported by a sampled pharmaceutical firm captures more than the returns accruing to its pharmaceutical operations. This issue is revisited in the next section, wherein the relationship between profitability and the level of competition is discussed. There, the analysis explicitly controls for the proportion of a firm's sales that are generated outside the U.S. pharmaceutical industry. Because the emphasis is on the returns accruing to the pharmaceutical products, the implied returns to the non-pharmaceutical sales are not emphasized. However, the method is sufficiently flexible to allow for inter-firm differences in returns accruing to non-pharmaceutical activities.

Operationalizing Normal Profitability. Equation 5.12 models the autoregressive properties of *normalized* profit time series. Mueller (1986) and others argue for the

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14 See also Mueller (1977:370) and Wernerfelt and Montgomery (1988:247).

necessity to control for overall economic trends in order to capture the extent to which firms earn persistent abnormal returns. That is, abnormal should be specified in relation to a valid indicator of normal profits. This section briefly discusses the average profit rates which are used to normalize firm profits.

In all previous persistent profitability research, the samples analyzed contain firms from a number of different industries. As such, the researchers have used some measure of economy-wide profitability as the indicator of normal profits. However, the same researchers also distinguish between economy-wide average, industry-average, and firm-specific returns (Cubbin & Geroski, 1987; Mueller, 1986; Rumelt, 1991). While certain elements of industry structure (Bain, 1956; Porter, 1980, 1985) are hypothesized to cause industry average returns to deviate from the economy-wide average, these effects are distinguishable from those factors that cause firm-level returns to deviate from their respective industry averages (Grant, 1991). This research is interested in the extent to which specific pharmaceutical firms earn profits that are persistently higher than those earned by *competing pharmaceutical firms*. As such, the required measure of average profitability is an intra-industry measure.

Table 7 reports the average and (asset) weighted-average profit rates across the nineteen firms for each of the seventeen sample years. As reported, the correlation between these two series is quite high (0.73). Moreover, in all of the following analyses, the results are not overly sensitive to the choice of average versus weighted-average ROA as an indicator of normal profits. As such, only the average-ROA results are reported.

Table 7
Average and Weighted Average ROA

	Average ROA	Weighted Average ROA
1977	10.25	10.54
1978	11.04	11.08
1979	10.70	10.96
1980	10.72	11.01
1981	10.45	10.52
1982	10.59	10.94
1983	10.92	11.34
1984	11.48	11.84
1985	10.01	9.14
1986	11.59	11.11
1987	12.68	11.92
1988	13.22	11.40
1989	13.48	10.93
1990	13.27	11.76
1991	13.40	12.02
1992	13.19	12.24
1993	10.18	10.29
Corr.		0.73

Results. As suggested above, equation 5.12 is estimated using two different sets of data, the first covering all observations and the second covering only those observations for which π_{it} is greater then zero. The overall results are reported in Table 8. The first thing to note is that this analysis is based on 295 profit observations instead of the 323 that might be expected given that there are nineteen firms and seventeen years of data. Six observations were dropped because the firm in question was involved in a major merger (Bristol Myers Squibb in 1989/1990, SmithKline Beecham in 1989/1990, and Marion Merrell Dow in 1990/1991). Several other observations were deleted because Searle was

Table 8
Firm-Level Profit Dynamics (all observations)

	α	β	α_{lr}	Adj. R^2	rho
Fixed Effects[a]	0.53	0.92**	6.39	0.72	-0.25*
Firm Effects:					
Merck (N=17)	5.30	0.70	17.39	0.76	n/a
Bristol Myers Squibb (N=15)	17.49	-0.10†	15.86‡		
Glaxo (N=16)	2.63	0.85	17.82		
Amer. Home Products (N=17)	57.21	-0.13†	50.52‡		
Johnson & Johnson (N=17)	3.84	-0.18†	3.24		
Lilly (N=17)	-0.83	0.63	-2.24		
Smithkline Beecham (N=15)	8.09	0.77	35.14#		
Pfizer (N=17)	-4.23	0.72	-15.20		
Abbott (N=17)	5.43	0.91	63.50		
Schering Plough (N=16)	-0.18	0.82	-0.98		
Upjohn (N=17)	-7.42	0.34	-11.24‡		
Marion Merrell Dow (N=14)	6.52	1.02	30.71		
Warner-Lambert (N=15)	-20.53	-0.00†	-20.24‡		
Syntex (N=17)	8.07	0.69	26.44#		
Rhone Poulenc Rorer (N=17)	-5.16	0.69	-16.71#		
Searle (N=8)	-0.34	0.60	-0.84		
American Cyanamid (N=16)	-31.08	0.26††	-48.47‡		
Sterling (N=10)	-5.24	0.39	-8.60#		
Carter-Wallace (N=17)	-8.49	0.79	-39.52‡		
All α identical (F-test)	3.33*				
All β identical (F-test)	3.25*				
All α and β identical (F-test)	2.87*				

[a] Because serial autocorrelation is present in the data (Durbin's H test is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from one at $p<0.01$

† significantly different from 0.92 at $p<0.01$
†† significantly different from 0.92 at $p<0.10$

‡ significantly different from 6.39 at $p<0.01$
# significantly different from 6.39 at $p<0.10$

acquired by Monsanto in 1985 and Sterling was acquired by Kodak in 1988. These exclusions reduced the number of observations to 301. The remaining six observations

(Glaxo in 1985, Schering Plough in 1993, Marion Merrell Dow in 1993, Warner Lambert in 1985, 1986 and Rhone Poulenc Rorer in 1993) were deleted as the original analysis found them to be extreme outliers based on an examination of the residuals, studentized residuals, COVRATIO and DFFITS statistics (see Jobson, 1991).

In the first variant of the model, the α_i and β_i estimates are forced to be equal across firms. The third column shows that the π_{it} estimate is not significantly different from zero. This suggests that, overall, abnormal firm-level ROA in the pharmaceutical industry over the 1977 to 1993 period tended toward long-run rates that were not significantly different from the industry average. At the same time, the β estimate is significantly less than one ($p<0.01$), indicating that relatively high and low profit outcomes do eventually dissipate. Taken together, these results are consistent with the findings of most previous persistent profitability research: abnormal profits eventually converge on more normal levels.

In the next step, the α_i and β_i estimates are allowed to vary across firms. As reported in Table 8, F-tests reject ($p<0.01$) the equality of the α_i estimates individually, the β_i estimates individually, as well as the α_i and β_i estimates jointly. Correspondingly, the adjusted R^2 increases from 0.72 to 0.76 when these coefficients are allowed to vary across firms. These results all confirm that there is significant variance across firms in the extent to which abnormal profit outcomes persist over time.

The second column of Table 8 reports the nineteen β_i estimates, which range from a high of 1.02 (Marion Merrell Dow) to a low of -0.18 (Johnson & Johnson). Five of the nineteen firms return β_i estimates that are significantly less than 0.92 (the result reported in the Fixed Effects model). These firms are Bristol Myers Squibb, American Home

Products, Johnson & Johnson, Warner Lambert and American Cyanamid. Similar inter-firm differences are observed for the α_{ir} estimates reported in the third column. These estimates range from a high of 63.50 (Abbott), to a low of -48.47 (American Cyanamid). That is, depending on the firm long-run profit rates range from roughly 60 percent above the industry average to 50 percent below average. Nine of these estimates are not significantly different from 6.39 (the estimate derived from the Fixed Effects model). However, four firms - Bristol Myers Squibb, American Home Products, Smithkline Beecham and Syntex - return α_{ir} estimates that are significantly greater than 6.39, while five firms - Upjohn, Warner Lambert, Rhone Poulenc Rorer, American Cyanamid, Sterling and Carter Wallace - return estimates that are significantly less than 6.39.

Table 9 shows how these results change if only the observations for which π_{it} is greater then zero are analyzed; i.e., only the persistence of above-average profitability is considered. Note that the following analysis starts with the 301 observations used in the above analysis (i.e., all the data points excluding mergers years but including outliers). It then selects only those specific observations for which the dependent variable, π_{it}, is greater than, or equal to zero. This reduces the number of observations to 168. Finally, as before, several of the extreme outliers have been removed from the data set (Bristol Myers Squibb in 1991, Glaxo in 1985, American Home Products in 1993, Abbott in 1993, and Schering Plough in 1993), this time leaving 163 observations. The first row of Table 9 (Fixed Effects) shows that, overall, the rate of convergence of relatively-high profits is more rapid (β=0.15), but the rate upon which above-average profits converge is now significantly greater than zero ($p<0.01$). Compared to Table 8, these results suggest

Table 9
Firm-Level Profit Dynamics ($\pi_{it}>0$ observations)

	α	β	α_{lr}	Adj. R^2	rho
Fixed Effects[a]	21.39*	0.15**	25.14*	0.53	0.63*
Firm Effects:					
Merck (N=14)	5.65	0.86†	40.97	0.57	n/a
Bristol Myers Squibb (N=14)	19.04	-0.39††	13.62‡		
Glaxo (N=10)	14.23	0.60†	35.80		
Amer. Home Products (N=16)	39.19	0.19	48.49‡		
Johnson & Johnson (N=13)	9.14	0.11	10.22‡		
Lilly (N=14)	11.23	0.17	13.51‡		
Smithkline Beecham (N=15)	8.09	0.77†	35.14		
Pfizer (N=4)	12.79	-0.12	11.41‡		
Abbott (N=15)	8.42	0.59	20.45		
Schering Plough (N=8)	6.39	0.66†	18.81		
Upjohn (N=3)	1.64	0.17	1.97#		
Marion Merrell Dow (N=8)	18.56	0.84†	116.60		
Warner-Lambert (N=6)	8.02	-0.05†	7.64‡		
Syntex (N=15)	16.28	0.55†	36.14#		
Rhone Poulenc Rorer (N=4)	4.91	-0.22	4.02‡		
Searle (N=3)	12.26	-0.10	11.16#		
All α identical (F-test)	0.99				
All β identical (F-test)	5.31*				
All α and β identical (F-test)	5.14*				

[a] Because serial autocorrelation is present in the data (Durbin's H test is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from one at $p<0.01$

† significantly different from 0.15 at $p<0.01$
†† significantly different from 0.15 at $p<0.10$

‡ significantly different from 25.14 at $p<0.01$
# significantly different from 25.14 at $p<0.10$

that examining the persistence of above- and below-average profitability together conceals the fact that above-average profits tend to persist, even into the long run.

Again, the α_i and β_i estimates are allowed to vary across firms.[15] There is once again a dramatic increase in the adjusted R^2 when these parameters are allowed to vary across firms. F-tests reject the equality of the β_i estimates ($p<0.01$), and the α_i and β_i estimates jointly ($p<0.01$). However, a separate F-test does not reject the hypothesis that the α_i estimates are constant across firms. As was the case when all observations were analyzed, these results suggest that there is significant firm-to-firm variance in the extent to which relatively high profit outcomes persist over time. The second column of Table 9 presents the β_i estimates, which range from a high of 0.86 (Merck) to a low of -0.39 (Bristol Myers Squibb). This time, six firms return a β_i estimate that is significantly greater than 0.15 (the result reported in the Fixed Effects model): Merck, Glaxo, SmithKline Beecham, Schering Plough, Marion Merrell Dow and Syntex. On the other hand, two firms (Bristol Myers Squibb and Warner Lambert) have β_i estimates that are significantly lower than 0.15.

Significant inter-firm differences are once again observed for the α_{ilr} estimates reported in column three. Now, the estimates range from 116.60 (Marion Merrell Dow) to 1.97 (Upjohn). In stark contrast with the results reported in Table 8, all of the firms now report α_{ilr} estimates that are greater then zero. This is consistent with the fact that, overall, above-average profits converge on long-run rates that are significantly greater than zero. However, note that although all of the α_{ilr} estimates are positive, only two firms return a α_{ilr} that is significantly greater than 25.14 (the result reported in the Fixed

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15 Note that three firms (American Cyanamid, Sterling and Carter Wallace) are not included in the Firm Effects model as they never demonstrate above-average profits.

Table 10
Summary of Firm-Level Profit Persistence
(based on all observations)

	Rapid Convergence: β significantly < 0.92	**Slow Convergence:** β not significantly < 0.92
High Long-Run Profit: $\alpha_{lr} \geq 6.39$	American Home Products Bristol Myers Squibb	Abbott Glaxo Marion Merrell Dow Merck Smithkline Beecham Syntex
Low Long-Run Profit: $\alpha_{lr} < 6.39$	American Cyanamid Johnson & Johnson Warner Lambert	Carter-Wallace Lilly Pfizer Rhone Poulenc Rorer Schering Plough Searle Sterling Upjohn

Effects model): American Home Products and Syntex. By contrast, eight firms report a α_{ilr} that is significantly lower than 25.14 (Bristol Myers Squibb, Johnson & Johnson, Lilly, Pfizer, Upjohn, Warner Lambert, Rhone Poulenc Rorer and Searle).

The qualitative features of the two Firm Effects models are captured in Tables 10 and 11, which organize firms in terms of their rates of profit convergence (rapid versus slow) and their long-run profit rates (high versus low). Table 10 shows that, when all observations are used, six firms (Abbott, Glaxo, Marion Merrell Dow, Merck, SmithKline Beecham, and Syntex) are persistently profitable in two different respects: their relatively high and low profits tend to dissipate at slower rates, and the profit levels that they ultimately converge upon are above the industry average. Two other firms

Table 11
Summary of Firm-Level Profit Persistence
(based on $\pi_{it}>0$ observations)

	Rapid Convergence: $\beta \leq 0.15$	**Slow Convergence:** $\beta > 0.15$
High Long-Run Profit: $\alpha_{ir} \geq 25.14$		Abbott American Home Products Glaxo Marion Merrell Dow Merck Smithkline Beecham Syntex
Low Long-Run Profit: $\alpha_{ir} < 25.14$	Bristol Myers Squibb Johnson & Johnson Lilly Pfizer Rhone Poulenc Rorer Searle Warner Lambert	Schering Plough Upjohn

(American Home Products and Bristol Myers Squibb) converge rapidly toward levels that are above the industry average. The remaining firms experience long-run profit rates that are below the industry average.

Table 11 organizes firms based on the extent to which their *above-average* profit rates persist over time. With two exceptions (Schering Plough and Upjohn), the firms fall into two groups. Seven firms (Abbott, American Home Products, Glaxo, Marion Merrell Dow, Merck, Smithkline Beecham and Syntex) demonstrate slow rates of convergence toward high long-run profit rates. These are the firms displaying persistent above-normal profitability. On the other hand, eight firms (Bristol Myers Squibb, Johnson & Johnson, Lilly, Pfizer, Rhone Poulenc Rorer, Searle and Warner Lambert) converge relatively rapidly upon lower long-run profit rates.

5.2 The Relationship Between Profits and Competition

Section 5.1 confirms that over the 1977 to 1993 period, there is evidence of variable firm-level persistent profitability in the U.S. pharmaceutical industry. In the remainder of this chapter, several features of the Schumpeterian framework, which may explain this inter-firm variance, are validated. This section focuses on the relationship between relative profitability and the level of competition faced by products. According to Schumpeter, relatively high profits flow to those products that are subject to low levels of competition (H1). The following paragraphs describe the method used to test this hypothesis, as well as the results attained.

Method. Because the profit-level of competition hypothesis is made at the product level, an ideal analysis would relate product-level profitability to information on product-level competition. However, whereas observations on firm-level profitability are readily available (e.g., from the Compustat data base), there are no corresponding data regarding the profits earned by a firm's specific product offerings. In principle, one could limit attention to those firms that produce and sell single products. However, this places huge restrictions on the firms qualifying for analysis (especially in the pharmaceutical industry). It is also inconsistent with one of the basic premises of the Schumpeterian framework: most large firms are multiproduct firms.

Alternatively, the analysis could take advantage of firms' internal costing functions to obtain product-level revenue and cost (and thereby profit) data. In those cases where the cost unit is appropriately specified (i.e., all costs are traced to individual products), and

revenue data are available at the product level, it would be possible to construct product-level profit figures. Unfortunately, such an approach is intractable. On one hand, it is difficult (if not impossible) to gain access to such data for a sufficiently large number of firms. Moreover, for a dynamic analysis, data must be available on a consistent basis over a considerable period of time. However, firms modify their cost accounting systems and/or the cost allocation assumptions they make as circumstances dictate, making period-to-period consistency problematic.

As neither of these approaches is workable, tests have been designed which are conducted at the firm level, but are consistent with the Schumpeterian logic embodied in H1. To test the hypothesis that profits tend to fall as competition intensifies, an indicator is constructed of the weighted-average level of competition faced by a firm's products and relate it to the firm's profitability (as indicated by its normalized ROA):

$$\pi_{it} = \gamma + \delta_1 * WC_{it} + \varepsilon_{it} \qquad 5.21$$

As in equation 5.12, π_{it} is the relative profitability of firm i in year t. WC_{it} refers to the weighted-average level of competition faced by firm i's products in year t. According to H1, the δ_1 estimate should be negative; as competition intensifies, relative profitability declines. Because WC_{it} plays such a central role in the following analysis, the following paragraphs are devoted to discussing its operationalization.

Measuring the Level of Competition. Making sense of the relationship between competition and profitability for multiproduct firms requires an indicator of the level of

competition faced by each product in each year. Consider the following approach:

$$COMP_{jt} = \left(1 - \frac{SAL_{jt}}{CMPSAL_{jt}}\right) * 100$$

where $COMP_{jt}$ indicates the level of competition faced by product j in year t, SAL_{jt} represents the sales of that product, and $CMPSAL_{jt}$ represents the sales of all products deemed to be in competition with product j.[16] As constructed, $COMP_{jt}$ ranges from zero when product j is in a true monopoly position (i.e., no other products possess sufficiently similar attributes to be considered product j's competitors) to 100 when the sales of product j's substitutes dwarf the sales of product j.

Constructing $COMP_{jt}$ requires some discretion on the part of the researcher. Although the required annual sales data are available from IMS America on a product-by-product basis (see Section 4.3), there are different ways in which $CMPSAL_{jt}$ may be conceived. For industries such as the pharmaceutical industry, product patents are available and are generally found to be effective (Levin *et al.*, 1987). Schwartzman (1979:98), for example, suggests that "in general, a single-source drug becomes a multiple-source drug when a patent expires." Under such a regime, it seems reasonable to assume substitutes arise in one of only two ways. Innovating firms may license a product's technology to competitors while patents are in force - either by choice or by force

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16 Note the similarity between this indicator and the market share measure. $COMP_{jt}$ is one minus product j's market share. We return to the relationship between our analysis and the more recognizable market share-profitability research in Chapter 7.

(Gorecki, 1986). Or, generic competitors may emerge when patents expire. Under such assumptions, one may wish to consider only those products that are licensed or generic versions of product j to be its competitors (e.g., Grabowski & Vernon, 1992; Hurwitz & Caves, 1988).

However, the pharmaceutical economics literature also suggests that such an approach may not adequately capture the true nature of product competition. For example, Weston (1979:93) argues that:

> the patent privilege provides a monopoly over individual drugs. However, the appearance of similar drugs introduces competition before the expiry of the seventeen-year patent period.

This propensity for competitors to invent around patents that are still in force is also stressed by Levin *et al.* (1987), Comanor (1964), Grabowski and Vernon (1990), and Kemp (1975). To the extent that such a claim is valid, assuming that the only competition for products comes from direct copies is erroneous.

The $COMP_{jt}$ variable is constructed in a way that allows for the emergence of close substitutes before and after the expiry of patents. The approach involves first taking stock of all potential substitutes (both direct and indirect) for a focal product, and to have $CMPSAL_{jt}$ reflect the degree to which the presence of such products has an effect on the demand for the focal product. In the words of Comanor (1964:377, fn), "relatively high cross elasticities of demand will be found when competing products treat the same or similar ailments or have similar therapeutic effects." Ideally, these cross elasticities would be estimated either directly based on actual price and quantity data on a product-by-product basis, or indirectly, based on input from the products' consumers; i.e., doctors and

pharmacists (Cocks & Virts, 1974). However, given the myriad of products and the long time frame involved in this study, such an approach is unworkable.

Fortunately, IMS America organizes its pharmaceutical products data into therapeutic classes and sub-classes. Their organizing framework parallels that suggested by Kemp (1975), whose research shows that breakthrough drugs define or redefine classes. These are followed to market by a second wave of drug offerings that are sufficiently similar to a breakthrough drug to fall within the same class, but differentiated enough to warrant the creation of a separate sub-class. The final wave of products, called follow-on drugs, are not substantially differentiated from some existing drug and, as such, increasingly populate established sub-classes (see also Achilladelis, 1993). Consistent with our concern about the exclusivity of patents, Kemp (1975:260) notes that:

> to the extent that firms are successful in developing follow-ons, some of the competitive response is transferred from the post-patent period to the time when the patent is in force.

In constructing $COMP_{jt}$, products occupying the same therapeutic sub-class are assumed to be in competition with one another. $CMPSAL_{jt}$ therefore includes the sales of all products falling within product j's therapeutic sub-class in year t. Correspondingly, products in different therapeutic sub-classes are not in competition with one another.

The product-level data file (see Section 4.3) contains the data needed to calculate a value for $COMP_{jt}$ for 18,929 product-year combinations. According to Table 12, the values of $COMP_{jt}$ range from zero to 100. As such, the observed data cover the entire possible range of the $COMP_{jt}$ variable. The average value of $COMP_{jt}$ is 83.93, while the standard deviation is 20.81. These statistics suggest that, in the majority of the cases,

Table 12
Descriptive Statistics for $COMP_{jt}$

N	18,929
Minimum	0.00
Maximum	100.00
Mean	83.93
Standard Deviation	20.81
25 %ile	79.53
50 %ile	92.59
75 %ile	97.34

pharmaceutical products experience levels of competition that are in the upper range of possible values for $COMP_{jt}$. In fact, only 25 percent of all observed values are found in the zero to 80 range.

Aggregating to the Firm Level. The IMS America data, combined with the above assumptions about the relevant cohort of competitors, allow us to construct a $COMP_{jt}$ variable which captures the level of competition faced by any product j in any year t. In the next step, the product-level $COMP_{jt}$ variable is used as an input into the construction of WC_{it}, an indicator of the level of competition faced by firm i's products in year t:

$$WC_{it} = \frac{\sum_{j} SAL_{ijt} * COMP_{ijt}}{\sum_{j} SAL_{ijt}}$$

It is assumed that the level of competition faced by firm i is the sales-weighted average of the level of competition faced by its various products. Similar to $COMP_{jt}$, WC_{it} ranges from a low of zero when all of firm i's products are in true monopoly positions to a high

of one when all of i's products are subject to extremely intense competition.

Accounting for Diversification. Equation 5.21 implicitly assumes that the firm-level competition variable (WC_{it}) may be calculated based on the sales of all of firm i's products in year t. However, each of the sampled pharmaceutical firms is diversified outside of the U.S. pharmaceutical industry (Hill & Hansen, 1991). And because we do not have access to product-level data describing the firms' non-pharmaceutical sales, $COMP_{jt}$ can not be calculated for non-pharmaceutical products. It is therefore necessary to control for the share of firm i's overall sales that are generated outside of the U.S. pharmaceutical industry in year t ($SHOUT_{it}$). Because of the need for this distinction, the following regression equation is also estimated:

$$\pi_{it} = \gamma + \delta_1 * WC_{it} + \sum_{i=1}^{19} \delta_{2i} * SHOUT_{it} + \varepsilon_{it} \qquad 5.21a$$

In equation 5.21a, the δ_{2i} coefficients indicate the impact of the non-pharmaceutical sales on each firm's relative profitability.

Following H1, a negative relationship is expected between relative profitability (π_{it}) and the overall level of competition faced (WC_{it}). However, it is possible to be more precise in interpreting δ_1, as well as the estimated intercept term (γ). When WC_{it} equals zero, all of firm i's products are in monopoly positions and (assuming that $SHOUT_{it}$=0) relative profitability is γ, the estimated intercept term. Therefore, γ may be interpreted as an estimate of the relative profitability accruing to monopoly pharmaceutical products. At

the other extreme, WC_{it} equals 100 when all products are subject to intense competition. In such a case (again assuming that $SHOUT_{it}=0$), the relative profitability is $\gamma+100*\delta_1$. Therefore, $\gamma+100*\delta_1$ may be interpreted as an estimate of the relative profitability of pharmaceutical products exposed to intense competition. To the extent that this approach is valid, it rectifies a concern expressed by Kemp (1975:270) who laments that "there is no direct evidence of the effect of the introduction of follow-ons on the profits within each sub-class" of drug products (see also Comanor, 1964). By comparing γ with $\gamma+100*\delta_1$, some evidence (albeit indirect) is provided of the effect of increased competition on the relative profitability of pharmaceutical products.

We may also say a few words about the effect of $SHOUT_{it}$ on a firm's relative profitability. In this section, the main hypothesis is that products that are exposed to more intense competition earn lower returns that those exposed to less intense competition. Just as WC_{it} varies from firm-to-firm (see Table 13), one should expect the degree of non-pharmaceutical product competition to vary across firms as well (although there is no data confirming this expectation). As a surrogate for including information on the firms' non-pharmaceutical product competition levels, the coefficient on $SHOUT_{it}$ is allowed to vary across firms. If the main hypothesis is supported, and if there is considerable firm-to-firm variance in the level of competition faced by non-pharmaceutical products, then allowing the δ_{2i} estimates to vary across firms should significantly increase the explanatory power of the regression equation. The results of a Fixed Effects model (i.e., one which forces δ_{2i} estimates to be equal across firms) are also presented in order to ensure the robustness of the δ_1 estimate.

With respect to the interpretation of the δ_{2i} estimates, Hill and Hansen (1991) find

Table 13
Descriptive Statistics for Profits-Competition Regression

	π_{it}	WC_{it}	$SHOUT_{it}$
N	297	297	297
Minimum	-75.86	37.39	2.65
Maximum	88.36	95.15	99.32
Mean	3.46	72.59	71.83
Standard Deviation	32.37	9.28	16.65
Corr(π_{it}, WC_{it})		0.16	

that pharmaceutical firms diversify outside of the drug industry in order to reduce risk and not necessarily to enhance profitability. Following their arguments and findings, the coefficients on the $SHOUT_{it}$ are expected to be negative. That is, as the share of outside sales increases from zero to one hundred percent, the relative profitability of a firm should decline.

Results. Table 13 presents summary statistics for the data used to estimate equations 5.21 and 5.21a. The data set contains information on 297 firm-year combinations. The values of π_{it} range from a low of -75.86 to a high of 88.36, suggesting that firm-level ROA is somewhere between 75 percent below average and 90 percent above average, depending on the firm and year being observed. The overall average for π_{it} is 3.46, while the standard deviation is 32.37. At the same time, WC_{it} ranges from a low of 37.39, to a high of 95.15. The overall average for WC_{it} is 72.59 and the standard deviation is 9.28. The minimum, average, and maximum values of $SHOUT_{it}$ are 2.65, 71.83, and 99.32, respectively. Finally, the correlation between WC_{it} and $SHOUT_{it}$ (the two explanatory variables) is a modest 0.16.

Table 14 presents results from several regressions relating relative profitability to

Table 14
Relationship Between Relative Profitability and Competition

	WC Only[a]	SHOUT Only[a]	Fixed Effects[a]	Firm Effects[a]
Intercept (γ)	57.29*	39.96*	83.13*	91.08*
WC_{it}	-0.75*		-0.65[a]	-0.80*
$SHOUT_{it}$:		-0.52*	-0.46[a]	
Merck (N=17)				-0.29
Bristol-Myers Squibb (N=15)				-0.02
Glaxo (N=17)				-0.25
Amer. Home Products (N=17)				0.14
Johnson & Johnson (N=17)				-0.45*
Lilly (N=17)				-0.67*
SmithKline Beecham (N=15)				-0.02
Pfizer (N=17)				-0.58*
Abbott (N=17)				-0.06
Schering Plough (N=17)				-0.26
Upjohn (N=17)				-0.87*
Marion Merrell Dow (N=15)				-0.79**
Warner-Lambert (N=14)				-0.56*
Syntex (N=17)				-0.15
Rhone-Poulenc Rorer (N=17)				-0.36**
Searle (N=8)				-0.74*
American Cyanamid (N=16)				-0.81*
Sterling (N=10)				-0.52*
Carter-Wallace (N=17)				-1.01*
N	297	297	297	297
Adjusted R^2	0.63	0.63	0.64	0.71
rho	0.78*	0.79*	0.77*	0.64*
F-test: Firm Effects				5.69*

[a] Because serial autocorrelation is present in the data (each Durbin Watson test is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from zero at $p<0.10$

the level of competition and the proportion of sales generated outside the pharmaceutical industry. The first column reports the results from a regression relating relative

profitability to competition (see equation 5.21). Consistent with H1, the δ_1 estimate indicates a negative and significant ($p<0.01$) relationship between relative profitability and level of competition faced. The results suggest that monopoly products earn profits that are roughly 60 percent above average ($\gamma=57.29$), while products exposed to intense competition earn profits that are roughly 17 ($\gamma+100*\delta_1$) percent below average. The second column presents the findings from a bivariate regression relating a firm's relative profitability the proportion of outside sales. The negative and significant ($p<0.01$) coefficient on $SHOUT_{it}$ provides evidence that a firm's relative profitability declines as the proportion of outside sales increases. In fact, a (hypothetical) firm that is 100 percent diversified outside of the pharmaceutical industry earns profits that are roughly 12 percent ($\gamma+100*\delta_2$) below the pharmaceutical industry average. This result is consistent with those reported by Hill and Hansen (1991).

The final columns of Table 14 report the findings of two variants of the model described by equation 5.21a. In the Fixed Effects model, the δ_{2i} estimates are forced to be identical across firms. The results obtain conform to the above-mentioned expectations. There is a negative and significant ($p<0.01$) relationship between relative profitability and the level of competition faced by a firm in its various pharmaceutical markets. Moreover, the firms' non-pharmaceutical sales contribute negatively and significantly ($p<0.01$) to relative profitability. More precisely, monopoly drug products earn returns that are roughly 85 percent above average ($\gamma=83.13$). By the time competition reaches its maximum intensity ($WC_{it}=100$), excess returns (for an undiversified pharmaceutical firm) fall to roughly eighteen percent ($\gamma+100*\delta_1$) above the average. Accounting for the fact that the average firm derives 73 percent of its sales from outside the pharmaceutical

industry (see Table 13), a firm selling only monopoly drug products earns profits that are roughly 35 percent ($\gamma+73*\delta_2$) above average. The same firm producing products that are exposed to intense competition earns profits that are roughly 15 percent ($\gamma+73*\delta_2+100*\delta_1$) below average.

In the final column of Table 14, the δ_{2i} estimates are allowed to vary across firms.[17] This modification increases the adjusted R^2 from 0.64 to 0.71, while the F-test for the equality of the nineteen δ_{2i} estimates returns a significant F-value ($p<0.01$). The most important point about these results is that the relationship between relative profitability and competition intensity is virtually the same in the Fixed Effects and Firm Effects models. In the latter case, monopoly products earn returns that are roughly 90 percent above average ($\gamma=91.08$). These returns fall as competition intensifies ($\delta_1=-0.80$). When competition reaches its maximum intensity, products earn returns which are only eleven percent above average ($\gamma+100*\delta_1$).

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17 The results in Table 14 might be sensitive to the fact that the sampled firms derive different proportions of their sales from proprietary, as opposed to ethical drugs. The data confirms that these proportions do differ across firms. The proportion of sales coming from ethical drugs ranges from 62 percent (Sterling in 1981) to 100 percent (numerous observations). However, when the proportion of ethical sales is added as a regressor in the Firm Effects model reported in Table 14, the coefficient is insignificant ($p=0.72$) and the adjusted R^2 is virtually unchanged. Moreover, there are no qualitative changes to any of the regression results reported in the final column of Table 14.

5.3 Competition and Elapsed Time

Having evidence that relatively high profits tend to flow to low-competition products, the analysis now turns to the relationship between the level of competition faced and elapsed time. Schumpeter suggests that innovative new products move through various stages, each characterized by different levels of competition. In the period directly following their introduction, these products face no, or very low levels of competition and earn high profits. As time elapses, imitators are attracted into the competitive arena by the above-average profits earned by innovators. These imitators increase the level of competition faced by innovative products. The analysis in this section empirically addresses the relationship between changes in the level of competition faced by innovative new products and the length of time they have been on the market. According to H2, which captures the imitative dynamic summarized in this paragraph, the relationship is expected to be positive. The following paragraphs describe the method used to test H2, as well as the results obtained.

Method. The aim of this analysis is to illuminate the relationship between changes in the level of competition faced by innovative products and the time elapsed since their introduction to the market. Consider the following approach:[18]

$$CMPCHNG_{jt} = \lambda * ELAPSE_{jt} + \varepsilon_{jt} \qquad 5.31$$

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[18] There is no intercept in equation 5.31. By definition, the change in the level of competition faced by product j when $ELAPSE_{jt}=0$ is zero.

where $CMPCHNG_{jt}$ is the change in the level of competition faced by product j between the current year (year t) and the year in which it was introduced (t_o):

$$CMPCHNG_{jt} = COMP_{jt} - COMP_{jt_o}$$

and $ELAPSE_{jt}$ is the number of years between year t and year t_o. According to H2, the λ estimate in equation 5.31 should be positive; the longer a product is on the market, the higher is the level of competition it faces relative to the level it faced at the point of introduction.

The approach summarized by equation 5.31 assumes that all new products are innovative. However, Kemp (1975) and others argue that new pharmaceutical products range from being truly innovative at one extreme to purely imitative at the other.[19] Innovative new products are those which define (or re-define) therapeutic classes and sub-classes. Imitator products, on the other hand, follow these innovative products into established market niches. This distinction between innovative and imitator products is not merely semantic as one expects qualitatively different relationships between changes in the level of competition faced and elapsed time for the two types of introductions.

The arguments which underpin an expectation of a positive λ for innovative new products have already been developed: relatively high profits attract imitators, which increase the level of competition faced. Applying this logic in reverse generates an

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19 Abernathy and Clark (1985:6) note that innovations may have a wide range of effects, from highly conservative on the one hand to extremely radical on the other.

expectation about the imitative dynamic for imitator products. Assuming that the conjecture about innovative products holds, imitator products increase the level of competition faced by innovative new products. That is, successful imitator products move from having no market presence at all at time t_o to establishing (often small) footholds for themselves as time passes. If the level of competition is operationalized with reference to the ratio of the sales of a product to the total sales of the market in which it competes, then a movement from no market presence to some presence implies that the level of competition faced by imitator products actually falls as time elapses. Therefore, with respect to equation 5.31, λ is expected to be negative for imitator products.

The design of the following analysis must therefore recognize that not all of the new products introduced by the sampled firms are innovative products, some are introduced to compete directly with existing products. Unfortunately, the product introductions in the data set are not be labeled (either objectively or subjectively) as innovative or imitator. As such, innovative products are defined as those introduced to extremely low levels of competition. This choice is consistent with Schumpeter's (as well as Kemp's, 1975) notion of innovative because pharmaceutical products that are introduced to very low levels of competition are those that either define or dramatically re-define therapeutic classes and/or sub-classes. Conversely, products introduced to extremely high levels of competition are considered imitator products.

This decision leaves the task of operationalizing extremely low and high levels of competition. For this, the distribution of $COMP_{jt}$ in the product-level data file is re-examined. Recall that there are 18,929 product-year combinations for which there is data available to construct the $COMP_{jt}$ variable. Table 12 indicates that the 25th, 50th, and

75th percentile values of $COMP_{jt}$ are 79.53, 92.59, and 97.34, respectively. In the following, extremely low competition is equated with $COMP_{jt}$ values falling between zero and 79.53; i.e., those falling in the lowest competition quartile. Conversely, extremely high competition corresponds to $COMP_{jt}$ values between 97.34 and 100; i.e., values within the highest competition quartile. Finally, $COMP_{jt}$ values falling in the second or third quartiles are considered to be intermediate innovative-imitator hybrids.

Equation 5.31 may now be rewritten to distinguish between innovative and imitator products in the following manner:

$$CMPCHNG_{jt} = \sum_{c=1}^{4} \lambda_c * Q_c * ELAPSE_{jt} + \varepsilon_{jt} \qquad 5.31a$$

where the Q_c are a series of dummy variables indicating the degree of innovativeness of a particular product. $Q_1=1$ for innovative product introductions and zero otherwise; i.e., their $COMP_{jto}$ is between zero and 79.53. At the other extreme, $Q_4=1$ for imitator product introductions, and zero otherwise (i.e., $97.43< COMP_{jto}<100$). According to H2, the λ_1 estimate is expected to be positive while, according to the logic summarized above, the λ_4 estimate is expected to be negative. Because Q_2 and Q_3 represent innovative-imitator hybrids, the λ_2 and λ_3 estimates should fall somewhere in between λ_1 and λ_4.

Equation 5.31a may be modified to test H3, which suggests that the rate at which innovative products are imitated varies across firms:

$$CMPCHNG_{jt} = \sum_{i=1}^{19} \lambda_{1i} * Q_1 * ELAPSE_{jt} + \sum_{c=2}^{4} \lambda_c * Q_c * ELAPSE_{jt} + \varepsilon_{jt} \qquad 5.31b$$

In equation 5.31b, the estimated relationship between changes in the level of competition and elapsed time for innovative products is allowed to vary across the nineteen sampled firms. If there is significant variation in the extent to which firms are shielded from competitor imitation, then allowing these estimates to vary across firms should significantly enhance the explanatory power of the model.

Results. The data for the analysis in this section are drawn from the product-level data file described in Section 4.3. As suggested, this file contains the data required to construct the $COMP_{jt}$ variable for 18,929 product-year combinations. However, in addition to current-year data, the analysis in this section also requires data on the timing of a product's introduction (in order to construct the $ELAPSE_{jt}$ variable), as well as the level of competition that it experienced in its initial year (in order to construct the $CMPCHNG_{jt}$ variable).[20] In several instances, a product's year of introduction is not known. Moreover, some of the products with known introduction dates were introduced prior to 1977 and, therefore, $COMP_{jt_0}$ is unknown. Excluding these products, the data file describes 5,598 product-year combinations. However, 71 (or roughly one percent) of the observations were excluded because they are found to be extreme outliers when equation 5.31b is estimated (i.e., each excluded observation's reported residual is more than four times the regression standard error). Summary statistics describing the dependent ($CMPCHNG_{jt}$) and independent ($ELAPSE_{jt}$) variables are presented in Table

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[20] Throughout the following, t_0 refers to the first full year in which a product is on the market; e.g., if a product is introduced in May 1980, its year of introduction is considered to be 1981.

Table 15
Descriptive Statistics for Competition-Elapsed Time Regression

	$CMPCHNG_{jt}$	$ELAPSE_{jt}$
N	5527	5527
Minimum	-98.39	0.00
Maximum	89.06	16.00
Mean	-1.05	4.84
Standard Deviation	12.62	3.91

15. $CMPCHNG_{jt}$ ranges from a low of -98.39 to a high of 89.06. The mean of $CMPCHNG_{jt}$ is -1.05, suggesting that, on average, the level of competition faced by new products is slightly lower in the years following introduction. At the same time, $ELAPSE_{jt}$ ranges from zero to sixteen years (its maximum value given the sample time frame). The mean value of $ELAPSE_{jt}$ is 4.8 years.

Table 16 reports the results of regressions run on equations 5.31 through 5.31b. The first column of Table 16 presents the findings from a bivariate regression relating $CMPCHNG_{jt}$ to $ELAPSE_{jt}$ (equation 5.31). Although small in absolute value, the λ estimate, is positive and significant ($p<0.10$). This lends support for H2; as time elapses, the level of competition facing all new products tends to rise. The results in the second column are from a model that allows the λ coefficients to vary depending on the degree of innovativeness of the new product (equation 5.31a). Note first that the hypothesis of no differences across the four types of new product introductions is rejected ($p<0.01$). More importantly, the hypotheses about the relationship between changes in competition and the passage of time are supported across the board. For innovative products, the relationship between changes in competition levels and elapsed time is positive and significant $p<0.01$). The same relationship is negative and significant ($p<0.01$) for the imitator products.

Table 16
Relationship Between Competition and Elapsed Time

	No Quartile[a]	Fixed Effects[a]	Firm Effects[a]
$ELAPSE_{it}$	0.04**		
INNOVATIVE		1.06*	
Merck (N=271)			0.79††
Bristol-Myers Squibb (N=534)			2.62
Glaxo (N=146)			-0.09†
American Home Products (N=582)			0.52†
Johnson & Johnson (N=494)			0.70††
Lilly (N=225)			7.07
SmithKline Beecham (N=241)			3.69
Pfizer (N=160)			1.02
Abbott (N=451)			0.18†
Schering Plough (N=314)			0.63††
Upjohn (N=166)			3.23
Marion Merrell Dow (N=80)			4.70
Warner-Lambert (N=330)			2.09
Syntex (N=182)			-2.78†
Rhone-Poulenc Rorer (N=155)			25.12
Searle (N=136)			-1.27†
American Cyanamid (N=307)			-0.45†
Sterling (N=145)			0.85
Other (N=558)			1.26
2nd QUARTILE		0.14**	0.14**
3rd QUARTILE		-0.27*	-0.26*
IMITATOR		-0.11*	-0.11*
Adjusted R^2	0.68	0.70	0.72
rho	0.83*	0.81*	0.82*
F-test: Quartile Effects / Firm Effects		85.81*	28.04*

[a] Because serial autocorrelation is present in the data (each Durbin Watson statistic is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from zero at $p<0.10$

† significantly less than 1.06 at $p<0.01$
†† significantly less than 1.06 at $p<0.10$

The third column of Table 16 presents the findings from a model that allows the rate of imitation of innovative products to vary across firms (equation 5.31b).[21] According to H3, firms are expected to differ in their ability to resist competitor imitation. Consistent with this hypothesis, the model with variable firm effects explains significantly ($p<0.01$) more of the variance in $CMPCHNG_{jt}$ than does the model without firm effects. A closer look at the results shows that the λ_{1i} estimates range from a low of -2.78 (Syntex) to a high of 25.12 (Rhone Poulenc Rorer). Moreover, nine of the firms demonstrate a significantly lower than average rates of competitor imitation; i.e., their λ_{1i} estimates are significantly less than 1.06 (the result from the Fixed Effects model).

This section concludes by commenting on the implications of the differing magnitudes of the estimated imitative effects. Consider a typical innovative product introduced at the start of the sample period to zero competition (i.e., a true monopoly product). According to the λ_1 estimate derived from equation 5.31b, by the end of the sample period, this same product will demonstrate a $COMP_{jt}$ of (16*1.06=) 16.96. According to the estimates summarized in Table 14, this increase in competition translates into a reduction in relative profitability from roughly 100 percent above average to

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21 Consistent with the concern raised in Note 17, the results in Table 16 might be sensitive to the extent to which the sampled products are proprietary, as opposed to ethical drugs. However, the results presented in the final column of Table 16 are virtually unchanged when proprietary drugs are excluded from the analysis. The specific regression results (based on 5165 observations), which are not reported here, suggest that there are no qualitative changes to any of the results reported in the final column of Table 16 (the one exception is that the λ_{1i} estimate for American Home Products is no longer significantly less than the result from the Fixed Effects model - $p=0.25$).

roughly 85 percent above average. However, expectations change dramatically if the identity of the firm introducing this product is known. If the pioneering firm is Glaxo (λ_{1i}=-0.09), the level of competition is not expected to change much over the sample period and the product will continue to earn profits that are roughly 100 percent above average. If, on the other hand, the pioneering firm is Lilly (λ_{1i}=7.07), the same typical product is expected to face extremely intense competition ($COMP_{jt}$ of roughly 100) by the end of the sample period and thereby earn profits that only slightly greater than average.

5.4 Differences in Firm's Propensities to Introduce Innovative New Products

This last section provides evidence suggesting that the sampled firms differ in their propensities to introduce innovative new products to the market (H4). In doing so, we return to the product-level data file and record the timing of each innovative product introduction as well as the identity of the innovating firm. In order to be consistent with the approach taken in Section 5.3, the focus is only on those products introduced to competition levels ($COMP_{jt_0}$) of less than 79.53.

Table 17 shows that 87 innovative new products were brought to the market during the sample period, 72 of which were introduced by one of the sampled firms.[22] This suggests that, on average, each firm generated 3.8 innovative new products over the seventeen-year period. However, these introductions are not evenly distributed across firms; there is considerable firm-to-firm variability in the propensity to bring innovative

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[22] The remaining nine products were introduced by firms that were, at some point during the sample, not part of one of the nineteen sampled firms.

Table 17
Innovative New Product Introductions

	Total	Years
Merck	14	1978(3), 1979(2), 1982(2), 1983, 1986(2), 1987(3), 1992
Bristol-Myers Squibb	4	1978, 1982, 1985, 1986
Glaxo	5	1983, 1984, 1988, 1989, 1991
American Home Products	3	1978, 1984, 1991
Johnson & Johnson	7	1977, 1978, 1980, 1981, 1988, 1989, 1991
Lilly	4	1981, 1987, 1988, 1992
SmithKline Beecham	3	1977, 1984(2)
Pfizer	4	1979, 1982, 1990, 1992
Abbott	5	1976, 1977, 1980, 1988, 1991
Schering Plough	5	1976, 1984, 1985, 1986, 1988
Upjohn	3	1981, 1986, 1988
Marion Merrell Dow	3	1978, 1991(2)
Warner-Lambert	1	1982
Syntex	3	1988, 1990(2)
Rhone-Poulenc Rorer	2	1988, 1990
Searle	1	1982
American Cyanamid	3	1982, 1983, 1989
Sterling	2	1976, 1992
Carter-Wallace	0	
Other	15	1976, 1977, 1980, 1981, 1983, 1984(2), 1985(5), 1987, 1989, 1991
Total	87	

products to the market. At one extreme, Merck is responsible for fourteen (or 16.0 percent) of the innovative product introductions. At the other extreme, Carter Wallace does not bring a single innovative new product to the market over the entire sample period. All told, Merck, Johnson & Johnson, Glaxo, Abbott and Schering Plough demonstrate better than average innovative propensity, while Carter Wallace, Searle, Warner Lambert, Sterling and Rhone Poulenc Rorer are worse than average.

Table 18 presents the product innovation data in a slightly different manner. The product-count approach underlying Table 17 does not recognize that different product introductions may make different contributions to a firm's overall sales. Table 18 reports

Table 18
Percent of 1993 Pharmaceutical Sales Accounted for by Innovative Products

	Innovative Introductions
Merck	51.8[a]
Bristol-Myers Squibb	23.7
Glaxo	71.8[a]
American Home Products	9.7
Johnson & Johnson	14.1
Lilly	30.8
SmithKline Beecham	48.4[a]
Pfizer	25.8
Abbott	14.5
Schering Plough	16.4
Upjohn	8.0
Marion Merrell Dow	37.0
Warner-Lambert	18.3
Syntex	23.7
Rhone-Poulenc Rorer	0.5[b]
Searle	1.0[b]
American Cyanamid	6.2
Sterling	3.8
Carter-Wallace	0.0[b]
Minimum	0.0
Maximum	71.8
Average	21.3
Standard Deviation	19.5

[a] more than 1 Standard Deviation above average
[b] more than 1 Standard Deviation below average

the proportion of each firm's 1993 pharmaceutical sales derived from the innovative products introduced during the sample period. On average, 21.3 percent of the firms' 1993 pharmaceutical sales come from these innovative product introductions. Once again, however, there is considerable firm-to-firm variability in this data. Based on innovative products' contribution to 1993 pharmaceutical sales, Glaxo is the most innovative of the

sampled firms, with 71.8 percent of its 1993 sales coming from the innovative new products. Other high innovators are Merck (51.8 percent) and Smithkline Beecham (48.4 percent). These three firms each den· nstrate an innovative propensity that is more than one standard deviation above the average. At the other extreme, none of Carter-Wallace's 1993 sales are from innovative products introduced over the sample period. Other relatively poor innovators were Rhone Poulenc Rorer (0.5 percent) and Searle (1.0 percent). These three firms are more than one standard deviation below the average in terms of their respective innovative propensities.

Summary

The above analyses validate the key features of the Schumpeterian framework on firm-level persistent profitability. They show that (at least within the pharmaceutical industry over the 1977 to 1993 period) there is an inverse relationship between relative profitability and the level of competition faced in product markets (H1), and that innovative new products tend to face increasing competition as time passes (H2). They also show that the sampled firms vary in the extent to which their innovative product introductions are imitated (H3), as well as in their propensity to bring innovative new products to the market (H4).

CHAPTER 6: INNOVATION, IMITATION AND THE PERSISTENCE OF FIRM-LEVEL PROFITS

Given that the specific mechanics of the Schumpeterian framework have been substantiated, the task for Chapter 6 is to test whether it may indeed be used to make sense of the pattern of profit persistence demonstrated in Section 5.1. This is done in two ways. Section 6.1 revisits the industry-wide autoregressive models estimated in Section 5.1 in order to determine the influence of innovative propensity and competitor imitation on the persistence of above-average profits. Then, the nineteen firm-specific α_i and β_i estimates generated in Section 5.1 are examined in Section 6.2 to determine whether the firms that are highly innovative and/or face lower rates of competitor imitation tend to demonstrate greater profit persistence.

6.1 Industry-Wide Effects

Persistent profitability may be linked (via the innovation argument) to the ability to introduce a series of innovative new products (see Table 2). If this is the case, then one expects abnormal profits to demonstrate a *more* rapid rate of convergence toward *more* typical long-run levels if the extent of innovation is lower over the sample period. With reference to equation 5.12, we therefore expect that:

H5a: The rate of profit convergence (β) is negatively related to innovative propensity.

H5b: The long-run profit rate ($\alpha/1-\beta$) is positively related to innovative propensity.

The Schumpeterian framework also allows for the possibility that product innovation does not explain all of the variance in firm-level persistent profitability. In the case of the monopoly-based explanation, product innovation explains none of this variability, all of which is understood with reference to variable competitor imitation. In the case of the hybrid explanation, product innovation accounts for some, although not all of the variance. In either case, differences in the extent to which innovative new products are shielded from competitor imitation is expected to explain some of the variance in firm-level profit persistence. More specifically, stronger positive relationships between increases in the level of competition faced by innovative products and elapsed time (see Section 5.3) should lessen the persistence of abnormal profitability. To assess this claim, the following pair of hypotheses are tested:

H6a: The rate of profit convergence (β) is positively affected by competitor imitation at the product level.

H6b: The long-run profit rate ($\alpha/1-\beta$) is negatively affected by competitor imitation at the product level.

The remainder of this section summarizes the method that is used to test these four hypotheses, as well as the results that are obtained.

Method. Hypotheses H5a through H6b refer to the industry-wide effects of innovative propensity and the rate of competitor imitation on the persistence of firm-level profitability. Such effects are assessed by estimating an expanded version of equation 5.12:

$$\pi_{it} = \alpha_1 + \alpha_2 * INN_i + \alpha_3 * IMIT_i + \alpha_4 * INN_i * IMIT_i + \beta_1 * \pi_{it-1} + \beta_2 * INN_i * \pi_{it-1} + \beta_3 * MIT_i * \pi_{it-1} + \beta_4 * INN_i * IMIT_i * \pi_{it-1} + \varepsilon_{it}$$

6.11

INN_i is a dummy variable that equals one if firm i is above the norm in terms of its innovative propensity. $IMIT_i$ is a dummy variable that equals one if firm i faces lower than average rates of competitor imitation. Note that the only difference between equations 5.12 and 6.11 is the inclusion of three dummy variables (INN_i, $IMIT_i$ and INN_i*IMIT_i) and their respective interactions with the lagged profit variable. Therefore, equation 6.11 allows for tests of whether either of these variables has a significant impact on the α_{it} (H5b and H6b) and/or β (H5a and H6a) estimates reported in Tables 8 and 9. Following the logic embedded in these hypotheses, the estimates of α_2, α_3, α_4, β_2, β_3 and β_4 in equation 6.11 should all be positive.

The INN_i and $IMIT_i$ dummy variables are operationalized in the following manner. Table 18 from Section 5.4 describes the share of each firm's 1993 pharmaceutical sales accounted for by the innovative products that it introduced during the sample period. In the following analysis, a firm is considered to be highly innovative (i.e., $INN_i = 1$) if its share is above the weighted average for all nineteen firms; i.e., a share of greater than 27.3 percent. Using this approach, five of the nineteen firms are found to be highly innovative: Glaxo, Lilly, Marion Merrell Dow, Merck and Smithkline Beecham. The imitation dummy variable is operationalized with reference to the parameter estimates reported in Table 16 (in Section 5.3). There, estimates were reported of the relationship between changes in the level of competition faced by the products produced by each sampled firm

($CMPCHNG_{jt}$) and the passage of time ($ELAPSE_{jt}$) (see the λ_{1i} in equation 5.31b). Relatively speaking, firms with lower λ_{1i} estimates face lower rates of competitor imitation. For the purposes of constructing the imitation dummy variable, a firm is considered to face lower than average rates of competitor imitation (i.e., $IMIT_i=1$) if its λ_{1i} estimate is significantly less than 1.06 (the estimate obtained in the Fixed Effects model). Using this approach, nine firms are considered to be particularly capable when it comes to resisting competitor imitation: Abbott, American Cyanamid, American Home Products, Glaxo, Johnson & Johnson, Merck, Schering Plough, Searle, and Syntex.

Results. Consistent with the analysis in Section 5.1, two variants of equation 6.11 are estimated.[23] The first uses all valid observations to ascertain the effects of innovation and imitation on the persistence of all abnormal returns. More interesting for the current purposes are the second set of results, which are obtained from a regression which uses only those profit observations that are above the norm - i.e., $\pi_{it}>0$. This latter set of results attests to the relationship between innovation, imitation and the persistence of *abnormally-high* profits.

The results from the model estimated using all observations are found in Table 19. Including the innovation and imitation dummy variables (and their associated interaction terms) has virtually no impact on the explanatory power of the model - the adjusted R^2 is 0.72 in both cases. Correspondingly, the χ^2 test for the joint significance of the six

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23 In each case, the data sets used are identical to those described in Section 5.1.

Table 19
Effects of Differential Innovation and Imitation Rates on Profit Dynamics (all observations)

	Base Model[a]	Innovation and Imitation[a]
Constant (α_1)	0.53	-3.43**
Higher Innovation (α_2)	-	4.67
Slower Imitation (α_3)	-	5.11**
Interaction (α_4)	-	-3.33
β_1	0.92	0.79
Higher Innovation (β_2)	-	0.18
Slower Imitation (β_3)	-	0.14
Interaction (β_4)	-	-0.29**
χ^2 test: Innovation or Imitation Effects		7.23
Adjusted R^2	0.72	0.72
rho	-0.25*	-0.24**

[a] Because serial autocorrelation is present in the data (the Durbin Watson test is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from zero at $p<0.10$

additional variables is not significant. Despite the lack of overall significance, it is interesting to comment briefly on the specific results. Note that the intercept term is influenced (in the predicted direction) by both innovative propensity and competitor imitation. The α_1 estimate represents the intercept for the base case; i.e., the firms in question are neither highly innovative nor able to effectively resist competitor imitation. This estimate, which was not significantly different from zero in the model reported in Table 8, is now significantly less than zero ($p<0.10$). The α_2 estimate suggests that highly innovative firms have an greater intercept term, although this result is not statistically significant. According to the α_3 estimate, firms that face lower than average rates of

competitor imitation have an intercept term that is significantly ($p<0.10$) greater than those which face greater imitation at the product level. Finally, the interaction effect (α_4) suggests that the positive effect of slower imitation rates is smaller when the level of innovative propensity is higher, although this result is not statistically significant. The parameter estimates obtained for the interaction effects with the lagged profit variable show that while the effect of innovative propensity is in the expected direction, the parameter estimate is not significant. The same can be said for firms with relatively slow rates of competitor imitation. Finally, according to the β_4 estimate, the impact of having lower competitor imitation on the persistence parameter is significantly ($p<0.10$) lower when the level of innovative propensity is higher. This result suggests that the impact on persistence of competitor imitation is lessened when paired with high innovative propensity.

The qualitative features of the results reported in Table 19 are summarized in Table 20. The latter table shows that firms with relatively low innovative propensities and relatively high rates of competitor imitation experience long run profit rates (π_{lr}) that are roughly sixteen percent below average. The long run profit rate increase to roughly 40 percent above average for those firms that have high innovative propensities. However, this difference of roughly 55 percentage points is not statistically significant, and therefore lends only weak support for H5b. The long-run profit rate is also higher for firms that experience relatively slow rates of competitor imitation. In this case, the long-run profit rate is roughly 23 percentage points above zero. This increase (relative to the base case) of roughly 40 percentage points is significant ($p<0.10$). As such, there is

Table 20
Summary of the Effect of Innovative Output and Imitation on Profit Dynamics (all observations)

	Slower Imitation	Faster Imitation
Higher Innovation	α=3.01	α=1.24
	β=0.82††	β=0.97
	α_{lr}=16.73	α_{lr}=39.48
Lower Innovation	α=1.67	α=-3.43*
	β=0.93††	β=0.79††
	α_{lr}=22.77	α_{lr}=-16.38*

* significantly different from zero at p<0.01
** significantly different from zero at p<0.10
† significantly less than one at p<0.01
†† significantly less than one at p<0.10

support for H6b.

To summarize, the results from the autoregressive model estimated using all profit observations provide weak support for H5a, H5b and H6a, and somewhat stronger support for H6a. However, as suggested above, the more interesting results are those from the regression model estimated using only those observations for which $\pi_{it}>0$. These results are found in Table 21. This time, the dummy variables and their respective interaction terms have a more pronounced impact on the overall fit of the model - the adjusted R^2 increases from 0.57 to 0.63. Moreover, the χ^2 test attests to the joint significance (p<0.01) of the additional explanatory variables.

The estimated coefficient on each of the dummy variables (α_2, α_3, and α_4) is relatively small and statistically insignificant (although the two base effects are in the predicted direction). This suggests that the model's intercept term is not affected by differences in either product innovation or competitor imitation. However, the inclusion

Table 21
Effects of Differential Innovation and Imitation Rates on Profit Dynamics ($\pi_{it}>0$ observations)

	Base Model[a]	Innovation and Imitation[a]
Constant (α_1)	21.39*	10.25*
Higher Innovation (α_2)	-	1.77
Slower Imitation (α_3)	-	3.01
Interaction (α_4)		-5.91
β_1	0.15	-0.05
Higher Innovation (β_2)	-	0.71*
Slower Imitation (β_3)	-	0.60*
Interaction (β_4)		-0.54*
χ^2 test: Innovation or Imitation Effects		53.61*
Adjusted R^2	0.57	0.63
rho	0.63*	0.65**

[a] Because serial autocorrelation is present in the data (each Durbin Watson test is significant at $p<0.01$), results are from an autocorrelation-corrected model which uses a Cochrane-Orcutt type iterative procedure.

* significantly different from zero at $p<0.01$
** significantly different from zero at $p<0.10$

of the two interaction terms has a dramatic effect on the results *vis-à-vis* the estimated rate of convergence of abnormally high returns. The β_1 estimate, which in Table 9 was 0.15, now falls to -0.05. This latter estimate is not significantly different from zero, which suggests that there is virtually no period-to-period correlation of abnormally high returns for those firms that are neither highly innovative nor able to effectively resist imitation. The convergence parameter increases dramatically if a firm is highly innovative - the β_2 estimate is positive and significant ($p<0.01$). The same may be said if a firm faces lower than average rates of competitor imitation: the β_3 estimate is also

Table 22
Summary of the Effect of Innovative Output and Imitation on Profit Dynamics ($\pi_{it}>0$ observations)

	Slower Imitation	Faster Imitation
Higher Innovation	$\alpha=9.12^{**}$	$\alpha=12.03^{*}$
	$\beta=0.73^{\dagger\dagger}$	$\beta=0.67^{\dagger}$
	$\alpha_{lr}=33.78^{*}$	$\alpha_{lr}=36.08^{*}$
Lower Innovation	$\alpha=13.27^{*}$	$\alpha=10.26^{*}$
	$\beta=0.55^{\dagger}$	$\beta=-0.05^{\dagger}$
	$\alpha_{lr}=29.75^{*}$	$\alpha_{lr}=9.81^{*}$

* significantly different from zero at $p<0.01$
** significantly different from zero at $p<0.10$
† significantly less than one at $p<0.01$
†† significantly less than one at $p<0.10$

positive and significant ($p<0.01$). Finally, note that firms that are *both* highly innovative and subject to low levels of competitor imitation, have a convergence parameter equal to 0.73, which is not significantly different from one ($p<0.01$). For all intents and purposes, these firms experience perpetual above-normal returns. Overall, these results provide strong support for H5a and H6a.

Once again, the main findings of Table 21 are summarized in Table 22, which shows that, in the base case, firms earn long-run returns that are roughly ten percent above average. At the same time, firms that are highly innovative earn long-run returns that are roughly 36 percent above the average. The difference between these two estimates (26 percentage points) is significant ($p<0.01$), lending support for H5b. Firms that are able to effectively resist competitor imitation earn long-run returns that are roughly 30 percent above average, and the difference (20 percentage points) is once again significant ($p<0.01$). As such, there is evidence in support of H6b. Finally, note that those firms that are both highly innovative and better than average at resisting imitation earn long-run

returns that are roughly 34 percent above average. Not surprisingly, the 44 percentage point increase over the base case is statistically significant ($p<0.05$).

These results provide considerable support for each of the hypotheses relating product innovation and imitation to firm-level profit persistence. Long-run profit levels and the rates at which abnormally-high profits converge on those levels are both influenced by product innovation and competitor imitation. In the next section, the analysis shifts to the firm level and show how the nineteen firm level α_i and β_i estimates relate to the specific firms' innovation and imitation records.

6.2 Examining the Effects of Innovation and Imitation at the Firm Level

Section 6.1 demonstrates how product innovation, competitor imitation and persistent profitability are interconnected at an aggregate, industry-wide level of analysis. This section demonstrates how persistently profitable firms are distinguished from their less successful counterparts in terms of their innovative propensity and/or their ability to resist competitor imitation. In Tables 10 and 11, each of the nineteen sampled firms are placed into 2x2 matrices based on (a) whether they experience rapid or slow rates of profit convergence and (b) whether they realize high or low long-run profit levels. This analysis seeks to make sense of this classification by making reference to the firms' innovative propensities and their differential rates of competitor imitation.

Table 23 reproduces Table 10 with two modifications. First, it shows whether each firm is classified as a relatively high innovator and/or subject to relatively low rates of competitor imitation. These classifications are based on the same information used to

Table 23
Summary of Firm-Level Profit Persistence
(based on all observations)

	Rapid Convergence: β significantly < 0.92	High Inn	Slow Imit	Slow Convergence: β not significantly < 0.92	High Inn	Slow Imit
High Long-Run Profit: $\alpha_{lr} \geq 6.39$	American Home Products	No	Yes	Abbott	No	Yes
				Glaxo	Yes	Yes
	Bristol Myers	No	No	Marion Merrell Dow	Yes	No
	Squibb			Merck	Yes	Yes
				Smithkline Beecham	Yes	No
				Syntex	No	Yes
Avg. Share Innovative Sales		16.70			41.20	
Avg. Rate of Imitation		1.57			1.08	
Avg. π		32.14			22.33	
Low Long-Run Profit: $\alpha_{lr} < 6.39$	American Cyanamid	No	Yes	Carter-Wallace	No	No
	Johnson & Johnson	No	Yes	Lilly	Yes	No
	Warner Lambert	No	No	Pfizer	No	No
				Rhone Poulenc Rorer	No	No
				Searle	No	Yes
				Upjohn	No	No
				Schering Plough	No	Yes
				Sterling	No	No
Avg. Share Innovative Sales		12.87			10.79	
Avg. Rate of Imitation		0.78			5.24	
Avg. π		-23.40			-16.09	

construct the INN_i and $IMIT_i$ variables in Section 6.1. Of the eight firms experiencing relatively high long-run profit levels, seven are either highly innovative or face lower than average rates of competitor imitation (the lone exception is Bristol Myers Squibb). Moreover, both of the firms classified highly on both the innovation and imitation dimensions (Glaxo and Merck) are in this group of firms. On the other hand, six of the

eleven firms experiencing relatively low long-run profit levels are relatively poor at both generating product innovations and protecting those products from competitor imitation.

The second addition to Table 23 is the inclusion of cell averages for (a) the share of 1993 sales coming from innovative new products (from Table 18), (b) the rate at which new products are imitated (from Table 16), and (c) the average normalized profit rate earned over the sample period. These statistics suggest that firms earning the high long-run profits are considerably more innovative than those earning low long-run rates of return. The cell averages for the former firms are 41.20 and 16.70, while the averages for the latter firms are 12.87 and 10.79. Similar conclusions may be reached when the ability to resist competitor imitation is examined. On average, the rate at which the level of competition increases as time elapses is lower for the high long-run profit firms (rates of 1.08 and 1.57, respectively) when compared to the lower long-run profit firms (rates of 0.78 and 5.24). Finally, the sample-period average rates of return are indicative of the value inherent in achieving persistent profitability. Over the sample period, the firms with above-average long run rates of return are considerably more profitable.

Table 24 makes similar amendments to Table 11 and focuses on how persistent are the firms' above-normal profit outcomes. This time, seven firms are unambiguously persistently profitability (i.e., they have relatively high long-run profit rates and relatively slow rates of profit convergence). Every one of these firms is either highly innovative or faces lower than average rates of competitor imitation. And, once again, both of the firms that are classified highly on both the innovation and imitation dimensions (Glaxo and Merck) are found in this group. At the other end, nine firms are found to have high profit levels that do not persist, while a further three never experience above-normal

Table 24
Summary of Firm-Level Profit Persistence
(based on $\pi_{it}>0$ observations)

	Rapid Convergence: $\beta \leq 0.15$	High Inn	Slow Imit	Slow Convergence: $\beta > 0.15$	High Inn	Slow Imit
High Long-Run Profit: $\alpha_{lr} \geq 25.14$				Abbott	No	Yes
				American Home Products	No	Yes
				Glaxo	Yes	Yes
				Marion Merrell Dow	Yes	No
				Merck	Yes	Yes
				Smithkline Beecham	Yes	No
				Syntex	No	Yes
Avg. Share Innovative Sales		n/a			36.70	
Avg. Rate of Imitation		n/a			1.00	
Avg. roa		n/a			26.37	
Low Long-Run Profit: $\alpha_{lr} < 25.14$	Bristol Myers Squibb	No	No	Schering Plough	No	Yes
	Johnson & Johnson	No	Yes	Upjohn	No	No
	Lilly	Yes	No			
	Pfizer	No	No			
	Rhone Poulenc Rorer	No	No			
	Searle	No	Yes			
	Warner Lambert	No	No			
	American Cyanamid[a]	No	Yes			
	Sterling[a]					
	Carter Wallace[a]	No	No			
		No	?			
Avg. Share Innovative Sales		12.42			12.20	
Avg. Rate of Imitation		4.19			1.93	
Avg. roa		-18.31			-1.11	

[a] no observations for which $\pi_{it}>0$

profitability. Of these firms, seven have relatively low innovative propensities *and* are poor at resisting competitor imitation.

Finally, the seven persistently profitable firms are considerably more innovative

than the other firms. On average, 36.70 percent of 1993 sales come from innovative products in the former group, compared to only 12.20 and 12.42 percent in the latter two groups. Similarly, the persistently profitable firms experience much slower rates of competitor imitation (an average of 1.00), compared to the remaining firms (4.93 and 1.93). Finally, the overall average profit rates across the four cells demonstrate that the firms with persistent above-normal profitability are considerable more profitable (26.36 percent above the norm, on average) than are those whose above-normal profits do not persist (1.11 and 18.31 below the norm, on average).

According to the results summarized in Tables 23 and 24, there is firm-level corroboration of the Schumpeterian framework to go with the industry-wide results reported in Section 6.1. This section closes by tying the contents of Table 24 to the three explanations for persistent profitability summarized in Table 2 (see Table 25). Recall that firm-level persistent profitability may be explained with reference to the traditional monopoly-based explanation. Here, above-normal profits persist because the firms in question are able to resist the imitation of their innovative products. Table 25 shows that Abbott, American Home Products, and Syntex are persistently profitable despite being relatively poor innovators because they are better than average at protecting their products from imitation. Persistent profitability may also be understood with reference to an innovation-based explanation. In such cases, profits persist in spite of relatively intense imitative pressure because the firms in question have relatively high innovative propensities. Table 25 shows that both Marion Merrell Dow and Smithkline Beecham were able to sustain their above-normal profit outcomes into the long run despite facing greater-than-average competitor imitation. And, both were better than average in terms of

Table 25
Persistently Profitable Firms and the Three Arguments

Explanation	Firms	Innovations Generated	Imitation Process
Monopoly-Based	Abbott American Home Products Syntex	Few	Slow
Innovation-Based	Marion Merrell Dow Smithkline Beecham	Many	Rapid
Hybrid	Glaxo Merck	Many	Slow

innovative propensity. Finally, the Schumpeterian framework recognizes that both the monopoly-based and innovation-based explanations may be in force at the same time, calling for a hybrid explanation of persistent profitability. According to Table 25, Glaxo and Merck call for such an argument because both were better than average in terms of innovative propensity as well as faces relatively low rates of competitor imitation.

In summary, this chapter attests to the fact that firm-level persistent profitability may be understood with reference to a properly-formulated Schumpetarian framework. In support of the position taken by persistent profitability scholars, resisting the imitation of products contributes to persistent profitability at the firm level. Moreover, the findings *vis-à-vis* the firms' innovative propensities indicate that product innovation may be related to the persistence of, as well as the generation of, above-normal profit positions.

CHAPTER 7: DISCUSSION AND CONCLUSIONS

The analysis presented in the preceding two chapters attests to the empirical validity of a Schumpeterian perspective on firm-level persistent profitability (as developed in Chapter 3). More specifically, the findings demonstrate that a firm's innovative propensity as well as its ability to resist competitor imitation both influence the extent to which its above-average profit outcomes persist over time. However, each process operates in a different manner. High innovative propensity yields a series of relatively temporary monopoly positions at the product level which, when aggregated to the firm-level, translate into persistent profitability. On the other hand, the ability to avoid competitor imitation implies a stronger correspondence between product-level and firm-level profit dynamics, yielding an explanation for firm-level persistent profitability that mirrors the monopoly argument popular within the economics literature.

In the course of developing this research, the above discussion alludes to several connections between it and the broader academic literature. This final chapter develops these linkages in greater depth. Chapter 2 notes that issues related to firm-level persistent profitability (or sustained superior performance) have been taken up by resource-based theorists within the strategic management field, and by persistent profitability researchers within IO economics. As such, Section 7.1 discusses how the Schumpeterian framework complements the resource-based perspective that is rapidly gaining prominence within the strategic management literature. Then, Section 7.2 discusses how the results presented in Chapters 5 and 6 impact on the persistent profitability research conducted by IO

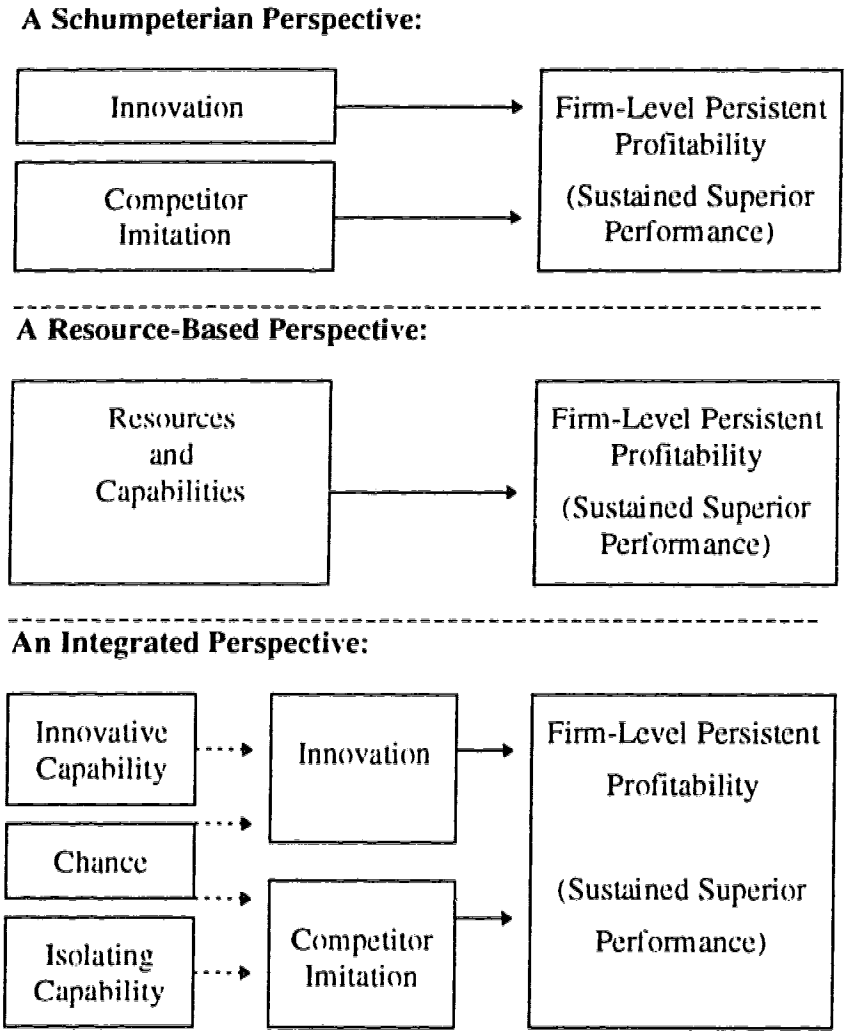
economists. Chapter 4 discusses the correspondence between the Schumpeterian framework and the research conducted on the sources of profitability in the pharmaceutical industry. Section 7.3 returns to this issue in order to examine the implications of this project for the ongoing research within the pharmaceutical economics literature. Finally, Section 7.4 briefly alludes to how this research contributes to other streams of literature, including that addressing the market share-profitability question, as well as the implications of first-mover advantage. Chapter 7 closes by summarizing the main implications of this work and by making several suggestions for future research.

7.1 Firm Capabilities and Sustained Superior Performance

The aim of this section is to illustrate how a Schumpeterian explanation of firm-level persistent profitability differs from, but complements, that suggested by the emerging resource-based perspective. In doing so, a broader integrated framework is suggested which captures the central features of both explanations. The section closes by discussing the benefits inherent in, as well as the challenges posed by, this integrated framework.

Drawing explicitly on Schumpeter's conception of competitive dynamics, one sees how the prospect for sustaining above-normal profitability at the firm-level depends on a firm's innovative propensity on one hand, and its ability to resist competitor imitation on the other. This general approach is outlined in the upper frame of Figure 4. At the most basic level, this lays the groundwork for an approach to firm-level profit dynamics whose *primary* emphasis is on the product markets in which firms participate. Firms that regularly bring valuable new products to the market tend to experience

Figure 4
An Integrated Model of Firm-Level Persistent Profitability



persistent above-normal profitability. The same can be said for those firms that frustrate normal market forces and resist the imitation of their products by potential competitors.

On the surface, this approach differs from that taken by resource-based theorists, who argue that the nature of the resources and capabilities of which firms are comprised determines the extent to which relatively high profits persists (see the middle frame in Figure 4). To be clear, these theorists do pay careful attention to the functioning of

markets, but tend to emphasize the markets (or lack thereof) in which resources are acquired (Barney, 1986b; Dierickx & Cool, 1989). Lined up next to one another, these two perspectives seem to offer competing explanations for the persistence of above-normal profitability. However, a challenge for future research is to recognize how these two perspectives actually complement one another (e.g., the lower panel of Figure 4).

It is quite easy to demonstrate how the resource-based line of thinking complements the Schumpeterian perspective outlined herein. Recall from Chapter 1 that the twin objectives of this study are to demonstrate and understand the general tendency for firms to achieve relatively high profitability which subsequently falls back to more normal levels, as well as the firm-level factors which explain the variance in persistent profitability. In this latter respect, Chapter 6 demonstrates how firm differences in both innovative propensity and the rate of competitor imitation explains a significant amount of the variance in firm-level profit persistence. However, this explanation is not complete as these two drivers of persistent profitability are actually *outcome* variables.

This study explicitly treats a firm's innovation and imitation records as endowments (as illustrated in the upper panel of Figure 4) when, in fact, they are outcomes of processes which depend on a firm having possession of (or at least access to) specific capabilities. The current framework may therefore be extended by situating it within a resource-based theoretic context. In resource-based terminology, the current approach suggests that firm capabilities which deliver persistent profitability should be those which enhance either a firm's ability to produce streams of valuable innovations (innovative capabilities) or its propensity to protect innovations from imitative competition (isolating capabilities - see Rumelt, 1984, 1987). More precisely, firm-level resources are

valuable (in terms of their impact on sustained high profitability) to the extent that they contribute to one or both of these two capabilities.

References to these two types of capabilities may be found in the resource-based literature. The following excerpt from Grant (1991:131) points to the significance of the innovative capability:

> in industries where competitive advantages based on differentiation and innovation can be imitated ... firms must be concerned not with sustaining existing advantages, but with creating the flexibility and responsiveness that permits them to create new advantages at a faster rate than the old advantages are being eroded by competition.

Similar references are made by Rumelt (1984, 1987), who stresses the significance of a firm's entrepreneurial ability, Brumagim (1994) who discusses organizational learning resources as contributors to a firm's sustained superior performance, and Collis (1994:144), who notes that "capabilities researchers are, therefore, now searching for the organizational structures and behaviors that will generate effective product introduction." Additionally, the importance of the innovative capability alludes to the usefulness of linking up with the literature on innovation management (e.g., Damanpour, 1991; Henderson, 1994; Lengnick-Hall, 1992; Van de Ven, 1986), to the extent that the latter is concerned with enhancing the efficacy of the innovation process.

The most obvious example of a reference to a firm's isolating capability is Rumelt's (1984, 1987) discussion of isolating mechanisms. In fact, his concept is derived explicitly

from an understanding of Schumpeterian competitive dynamics (Rumelt, 1987).[24] Related references to the isolating capability are found in Reed and DeFillippi's (1990) discussion of causal ambiguity (see also Lippman & Rumelt, 1982), Peteraf's (1993) discussion of *ex post* limits to competition, and Barney's (1991) discussion of resource inimitability. It must be stressed, however, that in the current context, a firm's isolating capability refers to its ability to resist the imitation of its product innovations, and not necessarily the capabilities that it has come to possess. This is an important distinction that tends to be overlooked in recent treatments of competitor imitation.

Consider the following passage from Lengnick-Hall (1992:400, emphasis added), which seems to treat these two types of imitation as synonymous:

> if *the innovation process* or *the outcomes of innovation* are difficult to copy, effective corporate entrepreneurship becomes an increasingly important ingredient in sustaining competitive advantage.

The current treatment of firm-level persistent profitability points to the importance of distinguishing between the imitability of the innovation process (or capability) and the imitability of the resulting innovative outcomes. On the one hand, an imitable innovative capability may still deliver persistent above-normal profitability if its early outputs (i.e., the product innovations generated before the capability was imitated) are protected from competitor imitation. Even assuming that this capability diminishes in value after imitation, the firm in question may be persistently profitable via the monopoly-based explanation described in Chapter 3. Here, the inimitability of innovative products drives

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24 Included among Rumelt's (1987) list of isolating mechanisms are information impactedness, buyer switching costs, and firm reputation.

persistent profitability and not the inimitability of the innovative capability.[25]

Similarly, if one formally distinguishes between an innovative capability and the nature of its innovative output, there is no reason to suspect that the value of an innovative capability must diminish after it has been imitated. This would only be the case in the unlikely instance of a one-to-one correspondence between an innovative capability and the innovative products that it generates. Then, diffusion of this capability across competitors would lead to the simultaneous introduction of similar innovative (i.e., new to the market) products, and the affected products would not enjoy the temporary monopoly positions that deliver above-normal profitability. It is more likely that the proliferation of an innovative capability will lead to a faster rate of introduction of different innovative products, enhancing the diversity of the novel offerings. In support of this consideration, Table 25 shows that five of the nineteen sampled firms (Glaxo, Lilly, Marion Merrell Dow, Merck and Smithkline Beecham) are in possession of valuable innovative capabilities, and that four of these firms (all but Lilly) experience persistently high profitability.[26]

This discussion surrounding innovative and isolating capabilities points to a limitation of the current research project, and in the direction of an obvious line of further inquiry. Although conceptual arguments and empirical evidence are present relating a firm's product innovation record and its performance *vis-à-vis* competitor imitation to the evolution of its financial performance over time, little has been said about the precise

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25 Geroski *et al.* (1992, 1993) find that the high profits accruing to specific innovations are distinct from the profits generated by an innovation process.

26 A similar line of reasoning suggests that the value of an isolating capability does not necessarily diminish as it is imitated.

nature the underlying capabilities. In this sense, the framework that has been presented deals with only part of the overall problem of understanding firm-level persistent profitability. In addition to calling for an extension of this research project, it is also useful to refer to other research that might illuminate the missing pieces of the integrated framework presented in lower panel of Figure 4.[27] Henderson and Cockburn (1993, 1994) present the results of research which tries to understand the causes of relatively high innovative propensity among U.S. pharmaceutical firms. The factors that they look to include firm size, scope of operations, component competence (i.e., unique disciplinary expertise), and architectural competence (the ability to access and integrate various types of expertise).

Combining the insights from their research with the current findings, one begins to trace the entire path from a firm's innovative capabilities through its innovative output to the persistence of its above-normal profit outcomes. However, the Schumpeterian framework, as well as the results from Chapter 6, stress that one should be cautious not to expect the innovative capability-innovation-persistent profitability path to be followed in all cases. In fact, three of the sampled firms (Abbott, American Home Products, and Syntex) have been persistently profitable despite lacking a discernible innovative capability (or at least one that may be described as valuable). These four firms experience persistent profitability because they possess valuable isolating capabilities. As such, one of the primary benefits gained by refining the resource-based perspective in light of the

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27 There is a large volume of research that examines the factors which influence a firm's innovative output (e.g., Pavitt, 1991). We choose to focus on the Henderson and Cockburn research because (a) it addresses these relationships from a resources and capabilities perspective and (b) it too is situated within the U.S. pharmaceutical industry.

arguments made in this paper is the formal recognition that there are (logically) different paths linking a firm's resources and capabilities to its ultimate profit dynamics.

This point may be taken to a more general level. Superior financial performance results from the more-or-less temporary monopoly positions that correspond with the introduction of valuable innovations to the market. It is sustained at the firm level only when innovation is repeated or when competitor imitation is absent. However, a valuable product innovation may arise as the result of an underlying innovative capability, or it may be the result of a chance event (in the latter respect, see Barney, 1986b). Similarly, competitor imitation may be resisted because a firm systematically applies an isolating capability, or because it was fortunate enough to stumble upon an innovation that resists competitor imitation. A firm might therefore be persistently profitable although it lacks any underlying, valuable capabilities; its performance being due to the interaction of two chance events. Any resource-based analysis must recognize this possibility, as well as the basic fact that any systematic (i.e., non-chance based) tendency for firms to achieve sustained superior performance must be linked to particular capabilities *vis-à-vis* the innovation *or* the imitation processes.

One final question that arises out of this integrated framework relates to whether firms can simultaneously invest in both of these strategically important capabilities. On the one hand, research in the IO economics literature would suggest that firms that are most effective at forestalling competitor imitation have the strongest incentive to innovate (e.g., Kamien & Schwartz, 1982). On the other hand, one might also expect that while these two capabilities are complementary in terms of their impact of firm profitability, they might be mutually distracting in terms of their organizational implications. Quite bluntly,

fit theorists (e.g., Miller, 1987) would argue that the structures and systems that foster valuable innovative capabilities might work against the development of valuable isolating capabilities.

Some anecdotal evidence has been presented suggesting that it is possible to simultaneously possess both an innovative and an isolating capability. Tables 23 and 24 demonstrate how both Glaxo and Merck have been above average in terms of their ability to develop innovative new products, as well as their propensity to avoid competitor imitation. However, a broader look across the nineteen sampled firms reveals that these might be (albeit important) exceptions. The correlation between the firms' innovative propensity (as measured by the proportion of 1993 sales coming from innovative new products) and their respective abilities to deter imitation is actually negative. Although this result is not statistically significant, it is suggestive of the problems that might be faced when trying to house both capabilities within one organization.

7.2 Implications for Persistent Profitability Research

The empirical findings presented in Chapter 5 are in many ways consistent with previous research that has addressed the persistent profitability question. Using similar methods but in an intra-industry context, Section 5.1 demonstrates that the norm is for abnormal profit outcomes to converge on levels that may be described as competitive.[28] It also shows that there is significant firm-to-firm variance in the extent to which profits persist over time and that some pharmaceutical firms are clearly persistently profitable.

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28 Waring (1995) provides an intra-industry analysis of persistent profitability.

When focus is shifted to abnormally high profit outcomes only, superior performance outcomes do not seem to vanish entirely, even in the long run. This conclusion mirrors that reached by Mueller (1977:72), who (following a different methodology) notes that:

> the probability that a firm starting in the highest group [in terms of profitability] can stay there is much greater than the probability that a firm starting in the bottom group must stay there.

These results are also consistent with Schohl's (1990) analyses of U.S., Japanese, and German firms, but are at odds with Jacobson's (1988) finding that the speed of profit convergence is not dramatically affected by whether a firm is in the top or bottom quintile in terms of its profit outcomes.[29]

The primary challenged posed by this project for the ongoing research into the persistent profitability question relates to the way in which the unit of analysis is conceived. By explicitly modeling firms as evolving portfolios of (in this case) product innovations, the locus of competition is shifted from the firm to the sub-firm level of analysis. That is, we formally recognize that individual product innovations yield superior profitability, and that it is the products, and not the firms, that directly experience imitative competition. This shift in focus both parallels and extends the previous movements away from industry-level studies of profit persistence. Mueller (1977:370), for example, suggests that:

> we thus prefer to test for the persistence of above-normal profits at the firm level, and a good case could be made for an even finer breakdown if data

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29 Note the Jacobson's approach is slightly different in that he examines the dynamics of unadjusted, as opposed to normalized profit series.

were available.

Consistent with Mueller's (1977) data-availability concerns, this analysis was not able to directly examine the dynamic profit profiles associated with individual pharmaceutical products.[30] However, by creatively combining existing firm-level and product-level data sources, it is able to model the dynamics firm-level profitability in a way that is sensitive to the fact that innovation and imitation are sub firm-level phenomena.

The implication shifting the level of analysis is the introduction of an innovation-based explanation for firm-level persistent profitability to go alongside the monopoly arguments that are typically proffered. This is especially relevant given the findings summarized in Table 25. Of the pharmaceutical firms found to be persistently profitable, only three are understood with reference to a monopoly-only argument. The remaining firms are best understood with reference to an innovation-only argument or a hybrid monopoly-innovation argument. These findings suggest that a complete reliance on monopoly as an explanation for persistent profitability is misleading.

Relatedly, one should comment briefly on the normative implications of the above remarks. As suggested in the introduction, IO economists interested in the persistent profitability question have been motivated by an underlying concern with the overall efficacy of the competitive process. The fact that some firms are able to earn persistently high profits is seen as evidence that competitive forces are either malfunctioning or are being pre-empted. The findings summarized in Table 25 suggest that one's normative aversion to firm-level persistent profitability should be tempered by the fact that some

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30 We did, however, raise the prospect of using firms' internal cost accounting functions in order to gain access to such data.

cases are witnessed even when competitive forces are sufficiently effective (e.g., Marion Merrell Dow and SmithKline Beecham). This is not to say that the current results invalidate all monopoly-based concerns. Rather, they suggest that the problems may not be as large as previously thought. In light of this, researchers may wish to revisit previous persistent profitability studies in order to gauge the extent to which innovation accounts for any of the observed profit persistence.

7.3 Implications for Pharmaceutical Economics

The contributions of this research to the pharmaceutical economics literature are two-fold. At a conceptual level, it provides a dynamic framework that embraces *both* the relevant features of pharmaceutical firm competition (i.e., product innovation and competitor imitation). Treating pharmaceutical firms as evolving portfolios of differentially-aged products, the dynamics of firm-level profitability are modeled as the outcome of both an innovation and an imitation process. What is generated is a framework that *jointly* embraces the innovation and monopoly arguments that have been put forth as explanations of the persistently high profits earned in the pharmaceutical industry (Comanor, 1986).

Relatedly, this research also provides empirical evidence that contributes to the ongoing debates about persistently high pharmaceutical profits. Table 26 demonstrates that the profits (e.g., ROA) earned within the pharmaceutical industry have consistently been well above those earned in the next highest earning industry (see also Office of Technology Assessment, 1993). As suggested in Chapter 4, commentators tend to argue

Table 26
Pharmaceutical ROA Relative to Next Highest Industry
(industry medians)

Year	Pharmaceutical Industry	Next Highest Industry	
1993	11.2	7.1	Publishing, Printing
1992	11.7	8.8	Toys, Sporting Goods
1991	12.1	7.1	Food
1990	13.1	8.7	Soaps, Cosmetics
1989	14.0	7.9	Furniture
1988	13.1	8.9	Soaps, Cosmetics
1987	12.5	8.7	Furniture
1986	12.2	9.9	Furniture
1985	10.0	11.3	Toys, Sporting Goods

Source: *Fortune*, various years

that such inter-industry profit differentials *either* suggest the presence of relatively strong monopoly positions *or* are due to the relatively high innovation rates of incumbent pharmaceutical firms. The findings of this research, which come from a firm-level (not an industry-level) analysis of profit persistence, suggest that such a bifurcated debate may miss the two nature of the phenomenon.

More specifically, Chapter 6 shows that some pharmaceutical firms are persistently profitable because they are more innovative (Marion Merrell Dow and SmithKline Beecham), while others are persistently profitable because imitation is, relatively speaking, absent (Abbot, American Home Products, and Syntex). Still others require elements of both explanations for an adequate understanding of their profit dynamics (Glaxo and Merck). Because the sampled pharmaceutical firms differ in the extent to which they develop valuable product innovations and/or resist competitor imitation, one should be wary of simplistic either/or explanations of pharmaceutical firm profitability.

However, as it stands, this project can only make limited and indirect inferences about inter-industry profit differentials, as it looks at the extent to which intra-industry

differences in profit persistence are attributable to differential innovation and imitation rates across firms. Therefore, the analysis itself cannot explain the observed differences between pharmaceutical and non-pharmaceutical industry profit dynamics. However, the Schumpeterian logic that is used to understand intra-industry profit differentials may be extended to understand inter-industry differentials. In several places, it has been suggested that pharmaceutical firm innovation rates tend to be higher than corresponding rates for non-pharmaceutical firms (e.g., Henderson, 1994). It has also been argued that - because of pertinent demand characteristics and/or a more effective patent regime (Caves, Whinston & Hurwitz, 1991; Mansfield, Schwartz & Wagner, 1981) - competitor imitation may be less intense within the pharmaceutical industry than without. If either (or both) of these conjectures stand up to empirical scrutiny, one may generate a Schumpeterian explanation of inter-industry differences in profit persistence. Profit persistence may be greater within the pharmaceutical industry because pharmaceutical firms tend to be more innovative and/or better able to resist competitor imitation than their non-pharmaceutical counterparts. This suggests a valuable line of further inquiry.[31]

The findings of this research may also contribute to debates surrounding the optimal regulatory regime for the pharmaceutical industry. These discussions have centered on how to design a set of policies that create the optimal incentives for firms to invest in valuable pharmaceutical R&D. Pharmaceutical economists typically refer a Schumpeterian trade-off between static efficiency, which is thought to come from

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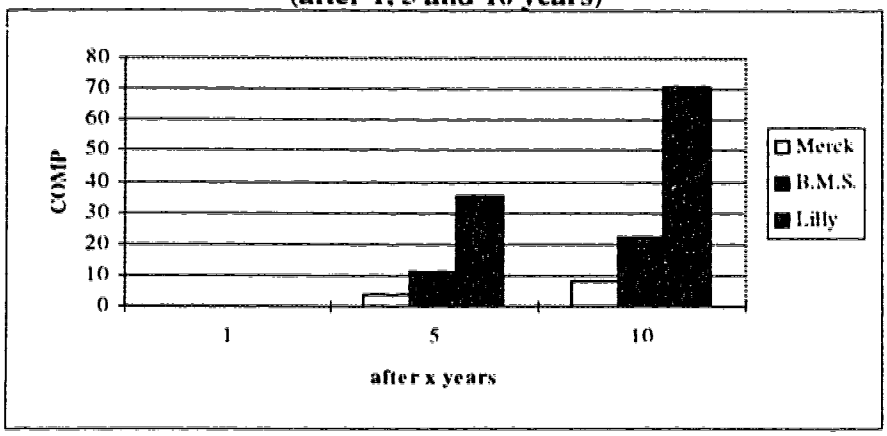
31 Data limitations might prohibit a multi-industry study. This study relies on the comprehensive product-level data supplied by IMS America. In order to meaningfully compare results across industries, one would require similar data for other industries.

Figure 5
Competition Faced by a Typical Innovative Product
(after 1, 5 and 10 years)



perfectly competitive markets, and the dynamic efficiency that is associated with the temporary monopoly periods that are required to encourage innovation. Scholars and regulators alike have recognized that the length of patent-protected periods and the arduousness of the drug approval process tend to have opposing effects on the expected length of these temporary monopoly periods. They have therefore sought to design policies in such a way so as to provide the proper incentives for product innovation at the lowest overall cost to society (Caves, Whinston & Hurwitz, 1991).

However, the results of this study show that, despite similar treatment by regulators, pharmaceutical firms face temporary monopoly periods of considerably different lengths (see Table 16). The three examples in Figure 5 provide a demonstration of this. After ten years, a typical innovative product (i.e., one introduced to $COMP_{j10}=0$) introduced by Merck would still face relatively little competition from imitators ($COMP_{j10}=8$). However, the same product introduced by Lilly would face very intense competition ($COMP_{j10}=71$), while Bristol-Myers Squibb occupies an intermediate

position ($COMP_{j10}$=26). This suggests that many factors that are beyond the direct influence of public policy affect the temporary monopoly returns to innovators, and thus the purported incentive to innovate. This point has been raised by Caves, Whinston and Hurwitz (1991) as a prelude to their analysis of inter-firm competition in post-patent periods. Finally, as suggested in Section 7.1, many of these factors may be firm-specific (Rumelt, 1987; Williams, 1991).

More importantly, these results show that there is no simple, one-to-one correspondence between the expected length of a firm's monopoly period and its propensity to innovate. In fact, as seen in Section 7.1, the correlation between a firm's innovativeness and the average rate of competitor imitation faced may actually be negative. So, while one may be tempted to argue that Glaxo and Merck are more innovative because their ability to resist imitation increases the incentive to do so, this line of reasoning does not explain why Marion Merrell Dow and Smithkline Beecham, who face shorter (and therefore less attractive) monopoly periods, are also highly innovative. Nor does it explain why Abbot, American Home Products and Syntex are less innovative despite facing relatively strong innovation incentives. Future policy debates must come to grips with the obvious variability in both the incentives that firms have to innovate, as well as differences in their inherent capabilities in this respect.

In closing this section, one should also recognize that the impact of patents on competitive dynamics has not been addressed in the current project. However, patents may be introduced into future analyses by examining their effects on the observed rate of competitor imitation (see Section 5.3). Patents, when in effect, are intended to slow (or stop) the rate at which imitators emerge to compete with a particular innovation. When

they expire, they have the reverse effect of rapidly disseminating the relevant information, thereby speeding up the rate of imitation (Caves, Whinston & Hurwitz, 1991). Returning to equation 5.31a, one would therefore expect the coefficient on $ELAPSE_{jt}$ for the innovative products to be lower when patents are in effect. However, because it is reasonable to expect that most (if not all) innovative products are protected by patents during the early years following introduction, this may translate into an expectation that imitation rates should be lower in the early years of an innovative product's life.

7.4 Other Implications

Two features of this research suggest links with other literatures within the strategy field. First, the level of competition faced by a product ($COMP_{jt}$) is a variant of the market share that is obtained by product j in year t (see Note 16). As such, the firm-level measure of the weighted-average level of competition faced (WC_{it}) may be interpreted as a weighted market share measure. Given the volume of research that has been published on questions concerning the market share-profitability relationship (e.g., Buzzell, Gale & Sultan, 1975; Jacobson & Aaker, 1985; Schwalbach, 1991), the implications of this research for such questions are discussed. Second, by formally distinguishing between innovative and imitator products, this research touches on issues that are addressed by researchers interested in the nature of first-mover advantage (e.g., Lieberman & Montgomery, 1988; Robinson, Kalyanaram & Urban, 1994).

Market Share and Profitability

Since the original PIMS studies, a large volume of research has been conducted on the relationship between a firm's market share and its profitability. The original research finds a positive and significant relationship between a firm's market share and its resulting profitability (Buzzell, Gale & Sultan, 1975). Recently, researchers have been exploring this relationship more deeply (Jacobson & Aaker, 1985; Schwalbach, 1991). There is an obvious correspondence between the $COMP_{jt}$ variable described in Chapter 5 and the market share for product j in year t (where the market share of product j is typically $SAL_{jt}/CMPSAL_{jt}$):

$$COMP_{jt} = \left(1 - SHARE_{jt}\right)*100$$

According to the operationalization of the level of competition faced, a product has 100 percent of its market (defined as a therapeutic sub-class) when it faces zero competition. Conversely, the level of competition faced is highest when a product's share of the market approaches zero. The following paragraphs discuss the applicability of the findings presented in Section 5.2 to research into the market share-profitability question, as well as comment on their implications for conceptual development in the area.

The results reported in Table 14 speak to the market share-profitability question. Controlling for the sampled firms' differential non-U.S. pharmaceutical operations (i.e., the final column of Table 14), the relationship between a pharmaceutical firm's weighted market share and its relative profitability is positive and significant.[32] More specifically, a

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[32] This is the same as saying that the relative profitability of a firm is lower when the weighted level of competition that its products face is higher.

typical pharmaceutical product having a 100 percent share of its therapeutic market earns profits that are roughly 90 percent above the industry average. For every one percent reduction in market share, the product's relative profitability declines by roughly 0.8 percent so that, at the other extreme, a product with a market share of virtually zero earns profits that are roughly ten percent above the pharmaceutical industry average.

For two reasons, the magnitude of this estimated relationship is not fully comparable with previous findings. First, the profit measure - π_{it} - is a relative and not an absolute measure. Previous market share-profitability research has not adjusted the dependent variable to account for variations in average industry profitability. Second, the market share measure built into the WC_{it} variable is actually the weighted-average share achieved by firm i's products across all of the product markets in which it participates. However, market share variables are typically constructed as the sales of a firm (or a business unit) divided by the total sales of the industry in which it competes (e.g., Robinson & Fornell, 1985:309). Table 27 shows how these two approaches give dramatically different pictures of the pharmaceutical firms' observed market shares. In all cases, a firm's overall share of U.S. pharmaceutical sales understates the market shares that it achieves in its specific product markets. More importantly, the firms' market share rankings differ depending on the measure that is used. For example, Bristol Myers Squibb's U.S. pharmaceutical sales in 1993 represents 5.9 percent of total U.S. pharmaceutical sales in that year, making it the second highest share firm in 1993. However, its weighted market share in the same year is 19.6 percent, making it the third lowest share firm according to that measure. While it is premature to suggest how the findings of previous market share research would be affected by the current modifications

Table 27
Market Share versus Weighted Market Share in 1993

	Weighted Market Share	Rank	Market Share	Rank
Glaxo	38.7	1	5.5	3
Lilly	34.7	2	4.8	6
Upjohn	34.5	3	3.0	11
SmithKline Beecham	31.0	4	4.5	7
American Home Products	30.8	5	5.3	4
Schering-Plough	30.6	6	3.2	10
Sterling Winthrop	29.6	7	0.9	18
Abbott	29.0	8	3.5	9
Johnson & Johnson	28.3	9	4.9	5
Pfizer	28.2	10	4.4	8
Merck	28.2	11	6.2	1
Rhone-Poulenc Rorer	28.1	12	1.4	15
Syntex	25.8	13	1.9	14
Carter-Wallace	22.2	14	0.5	19
Marion Merrel Dow	22.1	15	2.9	12
Warner-Lambert Co	20.8	16	2.5	13
Bristol-Myers Squibb	19.6	17	5.9	2
American Cyanamid	15.7	18	1.3	17
Searle	8.8	19	1.3	16

(i.e., the use of relative profitability measures, as well as a finer weighted market share measure), there may be some justification for revisiting the analyses.

At the same time, future variants of the current project may be enhanced by adopting some of the empirical approaches taken by market share researchers. For example, Jacobson and Aaker (1985) find that much of the market share-profitability relationship is explained away when other intervening factors (such as the degree of vertical integration, marketing intensity, capacity utilization, relative quality, and market growth) are controlled Because the same might be true for the level of competition faced-relative profitability results presented in Section 5.1, future research might consider introducing additional control variables into the models. And, using a linear spline

function approach, Schwalbach (1991) finds that the relationship between market share and ROI is not constant over the full range of the market share variable. Similar refinements of this project might yield corresponding results *vis-à-vis* the relationship between the level of competition and relative profitability.

This research may also provide additional conceptual grounding for market share-profitability researchers. So far, we have carefully avoided using market share terminology to frame the arguments, preferring to describe the relationship between the level of competition faced by a firm's products and its relative profit standing. In doing so, this research is able borrow from Schumpeter to build a dynamic framework which embraces these cross-sectional findings, a framework that embraces both innovation and imitation. In the end, the results demonstrate how successful innovation generates low-competition (or high market share) positions, which, in turn deliver high profits. This approach raises the possibility that the observed relationship between market share and profitability is not a direct causal one, "rather, it is the result of both being jointly influenced by some third factor (Jacobson & Aaker, 1985: 12)" - a firm's innovative propensity.[33] However, because innovation creates (at least temporary) monopoly positions, one might also suggest that high market share is consistent with a market power explanation of the market-share-profitability relationship, although not necessary in the collusive sense suggested by Jacobson and Aaker (1985:12).

This raises another issue that requires further attention. A Schumpeterian framework suggests that innovation leads to low-competition (and thus high market share)

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33 Jacobson and Aaker (1985) suggest that such third factors include good management and luck, both of which may affect a firms innovative propensity - see Figure 4.

positions. However, building on the observation that market share is correlated with profitability, the marketing literature stresses the importance of building market share over time. Recall from Table 15 that the minimum value of $CMPCHNG_{jt}$ is -98.39. This confirms that some of the sampled pharmaceutical products successfully moved from very low to very high market share positions with the passage of time. Taken together, these points suggest that high market share positions can either be 'invented' via product innovation or 'constructed' via deliberate efforts on the part of later entrants. It is possible that these two types of high market share positions have different profit implications. In the analysis in Section 5.2, the two are grouped together in order to estimate a single relationship between the level of competition and relative profitability. In future research, it will be interesting to see whether the profitability associated with the invented high market share positions is the same as that associated with positions that are constructed over time.

Similarly, one might examine whether the imitative dynamic addressed in Section 5.3 is constant across both types of high market share positions. The analysis in Section 5.3 shows that invented (or innovated) high market share positions are subjected to increasing competition from imitators as time elapses. However, there are at least two reasons why the same might not hold for high market share positions that are built up over time. As mentioned above, these latter positions may not be associated with the same high profits, and the incentives for competitors to imitate may be lower. It is also possible that invented and constructed high-share positions are surrounded by different barriers to imitation (or isolating mechanisms - Rumelt, 1987). For invented high market share positions, information asymmetries serve as a primary barrier to imitation. By definition,

innovators bring knowledge and information to the market that is not immediately available to all competitors. In the absence of other barriers to imitation, the level of competition that is faced is expected to rise as the relevant knowledge and information flows from innovator to imitators. However, constructed high-share positions are actually built up as the relevant information diffuses across potential competitors.[34] Therefore, if these position remain unassailable, they are likely protected by non-information based isolating mechanisms that may be more stable.

In closing, one must admit to the highly speculative nature of these statements. Future research should begin by assessing the validity of the invented versus constructed low-competition (or high market share) distinction, before addressing the specific issues raised in this section.

First-Mover Advantages

Relatedly, economists and strategy scholars devote considerable attention to issues surrounding the order-of-entry question (Lieberman & Montgomery, 1988; Robinson, Kalyanaram & Urban, 1994). This research tends to focus on the costs and benefits of moving first into new markets (i.e., market pioneering) versus those associated with later entry. At the conceptual level, Lieberman and Montgomery (1988) note that first movers may be advantaged over later entrants because of their technological leadership position, their ability to preempt valuable assets, and/or their ability to establish consumer switching

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[34] Lieberman and Montgomery (1988:43) note that "competitors typically gain access to detailed information on both products and processes within a year of development."

costs. Empirically, there is considerable evidence (including some from the pharmaceutical industry - Grabowski & Vernon, 1992) that "market pioneers tend to maintain market share advantages over later entrants (Robinson *et al.*, 1994:2)."[35]

By definition, the innovative pharmaceutical products in our sample are introduced to relatively high market shares (see the discussion surrounding equation 5.31a). The findings from Section 5.3 suggest that the sampled firms are differentially able to sustain the market share advantages associated with market pioneering. Although the results in Table 16 suggest that the market shares accruing to innovators tend to fall as time elapses, the rate of erosion is not constant across firms. In fact, five firms (Abbott, American Cyanamid, Glaxo, Searle and Syntex) experience no significant reduction in the market shares of their innovative products as time elapses. These findings suggest that firms may be differentially skilled when it comes to preserving the benefits associated with first-movership. Future research may also discover that firms are differentially skilled at enhancing the competitive positions of their imitator products. This would be done by modifying equation 5.31b to allow the estimated coefficient on the high-competition product introductions to vary across firms. With such evidence in hand, one could begin to comment on research by Robinson, Fornell and Sullivan (1992), which suggests that

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35 Lieberman and Montgomery (1988) remind scholars that order-of-entry research is primarily concerned with the profit implications of moving first into markets. However, data limitations tend to preclude the use of profitability as a dependent variable and researchers tend to employ market share and/or firm survival. Robinson *et al.* (1994) note that the combination of the entry order-market share results and the market share-profitability results attest to a positive relationship between market pioneering and firm profitability.

successful pioneers versus later entrants have different skill sets upon which they draw when making their entry timing decisions. More specifically, one might find that:

> firms whose entrepreneurial vision and new-product R&D are excellent will tend to find first-movership attractive, whereas firms having relative skill bases in manufacturing and marketing may not (Lieberman & Montgomery, 198:54)

Having said this, it must be recognized that this study stops short of fully addressing the entry timing issue as the products have not been explicitly identified as pioneers, early followers or late followers. Rather, it is assumed that pioneering products are those that are subject to low levels of initial competition, while followers are subject to higher initial competition (see Kemp, 1975). This empirical strategy is necessary because the therapeutic sub-classes described by IMS America have, in most cases, longer lives than each generation of pharmaceutical products that they subsume. In fact, only eleven of the sampled products have introduction dates that correspond to the emergence of an entirely new therapeutic sub-class. These are the products for which $COMP_{jt}$ equals zero. Future research should examine the evolution of specific therapeutic sub-classes in order to determine the dynamic relationship between the innovative products that have been identified and the various classes of follower products (including the imitators). With more precise timing data in hand, one would be in a better position to examine the order-of-entry questions.

Table 28
Levels of Competition at Date of Generic Entry
(products from Grabowski & Vernon, 1992 study)

Product	Corporation	Intro Date	Date of Generic Entry	$COMP_{it}$ at Entry
Triavil	Merck	1965	1986	40.95
Haldol	Johnson & Johnson	1967	1986	43.88
Diabinese	Pfizer	1958	1984	48.74
Aldomet	Merck	1963	1984	56.85
Mellaril	Sandoz	1959	1983	60.66
Valium	Roche	1963	1985	61.00
Inderal	American Home Products	1967	1985	67.35
Tolinase	Upjohn	1966	1984	71.27
Dalmane	Roche	1970	1986	76.97
Ativan	American Home Products	1975	1985	83.68
Sinequan	Pfizer	1969	1986	84.02
Calan	Searle	1982	1986	88.47
Tranxene	Abbott	1972	1987	88.52
Keflex	Lilly	1971	1987	88.57
Motrin	Upjohn	1974	1985	89.67
Etrafon	Schering Plough	1968	1986	91.13
Indocin	Merck	1965	1984	91.46

Having said this, we may comment on the implications of differences in market boundary definitions for identifying pioneering and follow-on products. In their analysis of the implications of first-movership in the pharmaceutical industry, Grabowski and Vernon (1992) identify eighteen major drugs whose patents expired during the 1981 to 1987 period (see Table 28). They analyze the market shares of these products relative to those attained by subsequent generic entrants and find that the pioneering products maintain significant market share differentials in the years following generic entry. It is important to note that Grabowski and Vernon (1992) define the market participants as the innovative drug plus the associated stock of generic competitors. The pioneering drug is assumed to have 100 percent of the market up to the point when the patent expires.

Recall from the discussion in Section 5.2 that this approach ignores the fact the close, but imperfect substitutes tend to emerge before the expiry of a patent. In fact, Table 28 indicates that, in the year during which the first generic product entered the market, Grabowski and Vernon's (1992) products were subject to widely diverging levels of competition. Merck's *Triavil* had a market share in excess of 50 percent, while *Indocin* had a share of less than 10 percent. These differences point to the importance of differences in market boundary definitions when addressing order-of-entry questions. At the very least, these initial differences should be controlled when examining the dynamics of market share in the post-patent period.

This completes the discussion of the several issues that relate directly to the development of, and application of, a Schumpeterian framework for persistent profitability analysis. The overall discussion is brought to a close in Section 7.5 by summarizing the main implications of this research, as well as the several ways in which it may be usefully extended.

7.5 Implications and Suggestions for Further Research

Recall from the introduction that the main goal of this researcher is to develop a conceptual framework which explains the tendency for firms to achieve relatively high profitability which subsequently falls back to normal levels, as well as the factors which account for the inter-firm variance in profit persistence. This has been accomplished by carefully analyzing Schumpeter's ideas and developing a Schumpeterian framework for persistent profitability analysis. The resulting framework recognizes that innovations yield

above-normal profits, but that competitor imitation typically ensures their eventual elimination. More importantly, the framework also recognizes that multiple innovations are embodied within a single firm, and that this has serious implications for firm-level persistent profitability analysis. Empirically, the results provided in Chapters 5 and 6 attest to the validity and applicability of the Schumpeterian framework. In doing so, this research provides an empirical application of Schumpeter's ideas that is truly dynamic in nature.

At the conceptual level, the main contributions of this research are two-fold. First, by more carefully attending to the specifics of Schumpeter's writing, Section 3.2 outlines a consistent, innovation-based explanation for firm-level profit persistence to go alongside the monopoly-based explanations that are typically proffered by IO economists. This insight is gained once the researcher admits the prospect of serial innovation within the firm. At the same time, by understanding the central role that innovation and imitation play in shaping the dynamics of firm performance, the framework offers a refinement of the resource-based view of the firm, which tends to (perhaps over-) emphasize the factor markets wherein strategic resources are acquired. In doing so, this research highlights the need to understand the multiple paths (i.e., an innovation route and a route that entails resisting imitation) that might connect a firm's resources to its ultimate performance outcomes.

As for future research, the discussion in Chapter 7 points in several interesting directions. Section 7.1 outlines how we are left with the task of trying to understand the factors (i.e., the specific capabilities) that deliver the sampled firms' innovation and imitation records. In this respect, future research might address the sources of differential

innovative propensities, as well as the differences in competitors imitation rates. These studies should also address the extent to which the capabilities that underpin these differentials are mutually reinforcing or detracting. Section 7.3 discusses how this research may be extended to address inter-industry (as opposed to inter-firm) profit differentials, as well as the direct impact of patents on the rate of competitor imitation. The previous section discusses how future strands of this research might contribute to the market share-profitability by examining the different competitive dynamics associated with 'invented' versus 'constructed' low-competition (or high market share) positions. It also alludes to potential contributions to the order-of-entry literature.

In closing, we offer one final extension. This research focuses explicitly on one type of innovation - product innovation. While the pharmaceutical industry emphasis on valuable new drug products has allowed us to credibly overlook other type of innovation in this empirical setting, the same may not hold for other industries. Future research should try to move the analysis beyond the study of products only in order to embrace the several types of innovation to which Schumpeter alludes (e.g., process innovations, organizational innovations, new sources of input supply and the introduction of existing products to new markets).

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