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The single market and pharmaceutical industry in the European Union: Is there any evidence of price convergence?

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The Single Market and Pharmaceutical Industry in the European Union:

Is There Any Evidence of Price Convergence?

by

Aysegul Timur

A dissertation submitted in partial fulfillment
of the requirements for the degree of
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Dedication

This dissertation is dedicated to special friends, an institution, and most especially to my family, my son and my husband. To my dear friends, my mentors, Susan Casey, Katherine Dew and Barbara Caldwell: from the first day I started this journey, you have never stopped encouraging and helping me. I could not have made it without you. To International College and especially, Dr. Frederick Nerone: I am thankful for your belief in me, your continuing support and leadership. To my family: even though we are many miles apart on different continents, your spirit was with me and helped me accomplish this goal. Finally, to my son Efehan and my husband Mete: I would not be where I am today without your never ending love, support and patience. You both gave me strength to move forward and reach my goal. We dreamed and did it together. I love you so much.

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ABSTRACT

During the last two decades, the European Union (EU) has experienced closer market integration through the removal of trade barriers, the establishment of a single market, and the reduction of exchange rate volatility. In addition, there have been several structural reforms in product markets designed to increase competition, monitor cross-country price differences and increase transparency. One anticipated effect of market integration is price convergence, because of the reduced potential for price discrimination across the EU. This dissertation explores market integration and price convergence in the European pharmaceutical market, which is the fifth largest industry in the EU. Since 1985, many EU directives have been adopted to achieve a single EU-wide pharmaceutical market, with the aim of enhancing the quality of life for European citizens and the European pharmaceutical industry's competitiveness and research and development capability. Using annual 1994–2003 data from five EU countries on prices of drugs used to treat cardiovascular disease, this dissertation explains how the integration process has affected cross-country drug price dispersion in the EU. The results show strong evidence of price convergence in the pharmaceutical market, with long term price differences arising from country fixed effects.

Chapter 1

Introduction

1.1 The Formation of the European Union

After World War II, there was a strong belief among a number of European leaders that the only way to secure a lasting peace between their countries was to unite them economically and politically. This effort began in 1951 when the Treaty of Paris created the European Coal and Steel Community, consisting of Belgium, West Germany, Luxembourg, France, Italy and the Netherlands. To integrate other sectors of their economies, these six countries signed the Treaties of Rome in 1957, which created the European Atomic Energy Community and the European Economic Community (EEC). The task of the latter was “by establishing a common market and progressively approximating the economic policies of Member States, to promote throughout the Community a harmonious development of economic activities” (Wertheimer 2003). The member states set about removing trade barriers between them to form a “common market,” and in 1967 the institutions of the three Communities were merged, establishing a single Commission. Denmark, Ireland and the United Kingdom joined in 1973, followed by Greece in 1981 and Spain and Portugal in 1986.

In 1992, the Treaty of Maastricht formed the European Union (EU) with the introduction of the Single Market Program (SMP), which created a common market with a free flow of goods, services, labor and capital. Austria, Finland and Sweden joined in

1995, and the European Monetary Union (EMU) replaced national currencies in 11 of the member countries (all except Denmark, the Netherlands, Sweden and UK) by the single currency “euro” on January 1, 2002. The EU then welcomed ten new countries in 2004, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia, raising total membership to 25 countries. Bulgaria and Romania expect to follow in 2007, and Croatia and Turkey began membership negotiations in 2005 (EUROPA 2005;Fontaine 2003).

1.2 The Impact of European Integration on Price Convergence: Theory

The SMP was originally established in a 1985 White Paper with the goals of eliminating targeted trade barriers in product markets and forming policies aimed to ensure that integration brought more competition (Flam 1992). A 1988 European Commission report on “costs of non-integrated Europe,” commonly known as the Cecchini report, estimated that the completion of a single European market would generate microeconomic gains of 4.3–6.4 percent of GDP, with an additional 2.5 percent if supplemented by appropriate macroeconomic policies, a reduction in consumer prices of 6.1 percent and an employment increase of 1.8 million (Peck 1989;Smith and Wanke 1993). Theory suggests that the SMP, along with the Economic and Monetary Union (EMU), have led the continuous European Integration process since the 1990s. The SMP has been an important driver of change in product markets through the elimination of trade barriers, whereas the EMU supports the internal market by facilitating cross-border transactions and making markets more transparent with the use of common notes and coins across the euro area. However, it is impossible to make a clear distinction between

the effects of the SMP and EMU on product markets because their different elements are continuously and dynamically interacting.

The analytical framework suggests three distinct effects of European integration on product markets (European Commission 2002). First, integration provides firms easier access to each other's markets, thus increasing competitiveness by eliminating trade barriers. Second, integration increases market size by raising efficiency, because of resource reallocation or economies of scale, and reducing transaction costs. Third, integration and the use of a single currency facilitate price comparisons across markets, making consumers more aware and responsive to price differences, producers more aware of their competitors' responses, and multinational firms less able to segment national markets and maintain profit margins.

A result of these three effects should be arbitrage among the member countries which ultimately leads to price convergence. According to the law of one price, the price of a specific good should not differ significantly across geographic locations, beyond differences arising from transport costs, tax differences, and other systematic location-specific factors. Price convergence is expected in an integrated market, and thereby provides important evidence regarding product market integration. However, the relationship between integration and price convergence depends on many structural, behavioral, and policy factors that influence price trends. Since these factors vary across markets, price convergence patterns may deviate across industries.

The absolute version of the law of one price states that, in absence of transfer costs, identical traded products should sell for the same price in different countries when expressed in a common currency. The intuition is that international arbitrage should

operate until prices are aligned. A less extreme version of the law of one price is the relative version, which holds that common currency prices for a particular product should change in the same way over time in different countries, but allows a stable price differential across markets.

1.3 The Single Pharmaceutical Market

The European Commission recognizes that the impact of market integration on the pharmaceutical industry is very complex. Different health care regimes in member states cause difficulties in achieving a single market and cause price variations between countries for the same product. This is unlike price differentials in other sectors which are the result of market forces, and has brought about the issue of parallel trade. The Commission has viewed distortions as barriers to establishing a single pharmaceutical market and has tried different strategies to address the issues (Permanand and Mossialos 2004).

Since 1985, several Community level directives were adopted to achieve a single, EU-wide market for pharmaceuticals, guided in parts by the Treaty of Rome objectives, particularly Articles 8, 30, 36, 85, 86 and 92 (Burstall 1991). Formation of the single market (1) gives patients access to the medicines they need at affordable prices, and (2) creates incentives for innovation and industrial development (European Commission 2005).

In response to concerns that the EU pharmaceutical industry was losing its competitiveness due to market divergence, in May 1998 the Internal Market Council recommended that Community policy be aimed at moving further towards a single

market (Communication Commission 1998a, 1998b). The Third Round Table of December 1998 established one goal in this effort as the development of a single price for pharmaceuticals (Huttin 1999). Among other barriers, many member governments have monopsony power (Read 1998). Although subsequent communications and further evidence revealed awareness of such problems,¹ little progress on the policy side was made until 2001, when the Commission set up a new High Level Group on Innovation and the Provision of Medicines (G10 Medicines 2002). In 2002, the new group issued fourteen specific recommendations in five different areas regarding the attainment of a single pharmaceutical market (European Commission 2003).

The most relevant recommendation for this dissertation is the sixth, which addresses the issue of the functioning and evaluation of the single market in pharmaceuticals. Specifically, it covers moving toward a competitive market structure for over-the-counter (OTC) products limiting the member states' regulatory authority to only medicines purchased or reimbursed by the state. The implementation of this recommendation could be seen as the beginning of EU pharmaceutical market liberalization (Pollard 2002).

Even though the single EU market was formally completed at the end of 1992, the pharmaceutical industry has lagged behind because of its unique structural and regulatory components (Kanavos 2000). This makes it quite uncertain whether price convergence has actually taken place in the EU pharmaceutical market.

¹ The report on global competitiveness in pharmaceuticals concluded that "Europe as a whole is lagging behind in its ability to generate, organize, and sustain innovation processes that are increasingly expensive and organizationally complex" (Gambardella, A., Orsenigo, L., and Pammolli, F. 2000. "Global Competitiveness in Pharmaceuticals: A European Perspective," Report prepared for the Directorate General Enterprise of the European Commission, pp. 1-100.).

Two pertinent developments that occurred during this time frame, i.e. the 1994–2003 sample period, concern medicinal product licensing and patenting. In 1995, two new Community licensing procedures were introduced (Liikanen 2004). One, a “centralized procedure,” involves applying directly to the European Medicines Evaluation Agency (EMA) for community-wide marketing approval. The other is a “mutual recognition” procedure whereby applications are made to particular member states and approvals are mutually recognized by national marketing authorities (European Commission 2000b) although evaluation of product safety, efficacy and quality is still coordinated by EMA (EFPIA 2002). Both procedures are designed to achieve a “European” rather than country-specific decision (Jefferys 1995). Implementation of these procedures has had a significant impact on pharmaceutical companies, particularly with regard to the structure of regulatory affairs departments.

On the intellectual property side, patent protection is currently provided by both national patent systems and the European Patent Systems. Patents granted by the latter become a bundle of patents enforceable in the designated states, which are each subject to national rules. In 2000, the Commission proposed a Community Patent, aiming to establish a single patent that is valid throughout the EU. However, EU agreement on the Community Patent is still pending (European Commission 2000a). On the other hand, the pharmaceutical industry is offered up to 15 years of effective protection from the date of first authorization in the Community, slightly more than the 14 year maximum in the US. The licensing process further protects the data used for license applications for 6–10 years, compared to a maximum of 5 years in the US.

The 2010 industry goal of national market pricing for all medicines does not necessarily mean a community-wide single price. Different prices may be negotiated with different customers to maximize access and affordability, but free movement of goods will ensure that there is no artificial segmentation of the market. In addition, the industry wants immediate access to all national markets after licensing for all medicines (EFPIA 1998).

The results of this study provide strong evidence of drug price convergence, with half lives of drug price shocks of 3-5 years. Long term price differentials between member states persist despite the removal of trade barriers, because prices are primarily determined by each country's distinct health care system and pharmaceutical pricing regulations. However, these price differences have recently been undermined by parallel trade, in which traditionally high price countries import lower priced goods from other EU countries. In addition, attempts to establish a single overall market in the EU over the last decade have reduced price differentials in the pharmaceutical industry.

The remainder of this dissertation is organized as follows. Chapter 2 provides a detailed look at the background of the pharmaceutical industry. Chapter 3 reviews the literature on market integration and price convergence in the EU, the impact of parallel trade in the EU, and cross country pharmaceutical price differences. Chapter 4 describes the data and empirical strategy. Chapter 5 presents and describes the results of the analysis. Finally, chapter 6 summarizes the main findings, limitations and areas for further research.

Chapter 2

The Background of the EU Pharmaceutical Industry

This chapter provides an overview of the European Union pharmaceutical industry. It discusses various important characteristics, including market structure, national health systems, price regulations and reimbursements, and parallel imports.

2.1 Distinguishing Characteristics of the Pharmaceutical Industry

The pharmaceutical industry is one of the world's most research-intensive industries, generating new drugs that satisfy vital consumer needs in health care by saving lives and significantly increasing quality of life. The industry is a crucial component in delivering health care (Scherer 2000). A defining difference from other industries is that several third parties, besides the manufacturer and consumer, are involved on both the demand and supply sides. Physicians, not the consumer, usually determine what drugs to purchase. Pharmacists usually follow physicians' instructions on what to dispense, but their decisions can be influenced by payment methods when multi-sourced products are available (Kanavos 2001). The consumer rarely pays the full price of the drug, with subsidies coming from governments, health insurance funds, and private insurance companies. They take part in pricing and reimbursement decisions. Because of these unique characteristics of the pharmaceutical industry and their interactions with

regard to size and intensity, the drug market fails to meet the criteria for a perfectly competitive market (Mossialos et al. 2004).

In the pharmaceutical industry, there are market imperfections on both the demand and supply sides. On the demand side, the demand does not reflect the marginal benefit to consumers, because the demand might to some extent reflect the doctor's preferences rather than the consumers. Also, if the patient has insurance coverage, the price the patient pays is lower than the market price. Even if market price is equal to marginal cost (MC), therefore, there is no guarantee that these equal the marginal benefit. Further, there is often monopsony power, particularly when there is a national health care system. On the supply side, supply is characterized by economies of scale because drugs have a high proportion of cost in R&D, patent restrictions allow producers to act as monopolists, and governments impose marketing restrictions through the approval processes and testing requirements (Capri and Levaggi 2005;2004). As a result, the pharmaceutical industry is among the most heavily regulated industries (Folland et al. 2004). Few aspects of the industry are unaffected by regulatory controls.

2.2 Regulating Pharmaceuticals in the EU

Regulating the pharmaceutical industry is a particularly difficult challenge for policy makers, who seek low health care costs and affordable drugs, but also want accessibility to the highest quality medicines and more generally a successful industry (Permanand and Mossialos 2004). Despite the earlier described EU-level movement toward the single pharmaceutical market and the European Commission's expanding role

in this area, pharmaceutical policy is still primarily determined at the national level by differences in health care systems, pricing and reimbursement regulations, demographics, cultures and attitudes towards consuming medicine (Norris 1998). Pharmacoeconomics, parallel importing, and generic substitution also impact policy decisions (Seget 2003).

Despite four decades of Community level attempts at convergence, European pharmaceuticals remain 25 separate national markets rather than a single “internal” market. The Commission has never proposed legislative measures to address pharmaceutical price controls and reimbursement regulations at the EU level, considering this to be primarily a national concern. Even though the industry continues requesting that the Commission remove certain forms of national price regulation, the industry cannot be wholly protected from inter-brand competition from generics following patent expiration or intra-brand competition created by parallel importing from lower priced EU countries (Mossialos et al. 2004) However, some national governments have been taking “me-too” approaches for regulating drug prices and controlling reimbursement (Redwood 1994), imitating policies of other governments despite the limited effectiveness and evaluation of many of the measures adopted. This is described in the literature as the “penguin effect” (Guillen and Cabiedes 2003). Consequently, both industrial policy and regulation of the pharmaceuticals remain responsibilities shared between the EU level and the member states. The Commission has no power to determine national prices, reimbursement regulations or profit controls, but attempts to ensure that national procedures are efficient, transparent and fair.

2.2.1 National Health Care Systems

A common political belief in Europe is that governments should ensure that medical care is available to everyone. Each Member State has its own health care system to protect public health, provide patient access to safe and effective medicine, maintain quality of care, and establish measures to meet these expectations. EU actions are limited by the member states' own decisions in managing pharmaceutical goals and budgets (Huttin 1999).

The current EU national health care systems are diverse in both funding and delivery of health care. Table A.1 shows the differences in health care systems in the five major pharmaceutical markets in Europe. National governments have implemented many different measures, from controls and incentives to directly influence supply and demand or indirectly reduce expenditures, which in terms of overall health have grown faster than GNP in all European countries over the last 20 years (Ess et al. 2003). To slow this growth, some countries have emphasized direct price controls and supply side cost containment regulations, while others have emphasized demand side financial incentives, quantity controls and physician educational initiatives (Kanavos 2001; Mossialos et al. 2004).

2.2.2 Regulating European Pharmaceutical Prices and Reimbursement

Regulating pharmaceuticals involves both supply and demand side regulations, various aspects of which are explained in the next two sections.

2.2.2.1 Supply-Side Regulations

Supply regulations and cost containment measures consist primarily of direct fixed price controls, profit (or rate of return) controls and reference pricing. Tables A.1 and A.2 show how pharmaceutical prices are regulated in the five major EU markets, which are Germany, France, Italy, Spain and United Kingdom.

Direct price controls include negotiated prices, price-caps (fixed maximum price), cost-plus prices, price comparison to other countries or similar products within the same country, price cuts or freezes or price-volume agreements. Almost all EU countries except Germany and the UK apply direct price controls to on-patent drugs. In the UK new patent drugs can be freely launched but the prices are indirectly controlled by the rate of return controls that ensure pharmaceuticals are not realizing excessive profits. The permitted rate of return on capital is around 17-21% (Ess et al. 2003). France also introduced free pricing in 2003, but only for products defined as innovative by the National Transparency Commission with some limitations. In some countries such as France, Italy, Spain, Austria, and Portugal, prices are directly controlled through negotiations. In others, prices are fixed by national authorities according to a list of factors that depend on whether the main objective is to achieve the lowest possible price or a price that balances profitability with cost containment. Many countries have additionally applied cuts and freezes to the maximum fixed prices, often in an attempt to meet short-term budget constraints. In France, prices are set initially for 5 years. In most countries, price cuts have been the norm.

Some countries, like Spain, reward companies that contribute to the economy or invest in research and development. In addition to using a cost-plus formula, Spain

considers therapeutic value. Price comparisons are another common measure. However, there is concern about accuracy of the comparisons because of methodological difficulties and differences across countries in strength, formulation and pack sizes available (Mossialos et al. 2004).

Another measure, reference pricing, has gained popularity over the years in places like Germany, Italy, France, and Spain. Reference pricing is “a system where the buying agent decides on a reimbursement price and then the user/patient or insurer pays the difference if the chosen medicine is more expensive” (Lopez-Casasnovas; Puig-Junoy 2000). Reference pricing aims to control pharmaceutical expenditures by defining a fixed amount to be paid by the government or other third party payer and can effectively eliminate price gaps between therapeutically similar products and improve market transparency by increasing patient and physician awareness of actual price levels (Dickson 1992). The latter can bring about switches to cheaper drugs that lead to price decrease for the more expensive version (Mossialos et al. 2004), which encourages downward price convergence (Lopez-Casasnovas; Puig-Junoy 2000).

Current EU price control systems limit the returns to any added therapeutic value of the drug. Reimbursement levels reflect negotiations between the pharmaceutical company (a monopolist with respect to a new drug) and the government or insurer (a monopsonist). A number of countries have started to incorporate further economic evaluations into the decision-making process, either as an additional tool to determine the reimbursement price (e.g. Finland) or as a mechanism to guide prescribers (e.g. the UK National Institute of Clinical Excellence). However, there has been little consistency in EU reimbursement regulations.

2.2.2.2 Demand-Side Regulations

Key elements of demand-side policies in member states are shown in table A.3. One is to influence the doctors who prescribe medicines for patients (Caves et al. 1991). This can be done through positive and negative lists, issuing guidelines to which medications can be prescribed for certain conditions, and monitoring prescribing practices (doctors act as a “gatekeeper”). Additionally, budgets are imposed to force doctors to take costs into consideration when selecting between alternative treatments (e.g. individual doctor or group practice budgets in the UK, budgets for all doctors in a region in Germany).

The second key element is restrictive lists that all member states operate in various ways. Regulatory approval that is necessary before a drug can be marketed does not imply that the drug will be covered by the health care system; in principle, drugs that are less effective or more expensive than substitutes should not be reimbursed. These lists operate in three different ways. In some countries, the drug must be on the “positive list” to be reimbursed, while inclusion on the “negative list” implies no government reimbursement. In others, only one list is used. In positive list countries, the drug must be on the list to be reimbursed. In negative list countries, only drugs on the negative list are not reimbursable.

Some countries (e.g. France) have been altering the system of paying physicians, moving from a fee-for-service and access to any physician/specialist regime to more restrictive gatekeeper systems. An alternative way to regulate demand is regulating what products pharmacists can sell, who may sell prescription medicines, what they can dispense, how prescriptions are written and substitution procedures (Kanavos 2001).

Another option is patient cost-sharing through paying some combination of a proportion of the total price, a fixed charge per prescription, and an annual deductible (Noyce et al. 2000). For example, in Spain co-payments are 40% of the sales price, while in France the majority of the population pays less than 5% of retail prices out of pocket.

Finally, the size of the generic market has grown recently in several EU countries. For example, in the UK, the use of generic drugs has increased from 16% of prescriptions in 1977 to 54% in 1994 (Ess et al. 2003). Table A.2 shows off-patent drug regulations. The two EU approaches to regulating generic drug prices are limiting the generic price to a fixed percent less than the originator product or the cheapest generic equivalent, and to apply a reference price scheme (Mossialos et al. 2004). In some countries (e.g. Germany), generic substitution has been a successful short-term cost containment policy (Ess et al. 2003).

2.2.3 Parallel Importing in Pharmaceuticals in the EU

Ganslandt and Maskus (2004) define parallel imports as “legitimately produced goods imported legally into a country without the authorization of a trademark, copyright, or patent holder.” The legal foundation is the principle of the free movement of goods, while the legal doctrine governing the permissibility of parallel imports is exhaustion. Patent distribution rights are exhausted over a pre-defined area upon first sale, after which the patent holder can no longer restrict the circulation of the product. Parallel trade is thus permitted in the geographical area where the rights to control distribution have been exhausted but not from regions or countries outside (Ganslandt and Maskus 2004). Under national exhaustion the right holder may prevent such importation. In the

EU, the exhaustion regime is the Community (Maskus and Chen 2004), and the Commission recognizes the manufacturer's right to control the use of the brand but not necessarily of the product. Specifically, the manufacturer's industrial and commercial property right cannot be used to prevent the parallel import of a medicinal product that has already been lawfully placed on the market in another member state.

The purpose of parallel importing is arbitrage between countries with different prices. Seget (2003) explains that parallel importing is the "transportation of a pharmaceutical product from its original market, where it was sold directly by its manufacturer or marketing partner, to a different market for resale by the importer. Parallel importing only occurs where there is sufficient difference in the price of the product in two markets to cover the importer's costs and generate some profit to the importing company. In most industries where it happens, parallel importing had led to the convergence of prices." Parallel imports emerge where international price differences exceed the costs of transportation and selling the product across borders, and hence would not exist without pharmaceutical price differences between member states. According to the Commission, a parallel import must (1) have been granted a marketing authorization in the origin country and (2) be sufficiently similar to a product that has already received marketing authorization in the destination country.

Recently, parallel imports have been growing as a fraction of EU pharmaceutical sales, as arbitrage opportunities have persisted despite the goal of a single market, while EMEA harmonization of regulatory requirements for registration (dosage requirements, labeling) has reduced repackaging costs. The major supplying countries are Belgium, France, Italy, Greece and Spain, while the main importers are Denmark, Germany, the

Netherlands and the UK (Chaudhry and Walsh 1995). As of 1999, parallel imports composed 15% of the prescription drug market in the Netherlands, 10% in Denmark and 7% in the UK. Overall, parallel imports made up 8% of the EU market in 2001 and are forecast to rise to 10% by 2006. The income loss from being undercut by parallel imports is estimated at \$5.5–7.6 billion in 2001 (Arfwedson 2003).

Parallel imports have complex effects on markets (Maskus 2001), but should cause prices to fall in high price countries, and may reciprocally cause prices to rise in low price countries (OECD 2000). According to Danzon (1998), parallel trade reduces economic welfare by undermining price differentials between markets. Theoretically, pharmaceutical R&D, which accounts for roughly 30% of total pharmaceutical costs, is a global joint cost of serving all consumers worldwide. Optimal pricing to cover joint costs, i.e. Ramsey pricing, requires setting lower prices in markets with higher demand elasticities. However, parallel trade tends to force price convergence. Moreover, in the long run, uniform prices might reduce drug development by limiting returns to R&D (Darba and Rovira 1998; Vogel 2004).

The economic literature on parallel trade is limited because of the data availability. Most studies find ambiguous welfare effects (Maskus and Chen 2004). However, these studies provide insights that are useful for framing policy and are thus summarized in the subsequent chapter.

2.2.4 EU Pharmaceutical Background Summary

As shown in Figure B.1, all member countries have different health care systems and pharmaceutical price controls that create market distortions, resulting in price differences. This creates the opportunity for parallel trade, which in combination with the EU single market principle calling for the free movement of goods could lead to price convergence (Danzon 1997b). As discussed in chapter 1, solutions to this conflict between national price regulations, open competitive markets, and reasonable profits for R&D are being debated by the EC. Currently, EU pharmaceutical prices are relatively low, i.e. 45 percent below US prices. One potential solution, a single European administered price control, is politically infeasible, and it is further unlikely that member nations would give up their market power while having to maintain the responsibility for their health care budgets (Pollard 2003). Therefore, the G10 recommends coordination of national results, not of the underlying regulations themselves.

An important question is how this conflict impacts price convergence among the member states. This dissertation helps enlighten this issue for the EU pharmaceutical industry by looking at empirical evidence of price convergence between 1994 and 2003.

Chapter 3

Literature Review

This chapter provides an overview of the literature relating to three different areas: market integration and price convergence in the EU, the impact of parallel trade on prices, and cross country price differences in pharmaceuticals.

3.1 Market Integration and Price Convergence in the EU

The European Commission recognizes the importance of price competition and price convergence through a single market program: “The removal of barriers and the freedom of supply which businesses will enjoy as a result of the single market program should lead, through increased competitive pressure, to some downward convergence of prices of benefit to the customer. From the point of view of producers, the competitive pressure will be exerted first and foremost on price-cost margins, particularly in those sectors in which they held a certain monopoly power or position. Producers will also be induced – urged on by pressure on their margins – to become more efficient and thus cut their production and distribution costs. The increased pressure which will be brought to bear in this way on costs and price-cost margins will be a powerful means of causing prices to converge on levels more consistent with economic and technical efficiency” (DRI 1996). Furthermore, the EU Treaty also requires the Commission and the European

Central Bank to report on convergence at the macroeconomic level because convergence will ensure that a single EMU interest rate is appropriate for all participants. Moreover, when the EMU is hit by a macroeconomic shock, a high degree of convergence limits asymmetric economic developments at the country level, which can no longer be addressed by adjusting the exchange rate (European Commission 2004). Finally, price convergence indicates the evolution of product market integration.

DRI (1996) showed a trend towards price convergence in the EU-12 during 1980–1993 using price indexes for detailed product and service categories collected by Eurostat. This trend was more pronounced for consumer and equipment goods than for energy, services, and construction. The convergence in consumer products and services has accelerated since the single market program. Convergence has been comparatively greater for the three 1989 entrants (Greece, Portugal and Spain) than the EU-9, which may reflect a catch-up effect of integration. The product categories with the greatest convergence were in highly traded (more open) industries. Four products and services related to health care had the highest price disparities in 1993. The study concluded that 78 product/services categories, representing 60% of EU private consumption expenditures, had significant price convergence, compared to only eight cases of price divergence (DRI 1996).

Using Eurostat panel data for 1975–1995 on monthly consumer price indexes for 12 EU countries, Sosvilla-Rivero and Gil-Pareja (2004) examined how European market integration has affected cross-country price dispersion in the EU. They used the Levin and Lin (1992) convergence equation to test for unit roots with panel data, with Germany as the benchmark country based on its central role in the EMS. The estimated speed of

convergence (β) for the general CPI was -0.006 , which implies a half life of a shock of 115 months. The highest estimated β was for fruits (-0.073) with a half life of 9 months, and the lowest estimated β was for recreation (-0.001) with a half-life of 693 months. The study concluded that there was empirical evidence of price convergence, especially for traded goods. The study failed to obtain such evidence in the cases of non-tradable goods or goods that are subject to special taxes or regulations.

A similar study by Gil-Pareja and Sosvilla-Rivero (2004) examined the degree and recent evolution of export-price dispersion between 1988 and 2001 among seven EU countries (Belgium-Luxembourg, France, Germany, Italy, the Netherlands, Spain and the UK) for a number of eight-digit products using the Eurostat data. The data set was based on the annual free on board (f.o.b.) value and quantity of exports to selected OECD countries. It is expected that relatively fixed exchange rates established by EMS would result in price convergence by imposing price discipline among its members. As a measure of export-price dispersion, they used the coefficient of price variation, i.e. the ratio of the standard deviation to the mean, which is invariant to changes of scale. To assess price convergence, the time series of variation for each source country-product pair were regressed on a constant and a linear time trend. The results of the study showed that export-price dispersion was usually lower in the sample than across OECD countries. There was little evidence of convergence, but this was also stronger across the EU countries. The conclusion was that although monetary stability may aid price convergence, it does not necessarily lead to complete convergence.

Two other studies, Rogers (2001) and Rogers et al. (2001), found direct evidence of price convergence in Europe, using European price indices from actual prices of 168

goods and services, in 26 cities, in 18 countries, between 1990 and 1999. Prices became less dispersed in the euro area and convergence was evident for traded goods, more in the first half of the 1990s than the second half. By some measures, traded goods price dispersion across the euro area was close to that across US cities.

European Commission (2004) also concluded that there is a continuing convergence of prices of recent entrants towards the considerably higher levels in the EU-15, again due to the catching-up process and price deregulation. As a result, price convergence in the new member states has been faster than in the EU-15.

Camarero et al. (2000) examined price and inflation convergence between three European countries (Italy, Spain and the UK). The results rejected long-run convergence in all cases but found that prices catch up with the European average.

There have been several studies of price convergence in specific EU product markets, particularly the car market (Gaulier and Haller 2000; Goldberg and Verboven 2001, 2004; Verboven 1996). Goldberg and Verboven (2005) investigated the relationship between integration and price convergence using panel data on car prices between 1970 and 2000. Approximately 150 vehicles per year and five markets [Belgium (the benchmark country), France, Germany, Italy and the UK] were included. They found strong evidence of both the absolute and relative versions of the Law of One Price. Hedonic regressions were estimated to control for possible variations in characteristics of models across countries, and these quality-adjusted prices were used to form the dependent variable for the Levin and Lin (1992) convergence equations. The relative version of the Law of One Price implied half lives of shocks between 1.3 and 1.6 years.

Kerem et al. (2005) estimated the convergence of health care expenditures in the EU using β - , σ - , γ - convergence for the 1992–2001 period. The study demonstrated that even though economic integration has facilitated economic growth, the EU's enlargement process has not brought about harmonization of health care expenditures in the EU-8 new member states (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia). It would take approximately three years for health care expenditures as a share of GDP in the EU-8 countries to move halfway to the EU-15 average.

Lastly, Ratfai (2006) examined price convergence among geographically close locations that share the same currency, using a sample of highly disaggregated product level prices of very narrowly defined homogeneous items in Hungary. Employing a series of panel data unit root tests using the Levin et al. (2002) procedure, the results showed that price differentials fading away quickly, with an estimated half-life of between 2.2 and 12.0 months and a median half-life of 4.0 months.

Price convergence in pharmaceutical markets has not been subject to empirical investigation. However, the pharmaceutical industry was placed high among the most sensitive sectors of the single market program (Allen et al. 1998).

3.2 Impact of Parallel Trade in the EU

Parallel imports, also called gray-market imports, is the process whereby goods protected by an intellectual property right (i.e. patent, trademark or copyright) are placed into circulation in one market, and then re-imported into a second market without the authorization of the local owner of the intellectual property right. There is debate as to whether parallel trade leads to lower prices for consumers or whether it undermines

intellectual property protection or both and therefore weakens the incentives to invest in R&D, which may in turn harm the consumer in various ways (Arfwedson 2003). A country's law concerning the territorial exhaustion of these rights is an important component of how it regulates and limits their use. The EU pursues community (regional) exhaustion but excludes parallel trade coming from nonmembers (Maskus 2001).

Parallel imports of pharmaceuticals dramatically increased during the last decade. PI were estimated at € 4,265 million in the EU in 2003, which represents 5% of the pharmacy market value (at ex-factory prices) (EFPIA 2005).

Economic theory predicts that parallel trade (imports) forces price convergence (Danzon 1998; Ganslandt and Maskus 2004; Huttin 1999; Maskus 2001; Towse 1998). However, there is limited empirical work on the impact of parallel imports on prices. Ganslandt and Maskus (2004) develop a model using bi-weekly pharmaceutical product data from Sweden. They use an OLS specification in which prices are affected by the number of parallel importers, the potential for parallel import competition and a time trend. The Swedish market provided a natural test of parallel trade because it was prohibited until 1995, when Sweden entered the EU and adopted the EU exhaustion principle. They found that the prices of drugs subject to competition from parallel imports fell relative to those of other drugs between 1994 and 1999, concluding that parallel imports significantly reduced prices of manufactured products by 12–19%.

Chaudhry et al. (1994) interviewed 36 multinational pharmaceutical managers about their expectations of parallel trade in the EU. A majority expected parallel imports to continue to exist, but opinions were mixed regarding whether future parallel imports threatened the industry. Pharmaceutical firms have been considering ways of reducing

the impact of drugs entering EU markets by way of parallel trade, especially from Spain (Chaudhry et al. 1997).

3.3 Cross Country Price Differences for Pharmaceuticals

International price comparisons in the pharmaceutical industry have been the subject of several empirical studies. Schut and Van Bergeijk (1986) compared the prices of identical packages of pharmaceutical products for 32 countries during 1975 and examined whether factors including GDP per capita, volume of consumption, population, volume of consumption per capita, patent protection, indirect price controls, and direct price controls contributed to price differences. From the OLS estimate, a 10% increase in per capita GDP was associated with 8% higher drug prices. In addition, direct price control measures resulted in a 20% price reduction. Bulk purchasing through a centralized government agency, promotion of the use of generics and excluding patent protection were also successful in lowering pharmaceutical prices.

To date, most studies have focused on pharmaceutical price differences for the US, Europe and Japan as a measure of industry competitiveness. Recently, cross-national price comparisons have been used for drawing conclusions about differences in average prices, evaluating regulatory system performance, and setting domestic prices as a regulatory policy.

Danzon and Kim (1998) argued that previous international price comparison studies were biased due to unrepresentative and small samples. They analyzed IMS data for the sales of cardiovascular products in the seven countries listed below during the year October 1991 to September 1992, defining the drug by molecule-therapeutic

category and using units of one tablet, one capsule, and five ml of a liquid as proxies for a single dose. They reported Laspeyres, Paasche and Fisher price indices relative to the US. The Laspeyres differentials of Japan 19.1%, Canada 16.6%, Germany –11.8%, Sweden –12.9%, Italy –29.6%, UK –35.4 and France –49.8% implies that other studies overstated US price differentials. A general conclusion was that international price comparisons are extremely sensitive to choices made about sample selection, price and quantity units, the relative weight given to consumption patterns in different countries, and the use of exchange rates.

Danzon and Chao (2000b) investigated cross-country price differences using IMS data on all molecules for the October 1991 to September 1992 period. They examined the contribution of various product and market characteristics to the dispersion of relative prices in the same countries as the previous study, using both price indices and the hedonic regression model. The conclusion was that the countries with strict price regulation, France, Italy and Japan, have systematically lower prices for older molecules and global products, relative to less-regulated regimes such as the US and UK. In addition, generic competition provides more effective price control in less regulated regimes such as the US. With the same data, Danzon and Chao (2000a) tested the hypothesis that the regulation of manufacturer prices and retail pharmacy margins undermines price competition. They found that price competition between generic competitors is significant in unregulated or less regulated markets (the US, the UK, Canada and Germany) but that regulation undermines generic competition in strict regulatory systems (France, Italy, Japan). Earlier, Danzon (1997a) found that the most

stringent regulatory regimes (France and Italy) have performed relatively poorly in terms of innovation, while Japan has produced many new drugs but few global drugs.

Recently, Danzon and Furukawa (2003) compared the average prices of pharmaceuticals in eight countries (Canada, Chile, France, Germany, Italy, Japan, Mexico and the UK) to those in the US, using post-1992 IMS data for 249 leading molecules. The results showed Japan's prices to be 27% higher than US prices, and other countries' prices ranging from 6% (the UK) to 33% (Canada) lower than US prices. They also concluded that income differentials contribute, both directly and indirectly, to price differentials.

Garattini et al. (1994) analyzed the differences between the pharmaceutical markets of Italy, the UK, Germany and France from both the supply and demand sides, taking into account public policy differences that affected public expenditure and industry turnover. The sample included eight drugs that were top sellers in all four countries in 1992. In most cases, retail prices were lowest in France and highest in Germany. The analysis concluded that on both the demand and supply sides, sectoral differences across in the four countries were striking. Price regulation was one of several variables involved in pharmaceutical policy, with demand side regulations being equally important.

Ess et al. (2003) showed that, as a consequence of pharmaceutical market fragmentation, prices varied across Europe. Prices were substantially lower in Greece, Spain and France but higher in Belgium, Switzerland, the UK and Denmark.

Chapter 4

Research Design

This chapter focuses on the data and methods used in this dissertation. The first section describes the objectives and hypotheses tested. The second section describes the data analyzed. The third section describes the methodologies applied, including the variables and model specifications.

4.1 Objectives and Hypothesis

As previously outlined, it is expected that market integration of sourcing, retailing and distribution contributes to price convergence among EU countries (Coopers 1996). However, because the relationship between European integration and price convergence depends on many different structural, behavioral, and policy factors that differ across markets, price convergence patterns are expected to vary by industry. The objective of this dissertation is to test the hypothesis of price convergence in the EU pharmaceutical industry, which has not yet been studied. The methods of controlling for the quality and market characteristics and the model specifications are adopted from Goldberg and Verboven (2005) and Danzon and Chao (2000b). The analysis also examines bilateral price differences using Laspeyres and Paasche indexes without these adjustments.

4.2 Description of Data

The data for this dissertation represent selected cardiovascular pharmaceuticals. They come from IMS Health, which collects and reports sales and price data at the level within the pharmaceutical market supply and distribution chain that provides the most accurate information for a country (IMS 2005a). Products are classified by the Anatomic Therapeutic Category (ATC) system, which is similar to the World Health Organization (WHO) system (WHO 2002), and is developed and maintained by EphMrA (EPHMRA 2004). Products are categorized in the sales, medical and promotional audits according to the EphMrA/PBIRG Anatomical Classification System, the main principle of which is that there is only one Anatomical Classification code allocated to a product/pack. This allows each product to be classified consistently in all countries (EphMrA/PBIRG 2005).

4.2.1 Definition of Drug and Characteristics of IMS Health Data

Prior to Danzon (1999), cross country studies compared the price for a single pack in the base country, but this pack may not be typical or even available in other countries (Berndt 2000). Danzon recognized that samples using only comparison packs with the same ingredient, manufacturer, brand name, dosage form, pack size and strength in each country will exclude generic and OTC products. These are likely close substitutes for originator and prescription drugs, respectively, so their omission will potentially result in unrepresentative samples (Hellerstein 1998), a problem that might be exacerbated by not including all forms and strengths (Ellison et al. 1997; Scherer 1993; Scherer 2000). Danzon therefore defined the drug by active ingredient, i.e. molecule (MOL), and ATC without regard to manufacturer and brand name. All forms of a given molecule,

including generics and licensed products, are combined to form a weighted average price per MOL/ATC. Differences between products with identical MOL and ATC are ignored, but this is presumed to be much less problematic than failing to sample substitutes and all forms and strengths.

The IMS Health measure that meets the criteria of being available for all dosage forms and strengths is the IMS Standard Unit (SU), which defines a single dose as one tablet or capsule, five milliliters of a liquid (i.e. one teaspoon), or one ampoule or vial of an injectable product (IMS 2002, 2005b). Aggregation of all dosage forms, strengths, and packs minimizes sample selection bias. Danzon and Kim (1998) found that this strategy permits over 90% of sales to be included for the US, the UK and Canada, and encompasses over two-thirds of sales for most other countries.

The ATC divides products into four hierarchical groups according to anatomical site of action, their indications, therapeutic use, composition and mode of action, etc. in the Anatomical Classification System, with levels beyond the 1st identifying therapeutic and pharmacological subgroups. For instance, the following scheme illustrates the complete structure of the data for one of the ATC categories (C10) used in this research:

C - CARDIOVASCULAR SYSTEM
(1st level, anatomical main group)

C10 - LIPID-REGULATING/ANTI-ATHEROMA PREPERATIONS
(2nd level, therapeutic main group)

C10A - CHOLESTEROL & TRIGLYCERIDE REDUCTION PREPERATIONS
(3rd level, pharmacological/therapeutic subgroup)

C10A1 - STATINS (HMG-CoA reductase inhibitors)
(4th level, chemical/pharmacological/therapeutic subgroup).

Consider the example of Zocor® (Merck), a well-known drug in the C10A category used to reduce the risk of heart attack and stroke in patients with multiple risk factors for heart disease such as high cholesterol and high blood pressure. It is difficult to compare the price of Zocor® across countries because strengths, forms and pack sizes vary greatly. In the UK, Zocor® is available in strengths of 10, 20, 40, and 80 MG, pack sizes of 10, 28, 30, and 100 tablets, and 20 different forms. In Germany, strength levels are 5, 20, 40 MG and MGFT (e.g. FT=Forts means strong), pack sizes are 28, 30, 50, 100, and there are more than 50 different forms. Moreover, many other products have the exact same MOL, Simvastatin, and are thus close substitutes. And Lipitor® (Pfizer) serves the same purpose and is thus under the same therapeutic category (C10A) as Zocor®, but has a different MOL, Atorvastatin, as well as different pack sizes, strengths and forms.

To avoid the above problem, the main unit of analysis in this study is the molecule-indication, defined by a single MOL and three-digit (3rd level) ATC (although results change little if the ATC requirement is dropped and the drug is defined simply as the MOL). A country's SU price for a MOL/ATC is its volume-weighted average price per dose over all presentations, including generics, licensed, OTC, and parallel imported products (Danzon and Furukawa 2003). Multiple molecule drugs are excluded because the relative mix of active ingredients varies across countries.

Because of data availability and cost, this study is limited to retail sales of drugs for cardiovascular disease (CVD), which is among the top three causes of death in OECD countries. CVD treatment has significant health policy implications, because once CVD patients begin drug therapy, it must continue for the remainder of their lives. Of the 29

IMS Health three-digit CVD categories, this dissertation samples the eight studied by Dickson and Jacobzone (2003). Listed in table A.4, these categories cover a wide range of both newer and older innovations that form the core of pharmacotherapy for CVD.

The five countries in the sample are Germany, the UK, Italy, Spain, and France. These countries have the largest pharmaceutical production (Figure B.2) and sales (Figure B.3) in the EU-15 (OECD 2003) and represent the five largest pharmaceutical markets in the world after the US and Japan (Table A.5) (Pammolli et al. 2004). Restricted as described above, the IMS Health data include 658 molecules (119 for France, 177 for Germany, 135 for Italy, 119 for Spain and 108 for the UK) for the 1994–2003 period.

4.2.2 Sample Construction

Different data sets are constructed for different parts of the analysis. Index calculations are based on bilateral matches (to Germany and Spain) across countries for each year. Depending on the benchmark country, an average of 50% of retail sales do not match bilaterally and thus are not included. A similar index calculation data set (for global molecules) is constructed based on matches for all five countries for each year. The match rate varies from 21% (Germany) to 32% (Spain) depending on the benchmark country. As Danzon and Chao (2000b) comment, “This heterogeneity in product-mix across countries implies that even the price indexes, which start with the universe of sales, may be unavoidably biased.”

Quasi-hedonic price regressions are based on two separate samples, a balanced panel of all 379 molecules and the 38 global molecules over the 10 years and five

countries, yielding sample sizes of 3,790 and 1,900, respectively. Table A.6 provides details for this data set by ATC/MOL and country.

To form the dependent variable in the price convergence regressions, two distinct bilateral matched samples are constructed, with 3,210 and 2,940 observations depending on whether Germany or Spain, respectively, serves as the base country. Another sample is constructed to form the dependent variable measured in deviations from the cross country average. This sample includes all 379 molecules and has 3,790 observations. A final sample for global molecules contains 38 molecules and has 1,900 observations.

4.3 Methodology

The first part of the analysis calculates price indexes by examining bilateral standard unit price differences for all molecules and global molecules using selected benchmark countries. The second part estimates quasi-hedonic regressions in order to generate price measures that control for variation in characteristics of the drugs. The third part uses the residuals from these regressions as the prices in the price convergence regressions. The next three sections describe the methods and model specifications used in each component of the analysis.

4.3.1 Price Indexes

The differences across sample countries in average drug prices, unadjusted for quality characteristics, are calculated using weighted price indexes. Previous studies showed that indexes using weighted averages are more accurate than those using unweighted averages (Gilles 1940). The most common price indexes, both generally and

in this literature, are the Laspeyres and Paasche indexes. Griliches and Cockburn (1994) used these indexes to show significant differences in effects of patent expiration and generic entry estimated using various price indexes. For one of the drugs studied, the standard price index rose by 14% over 45 months following patent expiration, while the preferred alternative index fell by 48%. A commentary response to their study by Feenstra (1997) supported their approach. Berndt et al. (1993) found that the BLS drug price index grows approximately 50% more rapidly than an alternative index using the IMS aggregate price data that includes generic drugs. Berndt et al. (1996) estimated weighted Laspeyres and Paasche price indexes using the IMS universe of antidepressant drug prices and found large differences between the fixed-weight and average-weighted versions. Berndt et al. (1999) reviewed the conceptual and measurement issues underlying the construction of US medical care consumer and producer price indexes.

Recently, Berndt et al. (2002) estimated Laspeyres, Paasche and Fisher indexes that showed a small rise in price and quantity for treatments of depression during 1991–1996. Kokoski (1992) had earlier used these indexes to make inter-area cost of living comparisons. In sum, the literature suggests these indexes are powerful tools that are useful for making bilateral and multilateral price, output, input and productivity comparisons but can come to different conclusions (Caves et al. 1982).

In this study, Laspeyres and Paasche price and quantity indexes are calculated both across areas and over time for individual country, using samples of all molecules and only global molecules, to examine quality-unadjusted price differences. In addition, the Bortkiewicz decomposition formula is used to examine the ratio of Paasche and Laspeyres index differentials.

4.3.1.1 Specification of the Indexes

The set of prices and quantities at time t are denoted p_t and q_t , respectively, and weights are fixed at time zero. The Laspeyres, i.e. base-weighted, price (quantity) index weights the price (quantity) of each good by the quantity (price) of that good at time zero:

$$P_{0t} = \frac{\sum p_t q_0}{\sum p_0 q_0} \quad (\text{Laspeyres Price Index})$$

$$Q_{0t} = \frac{\sum p_0 q_t}{\sum p_0 q_0} \quad (\text{Laspeyres Quantity Index})$$

The Laspeyres price index, for example, is a weighted average of individual good price changes, with the weights equaling the expenditure share for each good in the base period. It compares the price of a base period basket of goods with the price of the same basket in the current period. In contrast, the Paasche price index compares the price of a current basket of goods with the price of the same basket in the base period:

$$P_{0t} = \frac{\sum p_t q_t}{\sum p_0 q_t} \quad (\text{Paasche Price Index})$$

$$Q_{0t} = \frac{\sum p_t q_t}{\sum p_t q_0} \quad (\text{Paasche Quantity Index})$$

Because prices are weighted by current period quantities (and vice versa for the quantity index), the weights change for each period in which a Paasche index is calculated (Allen 1975). Additionally, because Laspeyres uses base weights while Paasche uses current weights, the two indexes are generally different even for the same period, but usually are similar when the periods being compared are not too far apart (as

in this study). The Paasche price index tends to be lower than the Laspeyres when prices are increasing and higher when prices are decreasing.

The ratios of the Paasche and Laspeyres price and quantity indexes are the same. This ratio, P/L , depends on the dispersion in price and quantity relatives to their means. Specifically, denoting price and quantity with the subscripts p and q , the Bortkiewicz decomposition formula, $P_p/L_p = P_q/L_q = 1 + (r V_p V_q)$, shows that P/L differs from one based on the coefficient of correlation between price and quantity (r), and the coefficients of variation of price (V_p) and quantity (V_q), all measured relative to the respective Laspeyres index (Jonas and Sardy 1970). The divergence between P and L increases with the correlation between price and quantity and their individual dispersions.

Because V_p and V_q are positive, $P > L$ if $r > 0$, i.e. prices and quantities tend to move in the same direction between years 0 and t , while $P < L$ if $r < 0$, i.e. prices and quantities tend to move in opposite directions. This is known as the Gerschenkron effect (Gerschenkron 1947, 1955) that price and quantity indexes change in different industries. The characteristics of Gerschenkron effect is a negative coefficient of correlation between price and quantity, which accounts for the direction of the divergence between Laspeyres and Paasche indexes. The typical economic case of $P > L$ is a market dominated by suppliers, so that the reaction to a price increase is an outward shift in supply. Examples include exporters selling on a large international market and suppliers selling both domestic and imported goods in a market. The typical economic case of $L > P$ is a demand-dominated market where consumers purchases vary inversely with price movements. The leading example is the market for consumer goods (Allen 1975). In

addition, $L > P$ might simply reflect a substitution effect, with each country using relatively more of those products that are relatively cheap in that country.

4.3.2 Quasi-Hedonic Price Regressions

When making international price comparisons, international differences in product specifications pose a problem (Kravis and Lipsey 1969). Products serving the same purpose might not only be highly differentiated across domestic producers, but might further have considerable differences in characteristics across countries. For example, a Honda Accord might have different horsepower in different countries, or come with automatic transmission in some countries and manual transmission in others. More relevant for this study, drugs come in different forms, pack sizes, and strength levels in different countries.

This study uses hedonic regressions to address this problem. Framing a product in terms of the characteristics that affect its value, hedonic regression estimates the marginal contribution of each characteristic (Sirmans et al. 2005), thus explaining the price of a good in terms of these characteristics (Wooldridge 2003). Here, hedonic price regressions estimate the value of observed characteristics of the drugs/molecules. Drug characteristics and prices also differ across countries because of their regulatory and reimbursement environments. Because market (competition) variables are used as explanatory variables along with drug quality characteristics, and pure hedonic models control for only the latter (Diewert 2003, 2005), the corresponding models in this study are more appropriately termed quasi-hedonic price regressions (Danzon and Chao 2000b).

4.3.2.1 Specification of the Quasi-Hedonic Price Models

The model is a semi-log model,

$$\ln P_{k,j,t} = \beta X_{k,j,t} + \gamma_t + \delta_j + \theta_{j,t} + c_k + u_{k,j,t},$$

where $\ln P_{k,j,t}$ is the log price per SU for molecule k in country j and year t , X is a vector of quality and market characteristics for that molecule, country and year t , γ_t is year indicators, δ_j is country indicators, $\theta_{j,t}$ is an interactions between indicators for country j and year t , c_k is an indicator for molecule k , and $u_{k,j,t}$ is the remaining error. The main goals of this regression are to obtain consistent estimates of $\theta_{j,t}$, which reflects the pattern of bilateral country price differences over time when the molecule and observable quality and market characteristics are held constant, and $u_{k,j,t}$, which represents cross country price differences that cannot be explained by observable drug characteristics, specific molecules available and average year-specific price differences.

This model is estimated using panel data methods that account for time- and country-invariant unobserved heterogeneity associated with each specific molecule. Both fixed and random effect models are estimated. These vary according to their treatment of the unobserved molecule-specific effect c_k , which is called a “random effect” when treated as a random variable and a “fixed effect” when treated as a parameter to be estimated for each molecule. Both models require zero conditional mean to hold, i.e. $E(u_{k,j,t} | X_{k,j,t}, c_k) = 0$, in order to generate consistent parameter estimates. Because the random effect model implicitly places c_k in the error term, for consistency it further requires zero correlation between the observed explanatory variables and the unobserved effect, i.e. $\text{Cov}(X_{k,j,t}, c_k) = 0$. In contrast, the fixed effect model allows arbitrary correlation between c_k and $X_{k,j,t}$. The fixed effect model is therefore more robust than the

random effect model. The tradeoff is that the effects of time-constant variables can be estimated in the latter but not the former, because there is no way to distinguish the effects of time-constant observables and unobservables (Baltagi 2005; Wooldridge 2001). Lastly, the Hausman (1978) test is used to check whether the random effects model gives similar results to the fixed effects model and is therefore valid.

Most measures of molecule quality and market competition in the data are time-varying, as are the country/year interactions. In principle, drug quality also encompasses therapeutic value and convenience, characteristics that are of intrinsic value but are not observable. If these are time-invariant and molecule-specific, the fixed effect model is appropriate. However, in order to include ATC3 indicators to proxy for market and regulatory factors that might differ across ATC3 categories, a random effect model is also estimated. One time-invariant market competition variable, therapeutic substitute molecule entry lag, is also included as an explanatory factor in the random effect model.

4.3.2.2 Description of Variables

Price (Leusuprice) is the average price per standard unit for each ATC/molecule, defined as the volume-weighted average retail price over all forms and packs. Local currency prices are converted to euros by IMS Health using constant exchange rates, which minimize effects of exchange rate fluctuations.

Molecule Age (Molage) is the number of years since the first product launch of molecule k in country j , and is the same for all products in a molecule.

Strength (Strengthg) is the mean grams of active ingredient per standard unit, averaged over all packs. Standard units are multiplied by the different strength levels,

and this quantity is divided by the total standard units. This variable was complicated to calculate due to the various measurements in the reported strength levels for packs in each molecule for the sample countries. All reported units, including international units, micrograms, percent, milligrams, pints, and qualitative units such as strong, weak, extra strong and mild, were converted to grams in consultation with IMS Health experts.

Form Code (Formcode) represents the number of different formulations of the products in each molecule, and is included as a measure of the choice and convenience available to patients. Forms include different types of tablets (e.g. film, chewable, gel), capsules, ampoules, powders, drops, syrups, syringes, and liquids, along with different strengths and pack sizes. For example, the molecule metoprolol (in C7A) was available in 118 different formulations/presentations in Germany in 2003.

Pack Size (Packsize) is the average number of standard units over all packs in a molecule. Pack sizes were converted to IMS standard units according to guidelines provided by IMS Health (IMS 2006), multiplied by standard units per molecule and divided by the total standard units in the molecule.

Global Penetration-Diffusion (Globpenet) is the number of sample countries (i.e. between 0 and 5) in which the molecule is available, as a measure of therapeutic value.

Generic Competitors (Gencompet) is the number of manufacturers of the products in the molecule, including originators, licensees, parallel imports and generics.

Therapeutic Substitute Molecules (Thsubsmol) is the number of therapeutic competitors that are chemically distinct but used to treat the same indication, i.e. the number of molecules in the ATC3.

Therapeutic Substitute Molecule Entry Lag (Thsubsmolentlag) is the number of years between this molecule's launch date and the launch of the first molecule in the ATC3, to control for any first mover advantage, and is time-invariant.

4.3.3 Price Convergence Regressions

The earlier described quasi-hedonic price regressions (without time, country and time-country interaction indicators) are used to form the dependent variable in the price convergence equations. In particular, the residuals capture price variation that cannot be attributed to observable characteristics, trends in price differences specific to country pairs, or specific molecules. These thus form the relevant prices in the price convergence regressions. Goldberg and Verboven (2005) used a similar method to test price convergence in the EU car market.

A common approach to examining price convergence is to apply a unit root test to determine whether price differential series are stationary, i.e. have mean and variance that do not vary systematically over time and are thus stable. The rejection of the unit root hypothesis implies that relative prices have stationary time series and will thus converge in the long run. Failure to reject the unit root hypothesis implies that relative prices follow a random path, so that any deviation from a single price becomes permanent (Fan and Wei 2006). Moreover, presence of a unit root implies that a shock today has a long lasting impact, determining whether a process has a unit root is of interest in its own right. Unit root tests for a single time series, such as the often used Augmented-Dickey Fuller test, have low power in the sense that they too often reject stationarity. Levin et al. (2002) showed that use of a unit root test for panel data can significantly increase test

power (Maddala 1999;Maddala and Wu 1999). Their model assumes that each panel unit shares the same AR(1) coefficient, but allows for individual and time effects and a time trend. This test maybe viewed as a pooled Dickey-Fuller test or an Augmented Dickey-Fuller test when lags are included, with the null hypothesis of nonstationary (Bornhorst and Baum 2001).

4.3.3.1 Specification of the Price Convergence Models

The following convergence equations are based on the panel data unit root test developed by Levin and Lin (1992;Levin and Lin 1993) and Levin et al. (2002):

$$\text{Model 1: } \Delta p_{k,j,t} = \beta p_{k,j,t-1} + \sum_{l=1}^L \gamma_l \Delta p_{k,j,t-l} + \varepsilon_{k,j,t}$$

$$\text{Model 2: } \Delta p_{k,j,t} = \alpha_{k,j} + \beta p_{k,j,t-1} + \sum_{l=1}^L \gamma_l \Delta p_{k,j,t-l} + \varepsilon_{k,j,t}$$

$$\text{Model 3: } \Delta p_{k,j,t} = \alpha_{k,j} + \beta p_{k,j,t-1} + \delta t + \sum_{l=1}^L \gamma_l \Delta p_{k,j,t-l} + \varepsilon_{k,j,t}$$

In model 1, the null hypothesis $H_0: \beta = 0$ is tested against the alternative $H_1: \beta < 0$.

In model 2, individual molecule/country fixed effects are added, and $H_0: \beta = 0$ and $\alpha_{j,k} = 0$ is tested against $H_1: \beta < 0$ and $\alpha_{j,k} \neq 0$.

In model 3, a time trend is added, and $H_0: \beta=0$ and $\delta=0$ is tested against $H_1: \beta < 0$ and $\delta \neq 0$.

These three models serve different purposes. The first is used to test the absolute version of the Law of One Price, while the second model is used to test the relative version of the Law of One Price. Model 3 is not preferred in the literature but it is estimated for both adjusted and unadjusted price convergence estimations to compare the

results. For series that have clear time trends, the process must be modified to test for unit roots. A trend stationary process can be mistaken for unit root process if we do not control for a time trend.

The convergence equation dependent variable represents the first difference in the log-price of molecule k in country j . This first difference is specified relative to a base country in one specification, and relative to the cross country average in another. In other words, if q represents log price, the two dependent variable specifications are

$$1) \Delta p_{k,j,t} = p_{k,j,t} - p_{k,j,t-1}, \text{ where } p_{k,j,t} = q_{k,j,t} - q_{k,BaseCountry,t} \text{ and } p_{k,BaseCountry,t} = 1;$$

$$2) \Delta p_{k,j,t} = p_{k,j,t} - p_{k,j,t-1} \text{ with } p_{k,j,t} = q_{k,j,t} - q_{Crosscountryaverage,j,t}.$$

The test for unit roots relates the first difference to the log price of the previous period; if the coefficient of the previous period's price is negative, price differentials across countries become smaller over time ($\beta < 0$) and the hypothesis of a unit root is rejected. Therefore, β denotes the speed of convergence. Under the null hypothesis of no convergence, $\beta = 0$ and a shock to $p_{k,j,t}$ is permanent (i.e. has a unit root). If $\beta \geq 0$, the price differential is non-stationary, implying persistent price divergence. If $\beta < 0$, prices converge. The coefficient estimate is tested according to the critical values reported in Levin and Lin (1992, 1993) and t-star statistics (adjusted t statistics, tabulated in Levin et al. 2002) are also reported. After transformation by factors provided by Levin and Lin (1992, 1993), the t-star statistic is distributed standard normal under the null hypothesis of nonstationarity. The half-life of a shock to the price differential is $\frac{-\ln(2)}{\ln(1 + \beta)}$.

Model 2, used to test the relative version of the Law of One Price, is the primary focus of this study. The $\alpha_{k,j}$ capture price differences that are specific to country pairs and

molecules. Large values would indicate market segmentation. Even in integrated markets, some permanent cross-country price dispersion might remain, reflecting local factors that cannot be arbitrated away. If this dispersion fully explains any price differentials, the relative version of the Law of One Price holds. If instead prices of identical products are equal across countries, the absolute version of the law of one price holds (Goldberg and Verboven 2004). Dividing these fixed effects by $-\beta$ yields the long-term systematic price differentials across countries. For brevity, the average $\alpha_{j,k}$ across molecules by country is reported.

The lags (L) $\Delta p_{k,j,t-l}$ are used to account for possible serial correlation in the error term. Because of the limited number of years available in the data set, the estimations include lags of zero, one or two years, consistent with previous studies. In addition to these, Campbell and Perron's top-down approach (Pammolli et al. 2004) is also used to find optimum amount of lag order when the equations are estimated. In this approach, the lag order is set to a maximum of two lags for each molecule/country estimation. If the absolute value of the t-statistic of γ_2 is less than 1.96, the lag order is set to one lag and the equation is re-estimated. If this t-statistic is less than 1.96, no lags are included.

Chapter 5

Research Results

This chapter describes the estimation results. The first section discusses the price indexes, the second section discusses the quasi-hedonic price regressions and the last section discusses price convergence.

5.1 Unadjusted Bilateral Standard Unit Price Differences

This section reports the estimated Laspeyres and Paasche price and quantity indexes, as well as the decomposition of P/L differentials, with Spain and Germany as the benchmark countries. Spain typically has the lowest drug prices in Europe and the most pharmaceutical regulations, while Germany has high prices and fewer regulations. The standard unit is the volume measure and the fixed euro is the monetary measure. The Laspeyres index uses benchmark country weights, whereas the Paasche index uses own country weights. The indexes are measured for both bilateral matched molecules and global molecules. In addition, to investigate country specific temporal fluctuations, year by year price differentials are measured for each country.

5.1.1 Standard Unit Price Differences for Bilaterally Matched Molecules

Table 1 shows SU prices relative to Germany. In 1994, Laspeyres prices are higher by 7.5% in the UK and 14.9% in France, but lower by 4.3% in Italy and 27.5% in Spain. In 2003, prices are higher in all four other countries, by 41.4% in the UK, 35.3% in France, 28.5% in Italy and 0.25% in Spain. The Paasche index generally shows smaller price differentials. In 1994 prices are lower by 1.7% in Italy, 2.3% in the UK, 11.7% in France and 27.8% in Spain. In 2003, prices are higher by 39.4% in the UK, 12.8% in Italy and 2.7% in France, but lower by 9.0% in Spain. Thus, both the magnitude and rank ordering of the price differentials depend on which weights are used. The Laspeyres index may be most relevant from the German perspective since it uses weights for Germany, and can thus be interpreted as an estimate of how much Germany might save by adopting another country's prices, although it is a lower-bound savings estimate because it assumes no change in German consumption patterns. The Paasche index provides an upper-bound estimate of potential savings because it assumes that while Germany would adopt the other country's consumption patterns, changes in prices and quantities would not affect R&D. Figures B.4 and B.5 show these bilateral Laspeyres and Paasche price differences.

The Laspeyres quantity index shows less consumption than in Germany for all countries except France, and the Paasche quantity index indicates consistently less consumption than in Germany for all countries. Indexes normalized by population size show that all countries have lower per capita consumption than Germany. The results reveal large cross-national differences in per capita drug consumption.

Table 1
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Germany

Index Measures	1994				1995				1996			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	81	73	74	89	78	73	72	89	78	74	73	85
Laspeyres Price Index (GR weighted)	0.7248	1.0754	1.1489	0.9571	0.7727	1.1250	1.2020	0.9334	0.8115	1.1745	1.2150	0.9986
Paasche Price Index (Own weighted)	0.7220	0.9775	0.8836	0.9834	0.7632	1.0861	0.9184	0.9053	0.7956	1.1186	0.9341	0.9643
Laspeyres Quantity Index	0.4342	0.5293	1.2233	0.6214	0.4393	0.5041	1.1681	0.6145	0.4294	0.5159	1.0794	0.5992
Paasche Quantity Index	0.4326	0.4811	0.9408	0.6385	0.4338	0.4867	0.8925	0.5960	0.4210	0.4913	0.8298	0.5786
Normalized Laspeyres Quantity Index by Relative Population Size	0.2095	0.3760	0.8657	0.4343	0.2120	0.3582	0.8273	0.4284	0.2070	0.3663	0.7643	0.4163
Normalized Paasche Quantity Index by Relative Population Size	0.2087	0.3418	0.6658	0.4462	0.2093	0.3459	0.6322	0.4155	0.2029	0.3489	0.5876	0.4020
Population Ratio (Comparison/GR)	0.4825	0.7105	0.7077	0.6989	0.4825	0.7106	0.7083	0.6972	0.4819	0.7101	0.7081	0.6948
$P_p/L_p = P_q/L_q$	0.9961	0.9090	0.7691	1.0275	0.9876	0.9654	0.7641	0.9700	0.9804	0.9525	0.7688	0.9657
r	-0.0067	-0.0045	-0.1098	0.0123	-0.0205	-0.0171	-0.3023	-0.0144	-0.0270	-0.0328	-0.0572	-0.0142
V_p	0.4035	0.4017	0.4584	0.4985	0.4053	0.3800	0.4241	0.5403	0.4403	0.3861	0.4103	0.5460
V_q	1.4224	50.7645	4.5873	4.4643	1.4956	5.3272	1.8404	3.8708	1.6528	3.7541	9.8455	4.4123
$r.V_p.V_q$	-0.0039	-0.0910	-0.2309	0.0275	-0.0124	-0.0346	-0.2359	-0.0300	-0.0196	-0.0475	-0.2312	-0.0343

Table 1 (Continued)
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Germany

Index Measures	1997				1998				1999			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	77	78	74	84	78	79	76	82	77	78	75	83
Laspeyres Price Index (GR weighted)	0.8754	1.2225	1.2590	1.0863	0.9154	1.2921	1.2574	1.1234	0.9304	1.2972	1.2361	1.1557
Paasche Price Index (Own weighted)	0.8383	1.1818	0.9617	1.0062	0.8651	1.2234	1.0275	1.0437	0.8647	1.2586	0.9778	1.0746
Laspeyres Quantity Index	0.4380	0.5353	1.0988	0.5740	0.4596	0.5733	0.9813	0.5849	0.4774	0.6156	1.0189	0.5934
Paasche Quantity Index	0.4194	0.5175	0.8393	0.5317	0.4343	0.5429	0.8019	0.5434	0.4436	0.5973	0.8060	0.5517
Normalized Laspeyres Quantity Index by Relative Population Size	0.2111	0.3801	0.7786	0.3981	0.2220	0.4080	0.7300	0.7238	0.2316	0.4396	0.7266	0.4116
Normalized Paasche Quantity Index by Relative Population Size	0.2021	0.3675	0.5948	0.3688	0.2098	0.3863	0.5697	0.3769	0.2152	0.4265	0.5747	0.3828
Population Ratio (Comparison/GR)	0.4819	0.7101	0.7086	0.6935	0.4831	0.7116	0.7105	0.6935	0.4852	0.7141	0.7131	0.6938
$P_p/L_p = P_q/L_q$	0.9576	0.9667	0.7639	0.9263	0.9450	0.9469	0.8171	0.9291	0.9294	0.9703	0.7910	0.9298
r	-0.0500	-0.0287	-0.0650	-0.0241	-0.0610	-0.0351	-0.1382	-0.0233	-0.0788	-0.0200	-0.1996	-0.0208
V_p	0.4819	0.3935	0.4639	0.5793	0.5146	0.4991	0.5016	0.5745	0.5338	0.4926	0.5467	0.6007
V_q	1.7619	2.9478	7.8313	5.2862	1.7511	3.0365	3.1691	5.3005	1.6799	3.0124	1.9152	5.6167
$r.V_p.V_q$	-0.0424	-0.0333	-0.2361	-0.0737	-0.0550	-0.0531	-0.2196	-0.0709	-0.0706	-0.0297	-0.2090	-0.0702

Table 1 (Continued)
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Germany

Index Measures	2000				2001				2002			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	78	77	73	83	76	73	73	83	74	73	70	80
Laspeyres Price Index (GR weighted)	0.9288	1.3144	1.2500	1.2063	0.8976	1.2551	1.2278	1.2151	0.9371	1.3122	1.2869	1.2709
Paasche Price Index (Own weighted)	0.8504	1.2718	0.9711	1.1059	0.8148	1.2152	0.9509	1.0969	0.8347	1.2548	0.9712	1.1326
Laspeyres Quantity Index	0.4811	0.6280	1.0248	0.6125	0.4781	0.6692	0.9748	0.6199	0.4778	0.7031	0.9085	0.5869
Paasche Quantity Index	0.4405	0.6077	0.7962	0.5615	0.4340	0.6479	0.7550	0.5596	0.4256	0.6723	0.6856	0.5230
Normalized Laspeyres Quantity Index by Relative Population Size	0.2345	0.4493	0.7334	0.4244	0.2353	0.4800	0.7009	0.4293	0.2374	0.5050	0.6557	0.4057
Normalized Paasche Quantity Index by Relative Population Size	0.2147	0.4348	0.5698	0.3891	0.2135	0.4647	0.5429	0.3875	0.2115	0.4829	0.4948	0.3616
Population Ratio (Comparison/GR)	0.4874	0.7155	0.7156	0.6929	0.4921	0.7172	0.7190	0.6925	0.4969	0.7183	0.7217	0.6913
$P_p/L_p = P_q/L_q$	0.9156	0.9676	0.7769	0.9168	0.9077	0.9682	0.7745	0.9027	0.8907	0.9563	0.7547	0.8912
r	-0.0847	-0.0211	-0.1900	-0.0196	-0.1030	-0.0193	-0.1734	-0.0198	-0.1141	-0.0253	-0.1666	-0.0198
V_p	0.5637	0.5143	0.6045	0.6371	0.5175	0.5136	0.6334	0.6439	0.5571	0.5464	0.6779	0.6846
V_q	1.7677	2.9850	1.9418	6.6707	1.7311	3.2135	2.0532	7.6203	1.7194	3.1633	2.1716	8.0274
$r.V_p.V_q$	-0.0844	-0.0324	-0.2231	-0.0832	-0.0923	-0.0318	-0.2255	-0.0973	-0.1093	-0.0437	-0.2453	-0.1088

Table 1 (Continued)
**Pharmaceutical Price and Quantity Indexes
for All Molecules, Relative to Germany**

Index Measures	2003			
	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	72	73	70	79
Laspeyres Price Index (GR weighted)	1.0025	1.4142	1.3528	1.2845
Paasche Price Index (Own weighted)	0.9100	1.3936	1.0273	1.1281
Laspeyres Quantity Index	0.4439	0.6673	0.8402	0.5475
Paasche Quantity Index	0.4029	0.6576	0.6381	0.4808
Normalized Laspeyres Quantity Index by Relative Population Size	0.2241	0.4806	0.6093	0.3803
Normalized Paasche Quantity Index by Relative Population Size	0.2034	0.4736	0.4627	0.3339
Population Ratio (Comparison/GR)	0.5048	0.7201	0.7252	0.6945
$P_p/L_p = P_q/L_q$	0.9077	0.9854	0.7594	0.8782
r	-0.0968	-0.0089	-0.1695	-0.0223
V_p	0.5155	0.5183	0.6190	0.6266
V_q	1.8495	3.1537	2.2930	8.7072
$r.V_p.V_q$	-0.0923	-0.0146	-0.2406	-0.1218

The ratios of the Paasche to Laspeyres indexes, P/L , are uniformly less than one, except for Italy in 1994. This is consistent with a negative correlation between price and quantity, i.e. a Gerschenkron effect, and can be interpreted as a demand-dominated drug market in which equilibrium quantity responds more to shifts in supply than in demand. It could also reflect a substitution effect in which consumers use relatively more of products that are relatively cheap. As in Danzon's (2000) study of price differentials relative to the US, the magnitudes of the correlation between price and quantity and coefficients of variations are small, showing that there are less variation in prices and quantities among the countries.

Table A.7 and figures B.6 and B.7 report price and quantity indexes relative to Spain for bilaterally matched molecules. The Laspeyres price index shows that Spain has the lowest drug prices in the sample, with prices higher in the UK, Germany, France and Italy by 38.5%, 38.0%, 32.8% and 46.6% in 1994 and 44.9%, 9.9%, 23.9% and 30.5% in

2003. The Paasche price index reports smaller but similar differentials for all countries except France. The quantity indexes show that per capita consumption is lower in Spain than in the other countries. On the other hand, P/L ratios are again less than one for all countries except France between 1994 and 2001.

5.1.2 Standard Unit Price Differences for Global Molecules

The price indexes for global molecules relative to Germany (table 2) generally show similar but some cases smaller price differences between countries than the indexes based on the larger bilaterally matched samples (figure B.8 and B.9). The P/L ratios are again below one for all countries except Spain between 1994 and 1997. The smaller coefficients of variation for both quantity and price indicate that consumption and prices variation falls as drugs become more universally available. This could reflect the European Commission's efforts to coordinate the EU pharmaceutical industry, particularly by increasing parallel trade and using the international price comparison regulatory method. Similar results are reported in table A.8 and figures B.10 and B.11 for global molecules relative to Spain.

Table 2
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Germany

Index Measures	1994				1995				1996			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (GR weighted)	0.7716	1.0671	1.0809	0.9778	0.8257	1.1189	1.1765	0.9670	0.8751	1.1720	1.2267	1.0601
Paasche Price Index (Own weighted)	0.8103	1.0365	0.9550	1.0531	0.8614	1.0929	0.9980	0.9721	0.9008	1.1325	1.0164	1.0393
Laspeyres Quantity Index	0.4108	0.5281	1.0769	0.5780	0.4072	0.5354	1.0348	0.5820	0.3990	0.5605	0.9838	0.5625
Paasche Quantity Index	0.4314	0.5130	0.9516	0.6225	0.4247	0.5230	0.8778	0.5851	0.4107	0.5416	0.8151	0.5515
Normalized Laspeyres Quantity Index by Relative Population Size	0.1982	0.3752	0.7622	0.7360	0.1965	0.3805	0.7329	0.4057	0.1923	0.3980	0.6966	0.3908
Normalized Paasche Quantity Index by Relative Population Size	0.2082	0.3644	0.6734	0.4351	0.2049	0.3717	0.6217	0.4079	0.1979	0.3846	0.5772	0.3832
Population Ratio (Comparison/GR)	0.4825	0.7105	0.7077	0.6989	0.4825	0.7106	0.7083	0.6972	0.4819	0.7101	0.7081	0.6948
$P_p/L_p = P_q/L_q$	1.0503	0.9713	0.8836	1.0770	1.0432	0.9768	0.8483	1.0053	1.0293	0.9663	0.8285	0.9803
r	0.1188	-0.0675	-0.1973	0.1143	0.1000	-0.0632	-0.2544	0.0084	0.0584	-0.0903	-0.2677	-0.0303
V_p	0.3677	0.4060	0.3841	0.4830	0.3764	0.3864	0.3787	0.5218	0.4213	0.4014	0.4108	0.5548
V_q	1.1506	1.0480	1.5364	1.3955	1.1473	0.9500	1.5749	1.2042	1.1912	0.9297	1.5590	1.1710
$r.V_p.V_q$	0.0503	-0.0287	-0.1164	0.0770	0.0432	-0.0232	-0.1517	0.0053	0.0293	-0.0337	-0.1715	-0.0197

Table 2 (Continued)
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Germany

Index Measures	1997				1998				1999			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (GR weighted)	0.9468	1.2196	1.3003	1.1495	0.9795	1.2684	1.3120	1.1892	0.9940	1.2952	1.2882	1.2241
Paasche Price Index (Own weighted)	0.9482	1.1979	1.0230	1.0874	0.9732	1.2392	1.0325	1.1296	0.9708	1.2688	1.0209	1.1609
Laspeyres Quantity Index	0.4208	0.5998	1.0208	0.5518	0.4412	0.6587	1.0403	0.5557	0.4532	0.7033	0.9977	0.5713
Paasche Quantity Index	0.4215	0.5891	0.8030	0.5220	0.4383	0.6436	0.8187	0.5279	0.4427	0.6890	0.7907	0.5418
Normalized Laspeyres Quantity Index by Relative Population Size	0.2028	0.4259	0.7233	0.3827	0.2131	0.4688	0.7336	0.7834	0.2199	0.5022	0.7114	0.3964
Normalized Paasche Quantity Index by Relative Population Size	0.2031	0.4183	0.5690	0.3621	0.2117	0.4580	0.5817	0.3661	0.2148	0.4920	0.5638	0.3759
Population Ratio (Comparison/GR)	0.4819	0.7101	0.7086	0.6935	0.4831	0.7116	0.7105	0.6935	0.4852	0.7141	0.7131	0.6938
$P_p/L_p = P_q/L_q$	1.0015	0.9822	0.7867	0.9460	0.9936	0.9770	0.7870	0.9499	0.9767	0.9796	0.7925	0.9484
r	0.0026	-0.0463	-0.2795	-0.0772	-0.0104	-0.0570	-0.2449	-0.0724	-0.0377	-0.0494	-0.2146	-0.0756
V_p	0.4803	0.4185	0.4840	0.6064	0.5022	0.4318	0.5237	0.6106	0.5035	0.4393	0.5527	0.6322
V_q	1.2222	0.9187	1.5768	1.1533	1.2312	0.9349	1.6608	1.1339	1.2289	0.9399	1.7496	1.0797
$r.V_p.V_q$	0.0015	-0.0178	-0.2133	-0.0540	-0.0064	-0.0230	-0.2130	-0.0501	-0.0233	-0.0204	-0.2075	-0.0516

Table 2 (Continued)
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Germany

Index Measures	2000				2001				2002			
	SPN	UK	FR	ITY	SPN	UK	FR	ITY	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (GR weighted)	1.0118	1.3495	1.3224	1.2915	0.9634	1.2798	1.3276	1.3107	1.0092	1.3928	1.4220	1.3807
Paasche Price Index (Own weighted)	0.9775	1.2897	1.0146	1.2258	0.9156	1.2172	0.9998	1.2214	0.9396	1.2847	1.0261	1.2842
Laspeyres Quantity Index	0.4521	0.7084	0.9971	0.5649	0.4487	0.7529	0.9691	0.5704	0.4392	0.7776	0.9238	0.5235
Paasche Quantity Index	0.4367	0.6770	0.7651	0.5362	0.4265	0.7161	0.7299	0.5315	0.4089	0.7172	0.6666	0.4869
Normalized Laspeyres Quantity Index by Relative Population Size	0.2204	0.5068	0.7135	0.3914	0.2208	0.5400	0.6968	0.3950	0.2182	0.5585	0.6667	0.3619
Normalized Paasche Quantity Index by Relative Population Size	0.2129	0.4844	0.5475	0.3715	0.2098	0.5136	0.5248	0.3681	0.2032	0.5152	0.4811	0.3366
Population Ratio (Comparison/GR)	0.4874	0.7155	0.7156	0.6929	0.4921	0.7172	0.7190	0.6925	0.4969	0.7183	0.7217	0.6913
$P_p/L_p = P_q/L_q$	0.9661	0.9557	0.7673	0.9491	0.9504	0.9511	0.7531	0.9319	0.9311	0.9224	0.7216	0.9301
r	-0.0531	-0.0994	-0.2151	-0.0754	-0.0864	-0.1091	-0.2132	-0.1054	-0.1206	-0.1575	-0.2367	-0.1027
V_p	0.5000	0.4909	0.5905	0.6477	0.4424	0.5038	0.6057	0.6413	0.4294	0.5334	0.5937	0.6422
V_q	1.2765	0.9084	1.8321	1.0423	1.2970	0.8902	1.9113	1.0083	1.3308	0.9237	1.9813	1.0598
$r.V_p.V_q$	-0.0339	-0.0443	-0.2327	-0.0509	-0.0496	-0.0489	-0.2469	-0.0681	-0.0689	-0.0776	-0.2784	-0.0699

Table 2 (Continued)
**Pharmaceutical Price and Quantity Indexes
for Global Molecules, Relative to Germany**

Index Measures	2003			
	SPN	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38
Laspeyres Price Index (GR weighted)	1.0980	1.5679	1.5275	1.4675
Paasche Price Index (Own weighted)	1.0590	1.5168	1.1217	1.3771
Laspeyres Quantity Index	0.3770	0.6946	0.8214	0.4576
Paasche Quantity Index	0.3636	0.6720	0.6031	0.4294
Normalized Laspeyres Quantity Index by Relative Population Size	0.1903	0.5002	0.5956	0.3178
Normalized Paasche Quantity Index by Relative Population Size	0.1835	0.4839	0.4374	0.2982
Population Ratio (Comparison/GR)	0.5048	0.7201	0.7252	0.6945
$P_p/L_p = P_q/L_q$	0.9645	0.9674	0.7343	0.9384
r	-0.0649	-0.0676	-0.2373	-0.0959
V_p	0.3578	0.4876	0.4931	0.5735
V_q	1.5306	0.9891	2.2706	1.1200
$r.V_p.V_q$	-0.0355	-0.0326	-0.2657	-0.0616

5.1.3 Country Price Differences for All and Global Molecules, Relative to 1994

Tables A.10 and A.11 and figures B.12 and B.13 show the price and quantity indexes over the years for all bilaterally matched and global molecules in each country. For all bilateral matched molecules, prices consistently decreased in Germany and France starting in 1998, whereas they increased until around 2000 and then decreased in the other three countries. The results for global molecules are similar.

5.2 Quality Adjusted Standard Unit Price Differences

This section shows the results of quasi-hedonic regressions that examine the contribution of various quality and market competition characteristics to the large cross-country dispersion of drug prices just documented. The residuals of these regressions

will then form the price variables in the price convergence regressions to be discussed in the subsequent section.

5.2.1 Drug Quality and Market (Competition) Characteristics

Table 3 shows descriptive statistics for quality and market characteristics in the bilaterally matched data on 3,790 molecule/country/year observations, while table 4 presents the same information for the 1,900 observations on globally diffused molecules. In the latter data, the SU price is lower while quantity and retail sales are higher.

Table 3
Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules Overall

Variable	Description	N	Overall Mean	Overall SD	Within SD
Suthnds	Standard units in thousands	3,790	73,189	125,996	41,562
Leuthnds	Total standard unit retail sales in thousands in euro	3,790	18,343	33,034	13,665
Leusuprice	Standard unit prices in euro	3,790	0.39	1.25	0.43
<i>Quality Characteristics</i>					
Strengthg	Strength per gram	3,790	0.15	0.55	0.06
Molage	Molecule age	3,790	19.62	12.15	2.87
Packsize	Pack size	3,790	57.27	65.02	35.22
Formcode	Form Code	3,790	7.67	11.99	2.59
Globpenet	Global penetration	3,790	4.16	1.20	0.27
<i>Market(Competition) Characteristics</i>					
Gencompet	Generic Competition	3,790	4.80	7.44	2.55
Thsubsmol	Therapeutic Substitute Molecule	3,790	15.95	6.31	1.37
Thsubsolentlag	Therapeutic Substitute Molecule Entry Lag	3,780	17.70	12.59	0.00

Table 4
**Pharmaceutical Drug Quality and Market (Competition) Characteristics for
 Global Molecules Overall**

Variable	Description	N	Overall Mean	Overall SD	Within SD
Suthnds	Standard units in thousands	1,900	107,664	144,484	54,522
Leuthnds	Total standard unit retail sales in thousands in euro	1,900	27,242	41,213	18,320
Leusuprice	Standard unit prices in euro	1,900	0.27	0.22	0.04
<i>Quality Characteristics</i>					
Strengthg	Strength per gram	1,900	0.18	0.58	0.09
Molage	Molecule age	1,900	20.58	11.59	2.87
Packsize	Pack size	1,900	58.08	74.38	41.44
Formcode	Form Code	1,900	9.97	14.97	3.31
Globpenet	Global penetration	1,900	5	0.00	0.00
<i>Market(Competition) Characteristics</i>					
Gencompet	Generic Competition	1,900	6.46	9.36	3.15
Thsubsmol	Therapeutic Substitute Molecule	1,900	14.73	5.47	1.28
Thsubsolentlag	Therapeutic Substitute Molecule Entry Lag	1,900	13.53	9.99	0.00

In table A.11, the SU price is €0.58, €0.54, €0.30, €0.27 and €0.21 in Germany, the UK, Italy, France and Spain, respectively. Similarly, average SU retail sales are the greatest in Germany and the smallest in Spain, while average total retail sales are the highest in France and the lowest in Spain. For globally diffused molecules, SU prices, in the order listed above, are €0.29, €0.32, €0.28, €0.27 and €0.21 (table A.12). The descriptive statistics are also listed by molecule, country and year, for all molecules in table A.13 and for global molecules in table A.14.

5.2.2 Quality Adjusted Standard Unit Price Differences for All Molecules

Table 5 shows the results of the quasi-hedonic price regressions estimated by both fixed and random effect models, with Germany as the base country. Most of the quality and market variables have the expected sign and are statistically significant, but their effects are small in magnitude, indicating overall reimbursement and regulation effects. Standard unit price is increasing in strength. The number of forms available is expected to be positively related in markets, if range of formulation enhances effectiveness, convenience and value. Additionally, introducing a new formation is a method of obtaining a price increase in countries that do not permit price increases for established products or when the product life cycle declines (Danzon and Chao 2000a). Here, form code is inversely related due to possible explanations of therapeutic category-specific differences in medical norms and insurance. Further investigation is needed for this relationship in the regulated markets. SU price is inversely related to molecule age, suggesting that newer molecules offer improved therapeutic quality, although molecule age may also reflect life-cycle regulatory effects, but it is not significant. Price decreases with pack size, consistent with economies of scale in packaging, and global penetration, which is a proxy for diffused therapeutic value. Generic competition lowers price as it is expected. Therapeutic substitute molecule is expected to be inversely related to price due to substitution effect (Danzon and Chao 2000b) but here again, it is directly related to the price. When a new molecule is introduced, assuming better therapeutic treatment, a few good substitutes will be available and the drugs with the new main ingredient will have high prices. But after time, competition eliminates some of the substitutes while at the same time lowers prices. Further investigation is needed for therapeutic substitute

molecules. Lastly, therapeutic substitute molecule entry lag has a positive price effect but it is insignificant. All of the ATC3 dummies are significant in the random effect model, implying significant differences in prices for different indications, presumably due to differences in therapeutic value and insurance coverage.

The Hausman test for fixed effect (FE) vs. random effect (RE) models tests the null hypothesis that the coefficients estimated by the random effects estimator, which is efficient but possibly inconsistent, are the same as the ones estimated by the consistent fixed effects estimator. Therefore, a failure to reject the null hypothesis means either that RE and FE estimates are sufficiently close so that it does not matter which is used, or the sampling variation is so large in the FE estimates that one cannot conclude practically significant differences are statistically significant. A rejection using Hausman test is taken to mean that the key RE assumption, i.e. $\text{Cov}(X_{k,j,t}, c_k) = 0$, is false, so that the FE estimates should be used. Here, the Hausman test fails to reject the null hypothesis, so the random effect estimator is presumed consistent and hence used to interpret the price differentials.

The main interest in these regressions is the coefficients of the country/year interactions, which trace out the pattern of price differences over time controlling for quality and market characteristics and molecule identity. The individual country dummy coefficients give the 1994 price differential between country and Germany, while the individual year dummy coefficients give the price differential for Germany between each year and 1994. Table 6 and Figure 1 show the price differences in percentages, estimated with the random effect model, relative to Germany in 1994 (the omitted country/year

combination), while table A.15 and figure B.14 do the same for prices relative to Spain in 1994.

Table 5
**Quasi-Hedonic Price Regression Results for All Molecules,
 Relative to Germany**

	Fixed Effect Model	Random Effect Model
Dependent variable: logleusuprice		
Explanatory Variables	Coefficient (Standard Error)^a	Coefficient (Standard Error)^a
<i>Quality Characteristics</i>		
STRENGTHG	0.0341 ^{***} (0.0185)	0.0313 ^{***} (0.0172)
MOLAGE	-0.0007 (0.0029)	-0.0039 (0.0028)
PACKSIZE	-0.0020 [*] (0.0001)	-0.0021 [*] (0.0001)
FORMCODE	-0.0046 [*] (0.0009)	-0.0049 [*] (0.0009)
GLOBPENET	-0.0430 ^{***} (0.0236)	-0.0627 [*] (0.0203)
<i>Market (Competition) Characteristics</i>		
GENCOMPET	-0.0044 [*] (0.0016)	-0.0044 [*] (0.0016)
THSUBSMOL	0.0123 [*] (0.0018)	0.0123 [*] (0.0020)
THSUBSMOLENTLAG	-	0.0006 (0.0017)
Country dummies	Yes	Yes
Time dummies	Yes	Yes
Country/Time dummies	Yes	Yes
ATC dummies	No	Yes
N	3,790	3,780
R ² (Within)	0.2495	0.2490
Prob>F	0.0000	0.0000

^a Standard errors are heteroskedasticity-robust. *, ** and *** reflect p<0.01, p<0.05 and p<0.10.

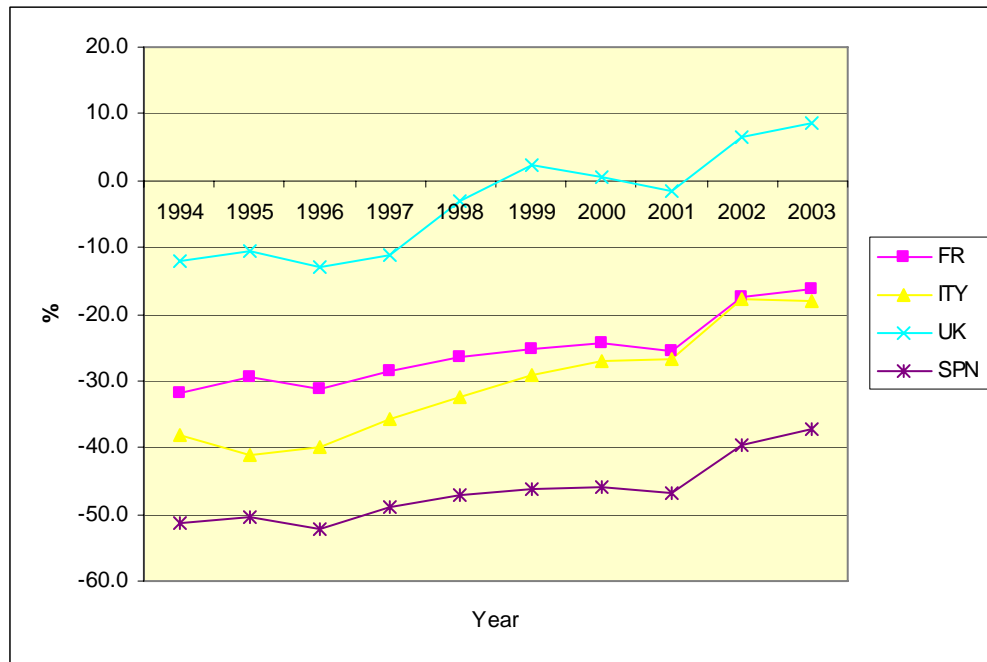
Table 6
**Quality Adjusted (by RE) Standard Unit Price Differentials for All Molecules,
 Relative to Germany^a**

Year	Germany	France	Italy	United Kingdom	Spain
1994	-	-31.91%	-38.02%	-12.12%	-51.23%
1995	0.21%	-29.25%	-41.05%	-10.47%	-50.24%
1996	1.99%	-29.16%	-38.06%	-10.84%	-50.15%
1997	0.70%	-27.71%	-35.10%	-10.57%	-48.23%
1998	-0.11%	-26.58%	-32.51%	-3.20%	-47.35%
1999	-0.39%	-25.65%	-29.61%	1.96%	-46.49%
2000	-0.78%	-25.17%	-27.84%	-0.27%	-46.65%
2001	-0.30%	-25.76%	-26.97%	-1.98%	-47.03%
2002	-4.83%	-22.42%	-22.52%	1.68%	-44.60%
2003	-6.10%	-22.43%	-24.20%	2.57%	-43.43%

The main result is that price differences are still significant, but the percentage differences are consistent with the expectations that price differentials are decreasing over time. All the countries have lower prices relative to Germany during the time period except the United Kingdom between 2002 and 2003. Prices in France, Italy and Spain move similarly, which is likely attributable to their pharmaceutical industries having similar characteristics. UK prices are getting higher at small percentages in 1999. It is observed that the price differences are decreasing at increasing rate, of possibly due to increased parallel imports and the European Commission's coordination efforts.

^a These are the coefficients of the country/time effects ($\theta_{j,t}$) in the random effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

Figure 1
**Quality Adjusted (by RE) Standard Unit Price Differentials
 for All Molecules, Relative to Germany^a**



Price differentials estimated from the fixed effect model are reported in tables A.16 and A.17 and figures B.15 and B.16. As expected, the results are quite similar. Additionally, the same models are estimated without year and country indicators. The quality adjusted prices, i.e. the residuals, from these latter models are used to form the dependent variable in the price convergence equations.

5.2.3 Quality Adjusted Standard Unit Price Differences for Global Molecules

Table 7 shows the results from applying the same model to the globally diffused molecules. Coefficient signs are the same, and magnitudes remain similar. Molecule age variable is significant in these specifications, indicating that older molecules have lower prices.

^a Normalized to Germany.

Table 7
**Quasi-Hedonic Price Regression Results for Global Molecules,
Relative to Germany**

	Fixed Effect Model	Random Effect Model
Dependent variable: logleusuprice		
Explanatory Variables	Coefficient (Standard Error)^a	Coefficient (Standard Error)^a
<i>Quality Characteristics</i>		
STRENGTHG	-0.1975* (0.0534)	-0.1735* (0.0465)
MOLAGE	-0.0104** (0.0044)	-0.0158* (0.0033)
PACKSIZE	-0.0019* (0.0002)	-0.0019* (0.0002)
FORMCODE	-0.0056* (0.0010)	-0.0055* (0.0010)
<i>Market (Competition) Characteristics</i>		
GENCOMPET	-0.0028*** (0.0017)	-0.0030*** (0.0017)
THSUBSMOL	0.0094* (0.0022)	0.0106* (0.0025)
THSUBSMOLENTLAG	-	-0.0019 (0.0017)
Country dummies	Yes	Yes
Time dummies	Yes	Yes
Country/Time dummies	Yes	Yes
ATC dummies	No	Yes
N	1,900	1,900
R ² (Within)	0.2593	0.2593
Prob>F	0.0000	0.0000

^a Standard errors are heteroskedasticity-robust. *, ** and *** reflect p<0.01, p<0.05 and p<0.10.

The estimated price differentials are reported in the table 8 and figure 2, relative to Germany, for global molecules. Price differences are significant and large relative to Germany, also much larger relative to Spain (tables A.18 and figure B.17). All countries price differences are decreasing at increasing rates. In 2003, Spain has the highest price differences for all the years, representing the lowest priced country, relative to Germany.

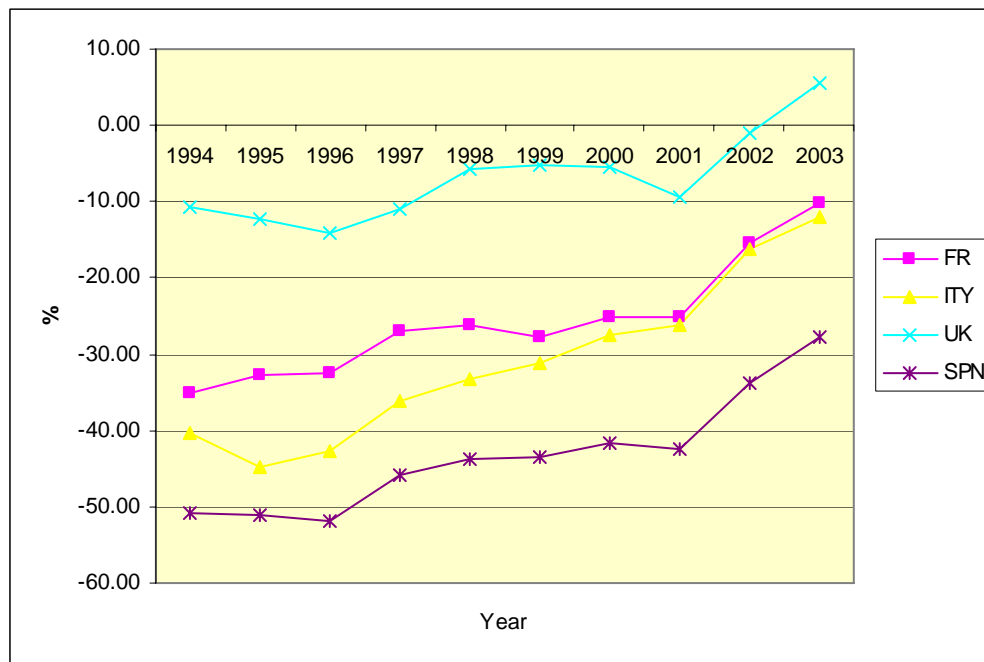
Table 8
**Quality Adjusted (by RE) Standard Unit Price Differentials for Global Molecules,
 Relative to Germany ^a**

Year	Germany	France	Italy	United Kingdom	Spain
1994	-	-35.18%	-40.37%	-10.63%	-50.84%
1995	1.26%	-31.41%	-43.44%	-11.15%	-49.78%
1996	2.87%	-29.62%	-39.71%	-11.38%	-48.88%
1997	0.60%	-26.35%	-35.67%	-10.43%	-45.12%
1998	0.52%	-25.71%	-32.66%	-5.08%	-43.25%
1999	1.79%	-26.03%	-29.49%	-3.36%	-41.80%
2000	1.01%	-24.19%	-26.46%	-4.53%	-40.75%
2001	1.69%	-23.48%	-24.38%	-7.61%	-40.76%
2002	-3.26%	-18.58%	-19.43%	-4.36%	-37.02%
2003	-6.32%	-16.39%	-18.32%	-0.82%	-34.03%

Not surprising results are obtained when price differentials are observed relative to Spain. Price difference decreases from 82% (1994) to 25% (2003) in the UK, where it decreases from 103% (1994) to 26% (2003) in Germany. Italy and France are -2% and 1% higher priced than Spain in 2003. Again, price differences decrease at increasing rates relative to Spain over the sample time period.

^a These are the coefficients of country/time effects ($\theta_{j,i}$) in the random effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

Figure 2
**Quality Adjusted (by RE) Standard Unit Price Differentials for Global Molecules,
 Relative to Germany^a**



Fixed effect model price differences for global molecules are reported in tables A.19 and A. 20 and figure B.18, with similar results. Moreover, the same models are estimated without year and country indicators. The quality adjusted prices, i.e. the residuals, from these latter models are used to form the dependent variable in the price convergence equations for global molecules.

5.3 Price Convergence Results

This section shows the price convergence results. The regression coefficients provide estimates of the speed of the convergence to the law of one price, which indicates how quickly deviations from long term price differentials are eliminated.

^a Normalized to Germany.

Table 9 reports estimation results with Spain and Germany as base countries. The Hausman test rejects the null hypothesis of fixed and random effects equivalence, thus fixed effects models are used to form the dependent variables for the convergence equations. The results are robust for zero, one and two lags, in addition to Campbell and Perron (1992) top down approach, with the latter reported in the tables.

Model 1 does not include molecule/country fixed effects and thus tests for convergence to the absolute version of the law of one price. The null hypothesis is that the price differences converge toward zero in the long run, i.e. $\beta < 0$. The β coefficient is negative in the specification where Germany is the base country, with implied half-life of a shock, i.e. $-\ln(2)/\ln(1+\beta)$, of 34.3 years. This half-life of 34.3 years is longer than the typical life cycle of a drug and provides of little, if any evidence of convergence. When Spain is the base country, the β coefficient is positive, indicating that there is no evidence of the absolute version of law of one price holding. The positive sign of the coefficient actually implies persistent price divergence. The results are mostly consistent with the international trade literature.

Table 9
**Results for Price Convergence Estimations for All Molecules
(Adjusted by FE)**

	Model 1		Model 2	
	Base: SPN	Base: GR	Base: SPN	Base: GR
Dependent Variable: $\Delta P_{i,k,t}$				
β^a	0.01	-0.02	-0.18	-0.17
Half-life of Shock (in years)	-	34.3	3.5	4.4
FR ^b	-	-	0.02	0.01
GR ^b	-	-	0.08	-
UK ^b	-	-	0.15	0.00
SPN ^b	-	-	-	-0.08
ITY ^b	-	-	0.06	-0.08
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1) ^c	Yes ^d	Yes ^d
t-star	8.89	-19.25	-8.39	-8.34
P>t	1.000	0.000	0.000	0.000
Molecule/Country Fixed Effects	No	No	Yes	Yes
Time Trend	No	No	No	No
N	2,940	3,210	2,940	3,210

Model 2 tests the relative version of the law of one price and finds estimated β ranges between -0.17 and -0.18 . Based on the adjusted t statistics (t-star) values, the unit root hypothesis is rejected, signifying significant evidence of price convergence. The implied half-lives of shocks, according to these β estimates, are between 3.5 and 4.4 years. These half-lives are longer than found in the recent international trade literature (Goldberg and Verboven 2005).

^a β coefficients are estimated by the Levin et al. (2002) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by the Augmented Dickey Fuller regressions in StataTM 9.2 (dfuller) and then averaged for each country.

^c The average number of lags for each molecule/country is 1.

^d The number of lags is determined by using the Campbell and Perron top-down approach.

The $\alpha_{i,k}$ in model 2 captures molecule country fixed effects that account for non-time dependent, molecule specific price differences across countries. Such effects could include transportation costs, unobserved quality differences that vary by destination, or markup differences. The presence of molecule/country fixed effects in the estimations implies testing the relative version of law of one price. The average molecule/country specific fixed effects are displayed in table 9. These large values of molecule/country fixed effects indicate market segmentation even if the relative version of law of one price holds in the data, consistent with other studies in the literature. By dividing the fixed effects by $-\beta$, long-term systematic price differences relative to Spain of 83% for the UK, 33% for Italy, 11% for France, and 44% for Germany are obtained. When Germany is the base country, long term price differentials are 6% for France, 0% for the UK, and -47% for Spain and Italy.

Similar convergence coefficients are obtained for both the absolute and the relative version of law of one price, using prices from random effect models (table A.21). Slightly smaller molecule/country price differentials emerge, which are higher than Spain by 11% for France, 47% for Germany, 53% for the UK and 37% for Italy, and lower than Germany by 50% for Spain, 39% for Italy, 0% for France and the United Kingdom. In addition, all specifications are also estimated using model 3, which includes a time trend. The expected results, that the deviations from the long term differences are eliminated in approximately a year, are obtained. This is shorter than without the time trend in model 2, but the long term price differences remain about the same.

In addition, the same hypotheses are tested for unadjusted prices. In this case, model 3, which includes a time trend, is also reported in the tables for comparison

purposes. Table A.22 reports the results for the three models. The results remain robust for the absolute version of the law of one price. In model 2, the estimated rates of convergence are very similar to the adjusted price estimates, but molecule/country fixed effects show very high price differences which are expected due to not accounting for quality adjustments.

The random effect quality adjusted price residuals for the globally diffused models are also used to test for price convergence because the Hausman test fails to reject the null hypothesis. Table 10 shows that these results are similar to those from before. Model 1 rejects the hypothesis of a unit root where Germany is the base country and fails to reject the unit root where Spain is the base. Model 2 shows that β coefficients are negative, showing evidence of price convergence and implied half-lives of shocks of 2.9 and 4.6 years. The long term price differentials are 36% (Germany), 186% (UK), 64% (Italy) and 0% (France) higher than Spain and 24% (Spain) and 38% (Italy) less and 19% (UK) and 33% (France) higher than Germany. The results are similar when prices are formed using the residuals from the fixed effect model (table A.23). Lastly, the same three models are re-estimated for global molecules for unadjusted prices (table A.24). Again, all estimations remain the same but molecule/country fixed effects are larger than adjusted estimation results. In model 2, the long term price differentials are much higher than the previous estimations.

Table 10
**Results for Price Convergence Estimations for
Global Molecules (Adjusted by RE)**

Dependent Variable: $\Delta P_{i,k,t}$	Model 1		Model 2	
	Base: SPN	Base: GR	Base: SPN	Base: GR
β^a	0.01	-0.02	-0.14	-0.21
Half-life of Shock (in years)	-	34.3	4.6	2.9
FR ^b	-	-	0.00	0.07
GR ^b	-	-	0.05	-
UK ^b	-	-	0.26	0.04
SPN ^b	-	-	-	-0.05
ITY ^b	-	-	0.09	-0.08
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1) ^c	Yes ^d	Yes ^d
t-star	11.50	-17.08	-5.71	-12.40
P>t	1.000	0.000	0.000	0.000
Molecule/Country Fixed Effects	No	No	Yes	Yes
Time Trend	No	No	No	No
N	1,900	1,900	1,900	1,900

^a β coefficients are estimated by the Levin et al. (2002) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by the Augmented Dickey Fuller regressions in StataTM 9.2 (dfuller) and then averaged for each country.

^c The average number of lags for each molecule/country is 1.

^d The number of lags is determined by using the Campbell and Perron top-down approach.

Chapter 6

Conclusions

This chapter summarizes the main findings regarding pharmaceutical prices in the European Union. Additionally, limitations and opportunities for future research are discussed.

6.1 Main Findings

This dissertation is the first attempt to investigate the convergence of pharmaceutical prices in the EU. It uses annual panel data from 1994–2003 on molecule level standard unit prices in the five largest pharmaceutical producing countries.

The analysis has three main findings:

1. The first part of the analysis uses weighted price indexes to compare price differences in the data for the selected nations. This approach is one of the suggested methods in the cross country price differences literature in the pharmaceutical industry (Danzon 2000). Using unadjusted per dose prices of bilaterally matching and global molecules, Laspeyres and Paasche indexes show that there are substantial diverse pharmaceutical price differences across EU markets. Bilaterally and using Germany as the base country, the results (tables 1 and figure B.4) indicate that Spain has consistent decreases in prices from -28% (1994) to 0.3% (2003) while the prices increase from the beginning (1994) to the end (2003) of the time period by 7.5% to 41.4% in the UK, 15%

to 35% in France, and -4.3% to 29% in Italy by Laspeyres index. Similar results are obtained when the indexes are calculated in the global molecules (table 2 and figure B.8) such that price differences increase from -23% to 10% in Spain, 7% to 59% in the UK, 8% to 53% in France and -2% to 47% in Italy. When the base country is Spain (tables A.7 and A.8 and figures B.6 and B.10), the results show that prices decrease in Germany, the UK and Italy but increase in France for all molecules; increase in the UK, France and Italy and decrease in Germany for global molecules. Besides the choices of base country and index, these price differences depend on the sample and method used. On their own, these price differences show price divergence across the countries and do not provide evidence of price convergence.

2. Even though the analysis employs molecule level standard unit prices, observed molecule characteristics vary across countries, particularly with regard to drug quality (form availability, pack sizes, strength levels) and market (competition) characteristics. Using quasi hedonic price regressions to control for this variation, price differentials are re-analyzed. The results show stronger evidence of decreasing price differences than those imputed from the index calculations. Price differences in all countries consistently decrease from 1994 and 2003 regardless of the choice of the base country, method and the sample. Price differentials decrease from 32% to 22% in France, 38% to 24% in Italy, 51% to 43% in Spain and -12% to 2.6% in the UK, relative to Germany for all molecules; there are smaller and again consistent decreases for global molecules in the time period of the study (tables 6 and 8, figures 1 and 2). Similar results are obtained relative to Spain (tables A.15 and A.18, figures B.14 and B.17). However,

the price differences across countries still remain substantial even when the observed quality and market characteristics are controlled in the analysis.

3. Controlling for variation in quality and market characteristics across countries, both the absolute and relative versions of the law of one price are tested by employing panel data unit root tests. Price convergence is expected in integrated markets like the European Union, but factors like transportation costs, tax differences and regulatory regimes that vary across countries, might produce fixed country-specific price differences. The relative version of the law of one price states that these price gaps tend to return to some long-run level over time, even if this level is not zero. Despite the fact that the data in this analysis control for observable quality and market characteristics, systematic price differences across countries could persist because of the nature of the pharmaceutical market and differences across countries with regard to demographics, culture and medicine consumption attitudes.

For the absolute version, the half life of a shock is 34 years, indicating very slow convergence. The main interest in this study is not the absolute version of the law of price because it is expected that cross country drug price differences cannot be completely eliminated. Results provide evidence in support of the relative version of the law of one price, which is a narrower definition of price convergence and is the key interest of the study. For the relative version, half lives are between 3 and 5 years. The estimated rates of convergence in the EU pharmaceutical industry are comparatively slower than the rates for analogous studies of different European industries, e.g. half lives of 1.3–1.6 years in the automobile industry. This could be explained by the different

health care systems, pricing and reimbursement regulations by the national governments across countries.

Long term price differentials imputed from the estimated molecule/country fixed effects show price differences across markets between 0% and 40% for countries other than the UK, providing evidence of market segmentation. Possible sources of the larger long term price differences between the UK and other countries include the fact that the UK is not a member of the “euro zone”, transportation costs (e.g. the UK is not contiguous like the other nations) and other different policies by the UK government. According to Kotzian (2004), the reason for these price differences could be the political arena in the EU: some governments grant high prices for newly introduced products to encourage therapeutic innovations, others set a very low price due to health care budget concerns.

This study contributes new results to the existing literature on European integration and pharmaceutical price convergence. The results show that even though the pharmaceutical industry is one of the most heavily regulated markets with divergent methods (tables A.1-A.3) in the EU and there are no legislative actions by the European Commission for the pharmaceutical industry toward a single market, price differences across countries do converge over time, albeit relatively slowly, conditional on the molecule/country fixed effects. Although price differences still exist, progress toward the single pharmaceutical market is evident. One of the possible explanations of finding the evidence of price convergence could be parallel import. However, this study does not test the direct impact of the parallel import on price convergence which also is not the scope of this dissertation. However, Ganslandt and Maskus (2004) analyzed the direct

impact of parallel imports on drug prices in Sweden, and concluded that parallel imports represented a significant form of competition in markets and reduced manufacturing prices by 12–19%. Another possible explanation could be international reference pricing that create spillover of price levels from one country to another.

The unique molecule level data set in this dissertation includes branded drugs along with generics, licensed, OTCs and parallel imports, and allows controlling for quality and market characteristics. The empirical results not only demonstrate consistent decrease in the prices overall but also provide evidence of relative price convergence in the pharmaceutical industry. As it is emphasized by the European Commission that there is no reason to exempt pharmaceuticals from the single market ideal.

Finally, this study attempts to be the first detailed empirical investigation of the drug price convergence in the EU.

6.2 Limitations

This research has several limitations that should be noted. First, the data set analyzed in this study spans only ten years. Several other studies in the literature use periods of similar length, but as with all time series, a longer series would permit a stronger test of the price convergence hypothesis. It would also allow for testing whether molecule/country effects are declining over time and if the speed of convergence has changed over time.

Second, the data set is based on bilaterally and globally matched samples of molecule/ATC3 criteria that failed to match nearly 50% of the total retail sales observations. Therefore, even the price indexes may be unavoidably biased by selection.

Third, quality and market characteristics are based on the measurability of variables in the data set. A better market characteristic variable, such as an “index” variable compiling all the different regulations and reimbursements in different countries, might be created in order to better capture the differences in prices.

Fourth, since IMS fixed euro standard unit prices are used to flatten exchange rate fluctuations, the role of exchange rate changes must be investigated separately.

Fifth, the data include all formations of the drugs including brand, OTC, parallel imports, etc. Because the structure of the data and variables, it is not possible to determine if the evidence of the price convergence is due to parallel importing or the alignment of government politics.

Lastly, of the 25 members of the European Union only the largest five members are part of this study.

6.3 Future Research

Future research should address several of the limitations mentioned above. The data should extend to more years, including exchange rates, and other quality and market characteristics to capture price differences. In particular, further research should investigate whether molecule/country effects are declining over time along with the investigation of the speed of convergence.

As a follow up, data from this dissertation should employ a similar analysis but match data by molecule/ATC4 category, product level under the same ATC and international product name (IPN). IMS assigns drugs the same IPN that have two of the following: same chemical compositions, same brand name, or same corporation.

The effect of price regulations (mostly demand-side regulations) on consumption patterns in relationship to the price convergence is an important topic for further research due to various cultural and consumption attitudes across countries.

Even though the European Commission has never proposed any common policy for the EU pharmaceuticals, only recommendations, it should be investigated if the European Commission, the G10 Medicine Group or the establishment of the EMEA in 1995 has had any impact on price convergence. In addition, because of the standardization in packaging and labeling, it is expected that there will be an increase in parallel importing and therefore an impact on the price convergence. This could be another area of future research.

Tables A.1-A.3 show all the different regulations across countries on both the demand and the supply side. It should be investigated if the penguin effect has resulted in any convergence of regulations in the EU pharmaceutical industry.

It is expected that parallel imports will impact price differences. Ganslandt and Maskus (2004) developed a theoretical model and also empirically tested whether parallel import reduced the price differences. As a follow up of this work, the theoretical work could be extended to the impact of the parallel import on the relative version of the law of one price and half life of a shock in the regulated markets. Moreover, a detail investigation of the determinants of price convergence in the EU pharmaceutical industry is subject to future research.

Finally, continued research in this area would give a better understanding of the relationship between market integration and price convergence in the pharmaceutical

industry in the EU. This dissertation represents a preliminary investigation of this subject; however it does seem to be very open area for future research.

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Appendices

Appendix A: Tables

Table A.1
National Controls for Pharmaceuticals on the Supply-Side

COUNTRY:	NATIONAL HEALTH SYSTEMS: *	PRICING:	REIMBURSEMENT:
Germany	GKV, statutory health insurance covers 88% of the population. Most of the remaining population had private insurance.	Price freedom for new products	<ul style="list-style-type: none"> a) Reference price for off-patent sector (products subjected to generic competition; reference price for identical molecule only) b) Drug budgets with caps re-introduced in 1999. c) Negative list d) Positive list
UK	The National Health Service since 1948 financed through central government.	<ul style="list-style-type: none"> a) PPRS: Agreement with industry on profit control, renewed in 1999 for a five-year period b) Price cut, as part of PPRS, of 4.5% c) Free price modulation by 2001. 	<ul style="list-style-type: none"> a) Negative List b) Homogeneous budget given to PCGs c) Practice guidelines d) Guidance on cost-effectiveness by NICE, influences prescribing
France	Universally covered (99% of the population) by statutory health insurance.	<ul style="list-style-type: none"> a) Price fixing through negotiation (product's medical value, prices of comparable medicines, volume sales and conditions used) b) Comparisons with other European Countries for "innovative" products c) Periodic price reductions for new and expensive products d) Price freedom has been introduced since 2003** 	<ul style="list-style-type: none"> a) Comite Economique du Medicament decides on reimbursable prices on advice from Transparency committee b) Positive List c) Medical References d) Targets for "gate-keeping" GP e) Pharmacoeconomic guidelines under development f) Prices of generics 30% lower than those of the original
Italy	SSN: National Health Service. Funds are supplemented by local taxes and health service charges.	<ul style="list-style-type: none"> a) Average European Price (all EU countries) for "old" products and products registered with the national procedure; AEP is calculated on ex-manufacturer's price (excl. VAT), of top five selling equivalents, including generics. b) Price negotiation (contractual model) for new and innovative products (for drugs registered with EMEA or for those for which AEP cannot be calculated) c) Price freedom for non-reimbursable drugs d) Generics are priced at least 20% below the original e) Frequent use of price cuts/freezes 	<ul style="list-style-type: none"> a) Positive list b) Reference listing and same prices for same drugs' principle for off-patent drugs c) Formal requirement for economic evaluation during price negotiations d) Guidelines and protocols defined and managed at local level e) Official earmarked budget for innovative drugs introduced in 1998, representing 1% of national drug budget
Spain	The National statutory health insurance	<ul style="list-style-type: none"> a) Price control through negotiation on a cost-plus basis b) International price comparisons c) Price-volume agreement for expensive products 	<ul style="list-style-type: none"> a) Positive list b) Negative list c) Reference pricing for estimating maximum reimbursement for multi-source products

Adapted from (Kanavos 2001)

* Compiled from (Seget 2003), (Blachier and Kanavos), (Jommi), (Kullman), (Mossialos et al. 2004), ** Added from (Mossialos et al. 2004)

Table A.2
**Summary of Approaches in the Regulation of Pharmaceutical Prices
 by On-Patent and Off-Patent Drugs (2003)**

Countries:	Market segment	Free Pricing	Direct Price Controls	Use of international price comparisons	Profit Controls	Reference Pricing
France	On-patent		X	X		
	Off-patent					X
Germany	On-patent	X				
	On-patent					X
Italy	On-patent		X	X		
	Off-patent					X
Spain	On-patent		X	X		
	Off-patent			X		X
UK	On-patent	X			X	
	Off-patent		X			

Adapted from (Mossialos et al. 2004)

Table A.3

Demand-Side Policies (Prescribing, Dispensing and Consumption) in the Member States

Country:	Positive List	Negative List	Budget	Guidelines / Monitoring	Generic Prescribing	Substitution	Incentives	Co-payment
France	Yes	No	Yes	Yes	Yes (limited-gatekeepers)	Yes	Yes (gatekeepers)	%
Germany	No (but planned)	Yes	Yes	Yes	Yes	Yes	Yes	Flat Fee
Italy	Yes	No	Yes	Yes	No	Yes	No	% + flat fee
Spain	Yes	Yes	No	Yes	Yes (limited)	No	No	% up to a max per item
UK	No	Yes	Yes	Yes	Yes (limited)	No	Yes	Flat

Adapted from (Kanavos 2001)

Table A.4

ATC Therapeutic Categories for Cardiovascular Disease

ATC Code	Category Name
C1A	Cardiac Glycosides and Combinations
C2A	Antihypertensives (of non-herbal origin) Plain: It includes plain antihypertensives and combinations other than those with diuretics, eg combinations of two synthetic antihypertensives or combinations of one synthetic antihypertensive with reserpine.
C3A	Diuretics: Combinations with potassium belong to C3A1, C3A2 or C3A3.
C4A	Cerebral and Peripheral Vasotherapeutics: This group includes all products (including citicoline) which are mainly recommend for cerebral vascular diseases or peripheral circulatory disorders excluding venous diseases. Combination products are only classified in this group if they do not belong to group C1-C3, C7-C11.
C7A	Beta-Blocking Agents, Plain: Includes, eg acebutolol, alprenolol, amosulalol, arotinol, atenolol, befunolol, betaxolol, bevantolol, bisoprolol, bopindolol, bucumolol, bufetolol, bunitrolol, bupranolol, butofilolol, carazolol, carteolol, carvedilol, celiprolol, cloranolol, dilevalol, esmolol, indenolol, labetolol, levobunolol, mepindolol, metipranolol, metoprolol, nadolol, nifenalol, nipradilol, oxprenolol, penbutolol, pindolol, practolol, propranolol, sotalol, tertanolol, tilisolol, timolol, toliprolol.
C8A	Calcium Antagonists, Plain
C9A	Ace Inhibitors, Plain : Angiotensin-Converting-Enzyme inhibitors. It includes eg alacepril, benazepril, captopril, cilazepril, delapril, enalapril, fosinopril, imidapril, lisinopril, moexipril, perindopril, quinapril, ramipril, spirapril, temocapril, trandolapril.
C10A	Cholesterol and Triglyceride Regulating Preparations: Includes all products regulating cholesterol and triglycerides only. Combinations with products of group C4 should be classified here.

Adopted from (Jacobzone 2000)

Table A.5
Largest Pharmaceutical Markets in the World,
National Currency (million), growth: US\$, NC

Rank 03	Country	2000			2001			2002			2003		
		Mill NC	+(S)	+NC	Mill NC	+(S)	+NC	Mill NC	+(S)	+NC	Mill NC	+(S)	+NC
1	USA	150,952	14	14	176,748	17	17	197,602	12	12	219,522	11	11
2	Japan	6,231,585	8	2	6,502,706	-7	4	6,603,811	-2	2	7,059,335	12	7
3	Germany	18,157	-8	6	19,921	7	10	21,515	14	8	24,631	30	14
4	France	18,111	-6	9	19,418	4	7	20,183	9	4	22,583	27	12
5	Italy	11,990	-1	15	13,441	9	12	14,136	11	5	15,592	25	10
6	United Kingdom	7,380	0	7	8,180	5	11	9,111	16	11	10,386	20	14
7	Spain	7,711	2	18	8,349	5	8	9,174	16	10	10,794	34	18
13	Australia	5,452	0	11	6,227	2	14	6,854	16	10	8,088	30	18
17	Belgium	2,722	-7	8	2,862	2	5	3,049	12	7	3,521	31	15
18	Poland	11,013	12	22	11,913	15	8	12,373	4	4	14,407	18	16
19	Greece	1,504	-1	19	1,805	15	20	2,281	33	26	2,898	44	27
20	Sweden	19,690	0	11	21,051	-5	7	22,737	15	8	24,711	22	9
21	Switzerland	2,971	-4	8	3,279	10	10	3,517	16	7	3,926	26	12
23	Austria	1,766	-9	6	1,864	3	6	2,038	15	9	2,284	27	12
24	Portugal	1,702	-6	8	1,848	5	9	1,998	14	8	2,183	24	9
29	Finland	1,071	-5	10	1,201	9	12	1,330	17	11	1,491	27	12
33	Denmark	7,105	-5	10	7,782	6	10	8,799	19	13	9,762	26	11
35	Norway	6,945	-3	9	7,742	9	11	8,912	30	15	9,384	16	5
36	Czeck Republic	28,254	0	11	29,896	7	6	32,763	27	10	38,138	29	16

Adapted from (Pammolli et al. 2004)

Table A.6

Balanced Sample ATC/Molecule and Country Availability for 1994-2003

ATC	Molecule	Country Availability	Global Molecule
C7A	Acebutolol	FR,GR,ITY,SPN,UK	X
C10A	Acipimox	GR,UK	
C4A	Alprostadil Alfadex	GR	
C3A	Amiloride	FR, UK	
C8A	Amlodipine	FR,GR,ITY,SPN,UK	X
C7A	Atenolol	FR,GR,ITY,SPN,UK	X
C3A	Azosemide	GR	
C9A	Benazepril	FR,GR,ITY,SPN	
C4A	Bencyclane	GR	
C3A	Bendroflumethiazide	UK	
C10A	Benfluorex	FR,ITY,SPN	
C8A	Bepidil	FR	
C7A	Betaxolol	FR, GR, ITY, UK	
C10A	Bezafibrate	FR,GR,ITY,SPN,UK	X
C7A	Bisoprolol	FR,GR,ITY,SPN,UK	X
C4A	Blood	GR	
C4A	Buflomedil	FR,GR,ITY,SPN	
C3A	Bumetanide	FR, SPN,UK	
C2A	Bunazosin	GR	
C2A	Cadralazine	ITY	
C3A	Canrenoic Acid	FR,GR,ITY	
C9A	Captopril	FR,GR,ITY,SPN,UK	X
C7A	Carteolol	FR,GR,SPN	
C7A	Carvedilol	GR,ITY,SPN, UK	
C7A	Celiprolol	FR,GR, SPN, UK	
C3A	Chlortalidone	GR,ITY, SPN, UK	
C2A	Cicletanine	FR,GR	
C9A	Cilazapril	FR,GR,ITY,SPN,UK	X
C4A	Cinnarizine	GR,ITY,SPN,UK	
C10A	Ciprofibrate	FR,UK	
C4A	Citicoline	ITY,SPN	
C2A	Clonidine	FR,GR,ITY,SPN,UK	X
C3A	Clopamide	GR	
C10A	Colestipol	GR,SPN,UK	
C10A	Colestyramine	FR,GR,ITY,SPN,UK	X
C4A	Cyclandelate	FR,GR,ITY	
C1A	Digitoxin	GR,SPN	
C1A	Digoxin	FR,GR,ITY,SPN,UK	X
C2A	Dihydralazine	GR	
C4A	Dihydroergocristine	GR, ITY,SPN	
C4A	Dihydroergotoxine	FR,GR,ITY,SPN,UK	X
C8A	Diltiazem	FR,GR,ITY,SPN,UK	X
C2A	Doxazosin	GR,ITY,SPN, UK	

Table A.6 (Continued)

Balanced Sample ATC/Molecule and Country Availability for 1994-2003

ATC	Molecule	Country Availability (1993-2003 Period)	Global Molecule
C9A	Enalapril	FR,GR,ITY,SPN,UK	X
C7A	Esmolol	GR,SPN	
C10A	Etofibrate	GR	
C10A	Etofylline Clofibrate	GR	
C8A	Felodipine	FR,GR,ITY,SPN,UK	X
C10A	Fenofibrate	FR,GR,ITY,SPN,UK	X
C4A	Flunarizine	ITY	
C10A	Fluvastatin	GR,SPN	
C9A	Fosinopril	GR,ITY, SPN, UK	
C3A	Furosemide	FR,GR,ITY,SPN,UK	X
C8A	Gallopamil	GR,ITY	
C10A	Gemfibrozil	FR,GR,ITY,SPN,UK	X
C4A	Ginkgo Biloba	FR,GR,SPN	
C4A	Glycosaminoglycan Polysulfate(S)	ITY	
C2A	Guanfacine	FR	
C2A	Hydralazine	SPN,UK	
C3A	Hydrochlorothiazide	FR,GR,ITY,SPN,UK	X
C4A	Ifenprodil	GR	
C3A	Indapamide	FR,GR,ITY,SPN,UK	X
C2A	Indoramin	GR,UK	
C8A	Isradipine	FR,GR,ITY,UK	
C4A	Kallidinogenase	GR	
C2A	Ketanserin	ITY	
C7A	Labetalol	FR, ITY, SPN,UK	
C8A	Lacidipine	FR,ITY, SPN,UK	
C9A	Lisinopril	FR,GR,ITY,SPN,UK	X
C10A	Lovastatin	GR, SPN	
C7A	Mepindolol	GR	
C2A	Methyldopa	FR,GR,ITY,SPN,UK	X
C1A	Metildigoxin	GR, ITY,SPN	
C3A	Metolazone	GR, ITY,UK	
C7A	Metoprolol	FR,GR,ITY,SPN,UK	X
C2A	Minoxidil	FR,GR,ITY,SPN,UK	X
C4A	Moxisylyte	FR,UK	
C2A	Moxonidine	GR	
C7A	Nadolol	FR,GR,ITY,SPN,UK	X
C4A	Naftidrofuryl	FR,GR,ITY,SPN,UK	X
C8A	Nicardipine	FR,GR,ITY,SPN,UK	X
C4A	Nicergoline	FR, GR,ITY,SPN	
C8A	Nifedipine	FR,GR,ITY,SPN,UK	X
C8A	Nilvadipine	GR	
C4A	Nimodipine	GR,ITY,SPN,UK	

Table A.6 (Continued)

Final Balanced Sample ATC/Molecule and Country Availability for 1994-2003

ATC	Molecule	Country Availability (1993-2003 Period)	Global Molecule
C8A	Nisoldipine	GR,ITY,SPN	
C8A	Nitrendipine	FR,GR,ITY,SPN	
C7A	Oxprenolol	FR,GR,SPN,UK	
C10A	Pantethine	ITY,SPN	
C7A	Penbutolol	GR	
C4A	Pentoxifylline	FR,GR,ITY,SPN,UK	X
C9A	Perindopril	FR,GR,ITY,SPN,UK	X
C4A	Phenoxybenzamine	GR	
C4A	Phentolamine	UK	
C7A	Pindolol	FR,GR,ITY,UK	
C3A	Piretanide	FR,GR,ITY,SPN	
C4A	Piribedil	GR,ITY	
C10A	Pravastatin	FR,GR,ITY,SPN,UK	X
C2A	Prazosin	FR,GR,SPN,UK	
C10A	Probucol	SPN	
C7A	Propranolol	FR,GR,ITY,SPN,UK	X
C9A	Quinapril	FR,GR,ITY,SPN,UK	X
C9A	Ramipril	FR,GR,ITY,SPN,UK	X
C2A	Rilmenidine	FR	
C10A	Simvastatin	FR,GR,ITY,SPN,UK	X
C7A	Sotalol	FR,GR,ITY,SPN,UK	X
C3A	Spirolactone	FR,GR,ITY,SPN,UK	X
C7A	Talinolol	GR	
C2A	Terazosin	GR,ITY,UK	
C7A	Tertatolol	FR	
C7A	Timolol	FR,ITY,UK	
C3A	Torasemide	GR,ITY,UK	
C9A	Trandolapril	FR,GR,SPN,UK	
C3A	Triamterene	UK	
C2A	Urapidil	FR,GR,ITY	
C8A	Verapamil	FR,GR,ITY,SPN,UK	X
C4A	Vincamine	FR,GR,ITY,SPN	
C3A	Xipamide	FR,GR,ITY,SPN,UK	X
Summary of Data Set by ATC, Molecule, Country and Global Molecules			
C1A=3 C2A=17 C3A=16 C4A=16 C7A=20 C8A=13 C9A=10 C10A=16	<u>Total Molecules: 118</u>	<u>Country Totals:</u> FR = 70 GR =94 ITY =75 SPN=69 <u>UK =71</u> Σ=379	<u>Total Global Molecules: 38</u> C1A=1 C2A=3 C3A=5 C4A=3 C7A=7 C8A=6 C9A=7 C10A=6

Table A.7
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Spain

Index Measures	1994				1995				1996			
	GR	FR	UK	ITY	GR	FR	UK	ITY	GR	FR	UK	ITY
Number of ATC/Molecule Matching	81	63	71	82	78	62	67	78	78	65	68	79
Laspeyres Price Index (SPN weighted)	1.3851	1.3798	1.3284	1.4659	1.3104	1.3779	1.3303	1.3032	1.2570	1.3663	1.3253	1.3245
Paasche Price Index (Own weighted)	1.3797	1.2787	1.4740	1.3244	1.2941	1.2517	1.4795	1.1753	1.2323	1.2400	1.4615	1.2126
Laspeyres Quantity Index	2.3118	1.1846	2.5719	1.4422	2.3050	1.2043	2.3777	1.4065	2.3753	1.2605	2.2487	1.3634
Paasche Quantity Index	2.3029	1.0979	2.8538	1.3030	2.2764	1.0940	2.6444	1.2684	2.3287	1.1439	2.4797	1.2482
Normalized Laspeyres Quantity Index by Relative Population Size	4.7912	1.7442	3.7724	2.0888	4.7770	1.7737	3.4903	2.0323	4.9286	1.8571	3.3041	1.9655
Normalized Paasche Quantity Index by Relative Population Size	4.7727	1.6165	4.1859	1.8872	4.7178	1.6112	3.8817	1.8327	4.8319	1.6853	3.6435	1.7995
Population Ratio (Comparison/SPN)	2.0725	1.4724	1.4667	1.4484	2.0725	1.4728	1.4679	1.4449	2.0750	1.4733	1.4693	1.4417
$P_p/L_p = P_q/L_q$	0.9961	0.9268	1.1096	0.9035	0.9876	0.9084	1.1122	0.9018	0.9804	0.9075	1.1027	0.9155
r	-0.0007	-0.1296	0.0502	-0.0492	-0.0003	-0.2261	0.1227	-0.1022	-0.0090	-0.2202	0.0473	-0.0879
V_p	0.6560	0.3607	0.4627	0.8024	0.6686	0.3707	0.4238	0.8001	0.6694	0.3709	0.4013	0.7553
V_q	8.0652	1.5659	4.7176	2.4459	68.146	1.0926	2.1567	1.2005	3.2668	1.1321	5.4115	1.2731
$r.V_p.V_q$	-0.0039	-0.0732	0.1096	-0.0965	-0.0124	-0.0916	0.1122	-0.0982	-0.0196	-0.0925	0.1027	-0.0845

Table A.7 (Continued)
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Spain

Index Measures	1997				1998				1999			
	GR	FR	UK	ITY	GR	FR	UK	ITY	GR	FR	UK	ITY
Number of ATC/Molecule Matching	77	65	68	74	78	69	68	75	77	66	66	73
Laspeyres Price Index (SPN weighted)	1.1929	1.3553	1.3137	1.3165	1.1559	1.3937	1.2885	1.2978	1.1565	1.4089	1.2701	1.3178
Paasche Price Index (Own weighted)	1.1423	1.2391	1.4314	1.2074	1.0924	1.2606	1.3847	1.2032	1.0748	1.3154	1.3463	1.2239
Laspeyres Quantity Index	2.3843	1.2934	2.1498	1.2633	2.3024	1.3120	2.0025	1.2147	2.2541	1.3322	1.9368	1.2151
Paasche Quantity Index	2.2831	1.1825	2.3424	1.1586	2.1758	1.1867	2.1520	1.1261	2.0949	1.2438	2.0531	1.1285
Normalized Laspeyres Quantity Index by Relative Population Size	4.9471	1.9057	3.1610	1.8180	4.7662	1.9327	2.0366	1.7273	4.6459	1.9607	2.8465	1.7375
Normalized Paasche Quantity Index by Relative Population Size	4.7374	1.7423	3.4442	1.6673	4.5042	1.7481	3.1650	1.6167	4.3177	1.8306	3.0174	1.6137
Population Ratio (Comparison/SPN)	2.0749	1.4735	1.4703	1.4391	2.0701	1.4731	1.4707	1.4356	2.0611	1.4717	1.4697	1.4299
$P_p/L_p = P_q/L_q$	0.9576	0.9143	1.0896	0.9171	0.9450	0.9045	1.0746	0.9271	0.9294	0.9336	1.0600	0.9288
r	-0.0222	-0.0933	0.0456	-0.1073	-0.0398	-0.1098	0.0302	-0.0207	-0.0413	-0.0991	0.0741	-0.0143
V_p	0.6367	0.3640	0.3832	0.6963	0.5776	0.3860	0.3487	0.6146	0.5245	0.3573	0.3166	0.5521
V_q	2.9994	2.5251	5.1234	1.1090	2.3900	2.2530	7.0822	5.7195	3.2576	1.8747	2.5596	8.9937
$r.V_p.V_q$	-0.0424	-0.0857	0.0896	-0.0829	-0.0550	-0.0955	0.0746	-0.0729	-0.0706	-0.0664	0.0600	-0.0712

Table A.7 (Continued)
Pharmaceutical Price and Quantity Indexes for All Molecules, Relative to Spain

Index Measures	2000				2001				2002			
	GR	FR	UK	ITY	GR	FR	UK	ITY	GR	FR	UK	ITY
Number of ATC/Molecule Matching	78	65	64	72	76	63	65	70	74	63	62	69
Laspeyres Price Index (SPN weighted)	1.1759	1.4349	1.2938	1.3770	1.2274	1.4384	1.2964	1.3824	1.1980	1.4492	1.2680	1.3870
Paasche Price Index (Own weighted)	1.0767	1.3567	1.3402	1.2773	1.1141	1.3513	1.3029	1.2768	1.0671	1.3633	1.2643	1.2938
Laspeyres Quantity Index	2.2703	1.3576	1.9679	1.2270	2.3042	1.4704	1.9692	1.2806	2.3495	1.5478	1.8747	1.2126
Paasche Quantity Index	2.0787	1.2836	2.0385	1.1382	2.0916	1.3814	1.9789	1.1827	2.0927	1.4560	1.8693	1.1312
Normalized Laspeyres Quantity Index by Relative Population Size	4.6576	1.9927	2.8891	1.7441	4.6828	2.1433	2.8773	1.8023	4.7283	2.2374	2.7230	1.6872
Normalized Paasche Quantity Index by Relative Population Size	4.2646	1.8840	2.9927	1.6179	4.2508	2.0136	2.8915	1.6645	4.2116	2.1047	2.7151	1.5738
Population Ratio (Comparison/SPN)	2.0515	1.4678	1.4681	1.4215	2.0323	1.4576	1.4612	1.4074	2.0125	1.4456	1.4525	1.3913
$P_p/L_p = P_q/L_q$	0.9156	0.9455	1.0359	0.9276	0.9077	0.9395	1.0050	0.9236	0.8907	0.9407	0.9971	0.9328
r	-0.0539	-0.1530	0.0530	-0.1562	-0.0983	-0.1670	0.0061	-0.1786	-0.1061	-0.1698	-0.0034	-0.1665
V_p	0.5106	0.3418	0.2980	0.4875	0.4550	0.3450	0.3394	0.4594	0.4513	0.3367	0.3591	0.4283
V_q	3.0649	1.0428	2.2700	0.9506	2.0631	1.0508	2.3968	0.9319	2.2818	1.0373	2.3538	0.9425
$r.V_p.V_q$	-0.0844	-0.0545	0.0359	-0.0724	-0.0923	-0.0605	0.0050	-0.0764	-0.1093	-0.0593	-0.0029	-0.0672

Table A.7 (Continued)
**Pharmaceutical Price and Quantity Indexes
for All Molecules, Relative to Spain**

Index Measures	2003			
	GR	FR	UK	ITY
Number of ATC/Molecule Matching	72	61	61	71
Laspeyres Price Index (SPN weighted)	1.0989	1.4487	1.2392	1.3054
Paasche Price Index (Own weighted)	0.9975	1.3730	1.2339	1.1987
Laspeyres Quantity Index	2.4817	1.6173	1.8352	1.2398
Paasche Quantity Index	2.2528	1.5328	1.8275	1.1384
Normalized Laspeyres Quantity Index by Relative Population Size	4.9164	2.3072	2.6365	1.7057
Normalized Paasche Quantity Index by Relative Population Size	4.4628	2.1867	2.6254	1.5663
Population Ratio (Comparison/SPN)	1.9810	1.4266	1.4366	1.3758
$P_p/L_p = P_q/L_q$	0.9077	0.9478	0.9958	0.9183
r	-0.0840	-0.1388	-0.0009	-0.1599
V_p	0.4386	0.3509	0.3353	0.4292
V_q	2.5050	1.0722	14.448	1.1907
$r \cdot V_p \cdot V_q$	-0.0923	-0.0522	-0.0042	-0.0817

Table A.8
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Spain

Index Measures	1994				1995				1996			
	GR	UK	FR	ITY	GR	UK	FR	ITY	GR	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (SPN weighted)	1.2340	1.3125	1.2547	1.2163	1.1609	1.3057	1.2838	1.0890	1.1102	1.3025	1.2958	1.1345
Paasche Price Index (Own weighted)	1.2961	1.2632	1.3138	1.2831	1.2111	1.2342	1.3294	1.1414	1.1427	1.2224	1.3255	1.1800
Laspeyres Quantity Index	2.3180	1.3020	2.3520	1.4253	2.3544	1.3519	2.2150	1.4134	2.4347	1.4448	2.0988	1.3784
Paasche Quantity Index	2.4345	1.2531	2.4627	1.5036	2.4561	1.2779	2.2937	1.4814	2.5060	1.3559	2.1468	1.4337
Normalized Laspeyres Quantity Index by Relative Population Size	4.8040	1.9171	3.4498	2.0643	4.8794	1.9911	3.2514	2.0422	5.0519	2.1286	3.0838	1.9871
Normalized Paasche Quantity Index by Relative Population Size	5.0455	1.8450	3.6121	2.1778	5.0902	1.8821	3.3670	2.1404	5.1998	1.9977	3.1543	2.0669
Population Ratio (Comparison/SPN)	2.0725	1.4724	1.4667	1.4484	2.0725	1.4728	1.4679	1.4449	2.0750	1.4733	1.4693	1.4417
$P_p/L_p = P_q/L_q$	1.0503	0.9624	1.0470	1.0550	1.0432	0.9453	1.0355	1.0481	1.0293	0.9385	1.0229	1.0402
r	0.0698	-0.1073	0.0976	0.2661	0.0615	-0.1625	0.0726	0.2386	0.0385	-0.1885	0.0424	0.1898
V_p	0.3816	0.3611	0.2755	0.3078	0.4081	0.3790	0.2725	0.2993	0.4400	0.3894	0.2915	0.2988
V_q	1.8860	0.9701	1.7490	0.6710	1.7209	0.8893	1.7967	0.6733	1.7273	0.8378	1.8489	0.7081
$r.V_p.V_q$	0.0503	-0.0376	0.0470	0.0550	0.0432	-0.0547	0.0355	0.0481	0.0293	-0.0615	0.0229	0.0402

Table A.8 (Continued)
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Spain

Index Measures	1997				1998				1999			
	GR	UK	FR	ITY	GR	UK	FR	ITY	GR	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (SPN weighted)	1.0546	1.2847	1.2949	1.1479	1.0275	1.3251	1.2857	1.1662	1.0300	1.3596	1.2707	1.2059
Paasche Price Index (Own weighted)	1.0562	1.2171	1.3064	1.1724	1.0209	1.2331	1.2730	1.1778	1.0060	1.2802	1.2474	1.2099
Laspeyres Quantity Index	2.3727	1.4794	2.0031	1.2827	2.2814	1.5418	1.9653	1.2414	2.2590	1.5841	1.8558	1.2458
Paasche Quantity Index	2.3762	1.4015	2.0208	1.3101	2.2667	1.4347	1.9459	1.2537	2.2064	1.4916	1.8218	1.2500
Normalized Laspeyres Quantity Index by Relative Population Size	4.9231	2.1799	2.9452	1.8459	4.7226	2.2713	2.8904	1.6909	4.6561	2.3314	2.7274	1.7814
Normalized Paasche Quantity Index by Relative Population Size	4.9305	2.0651	2.9713	1.8853	4.6922	2.1136	2.8618	1.7999	4.5476	2.1953	2.6775	1.7873
Population Ratio (Comparison/SPN)	2.0749	1.4735	1.4703	1.4391	2.0701	1.4731	1.4707	1.4356	2.0611	1.4717	1.4697	1.4299
$P_p/L_p = P_q/L_q$	1.0015	0.9473	1.0088	1.0213	0.9936	0.9306	0.9901	1.0099	0.9767	0.9416	0.9817	1.0033
r	0.0018	-0.1654	0.0152	0.0938	-0.0071	-0.1966	-0.0164	0.0434	-0.0247	-0.1685	-0.0303	0.0140
V_p	0.4710	0.3857	0.3009	0.2983	0.4592	0.4211	0.2875	0.2782	0.4347	0.3951	0.2702	0.2646
V_q	1.8240	0.8252	1.9343	0.7624	1.9879	0.8386	2.0952	0.8211	2.1714	0.8770	2.2367	0.9004
$r.V_p.V_q$	0.0015	-0.0527	0.0088	0.0213	-0.0064	-0.0694	-0.0099	0.0099	-0.0233	-0.0584	-0.0183	0.0033

Table A.8 (Continued)
Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to Spain

Index Measures	2000				2001				2002			
	GR	UK	FR	ITY	GR	UK	FR	ITY	GR	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38	38	38	38
Laspeyres Price Index (SPN weighted)	1.0231	1.3745	1.2870	1.2717	1.0922	1.3833	1.3311	1.3591	1.0643	1.4404	1.3229	1.3533
Paasche Price Index (Own weighted)	0.9884	1.3077	1.2444	1.2639	1.0380	1.2974	1.2440	1.3193	0.9909	1.3461	1.2277	1.3147
Laspeyres Quantity Index	2.2897	1.5810	1.8399	1.2399	2.3449	1.7193	1.8959	1.2854	2.4456	1.7984	1.8710	1.2391
Paasche Quantity Index	2.2120	1.5041	1.7790	1.2323	2.2286	1.6126	1.7719	1.2477	2.2771	1.6806	1.7363	1.2038
Normalized Laspeyres Quantity Index by Relative Population Size	4.6974	2.3206	2.7011	1.7625	4.7655	2.5061	2.7703	1.8091	4.9217	2.5997	2.7176	1.7240
Normalized Paasche Quantity Index by Relative Population Size	4.5381	2.2078	2.6117	1.7517	4.5292	2.3505	2.5890	1.7560	4.5826	2.4295	2.5220	1.6748
Population Ratio (Comparison/SPN)	2.0515	1.4678	1.4681	1.4215	2.0323	1.4576	1.4612	1.4074	2.0125	1.4456	1.4525	1.3913
$P_p/L_p = P_q/L_q$	0.9661	0.9514	0.9669	0.9939	0.9504	0.9379	0.9346	0.9707	0.9311	0.9345	0.9280	0.9715
r	-0.0337	-0.1378	-0.0520	-0.0264	-0.0552	-0.1665	-0.0847	-0.1164	-0.0715	-0.1786	-0.0811	-0.0964
V_p	0.4524	0.3770	0.2747	0.2510	0.3975	0.3795	0.3389	0.2787	0.4103	0.3652	0.3660	0.3137
V_q	2.2262	0.9358	2.3193	0.9243	2.2585	0.9828	2.2785	0.9036	2.3503	1.0042	2.4245	0.9442
$r.V_p.V_q$	-0.0339	-0.0486	-0.0331	-0.0061	-0.0496	-0.0621	-0.0654	-0.0293	-0.0689	-0.0655	-0.0720	-0.0285

Table A.8 (Continued)
**Pharmaceutical Price and Quantity Indexes
for Global Molecules, Relative to Spain**

Index Measures	2003			
	GR	UK	FR	ITY
Number of ATC/Molecule Matching	38	38	38	38
Laspeyres Price Index (SPN weighted)	0.9443	1.4832	1.3183	1.3119
Paasche Price Index (Own weighted)	0.9107	1.3923	1.2291	1.2507
Laspeyres Quantity Index	2.7505	1.8956	1.8777	1.2621
Paasche Quantity Index	2.6528	1.7794	1.7506	1.2032
Normalized Laspeyres Quantity Index by Relative Population Size	5.4488	2.7043	2.6976	1.7364
Normalized Paasche Quantity Index by Relative Population Size	5.2552	2.5385	2.5150	1.6553
Population Ratio (Comparison/SPN)	1.9810	1.4266	1.4366	1.3758
$P_p/L_p = P_q/L_q$	0.9645	0.9387	0.9323	0.9533
r	-0.0388	-0.1616	-0.0118	-0.1207
V_p	0.3891	0.3522	0.3369	0.3517
V_q	2.3560	1.0771	17.0891	1.1002
$r.V_p.V_q$	-0.0355	-0.0613	-0.0677	-0.0467

Table A.9
**Pharmaceutical Price and Quantity Indexes for All Molecules,
Relative to 1994**

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Germany									
Number of ATC/Molecule Matching	156	152	148	144	143	141	138	135	130
Laspeyres Price Index	0.9742	0.9582	0.9223	0.8931	0.8842	0.8694	0.8691	0.8358	0.7993
Laspeyres Quantity Index	1.0842	1.1919	1.2274	1.2385	1.2652	1.3397	1.4593	1.6497	1.8903
Paasche Price Index	0.9695	0.9406	0.8909	0.8518	0.8330	0.7997	0.7951	0.7405	0.6853
Paasche Quantity Index	1.0790	1.1700	1.1857	1.1812	1.1919	1.2322	1.3351	1.4615	1.6207
United Kingdom									
Number of ATC/Molecule Matching	93	93	92	92	90	87	82	81	81
Laspeyres Price Index	1.0072	1.0075	1.0047	1.0217	1.0819	1.1046	1.0319	1.0225	1.0333
Laspeyres Quantity Index	1.1164	1.2987	1.4457	1.5747	1.7187	1.8432	2.1377	2.4391	2.6650
Paasche Price Index	1.0071	1.0070	1.0097	1.0268	1.0695	1.0749	1.0293	1.0357	1.0485
Paasche Quantity Index	1.1162	1.2981	1.4529	1.5826	1.6990	1.7935	2.1324	2.4705	2.7041
France									
Number of ATC/Molecule Matching	101	99	97	95	92	89	88	85	84
Laspeyres Price Index	1.0221	1.0346	1.0348	1.0306	1.0235	1.0049	0.9910	0.9711	0.9485
Laspeyres Quantity Index	1.0154	1.0206	1.0437	1.0357	1.0197	1.0495	1.0909	1.1269	1.1445
Paasche Price Index	1.0194	1.0248	1.0168	1.0029	0.9849	0.9653	0.9571	0.9405	0.9338
Paasche Quantity Index	1.0126	1.0109	1.0256	1.0078	0.9813	1.0082	1.0536	1.0913	1.1268
Italy									
Number of ATC/Molecule Matching	116	111	104	101	99	97	95	91	88
Laspeyres Price Index	0.9015	0.9497	0.9686	0.9861	1.0162	1.0378	1.0479	1.0274	0.9574
Laspeyres Quantity Index	1.0667	1.1160	1.1118	1.1172	1.1658	1.2233	1.3335	1.3837	1.4648
Paasche Price Index	0.8997	0.9422	0.9511	0.9626	0.9874	1.0067	1.0162	1.0031	0.9387
Paasche Quantity Index	1.0646	1.1072	1.0917	1.0905	1.1326	1.1867	1.2931	1.3510	1.4362

Table A.9 (Continued)
**Pharmaceutical Price and Quantity Indexes for All Molecules,
 Relative to 1994**

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Spain									
Number of ATC/Molecule Matching	100	98	95	94	93	88	86	84	81
Laspeyres Price Index	1.0161	1.0328	1.0516	1.0627	1.0619	1.0385	1.0023	0.9886	0.9924
Laspeyres Quantity Index	1.0950	1.1744	1.2461	1.2762	1.3187	1.3815	1.4652	1.5697	1.6227
Paasche Price Index	1.0145	1.0258	1.0345	1.0342	1.0719	0.9986	0.9632	0.9481	0.9407
Paasche Quantity Index	1.0933	1.1665	1.2258	1.2420	1.3312	1.3284	1.4080	1.5053	1.5383

Table A.10

Pharmaceutical Price and Quantity Indexes for Global Molecules, Relative to 1994

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Number of ATC/Molecule Matching	38	38	38	38	38	38	38	38	38
Germany									
Laspeyres Price Index	0.9609	0.9345	0.8837	0.8549	0.8454	0.8167	0.8084	0.7622	0.7020
Laspeyres Quantity Index	1.0920	1.2154	1.2801	1.2837	1.3281	1.4367	1.6112	1.8680	2.1973
Paasche Price Index	0.9538	0.9104	0.8468	0.8173	0.8070	0.7696	0.7618	0.6967	0.6300
Paasche Quantity Index	1.0840	1.1840	1.2267	1.2272	1.2677	1.3539	1.5184	1.7076	1.9721
United Kingdom									
Laspeyres Price Index	1.0064	1.0075	1.0033	1.0160	1.0995	1.0713	0.9986	0.9876	0.9980
Laspeyres Quantity Index	1.1067	1.2744	1.4106	1.5281	1.6626	1.7569	2.0333	2.3407	2.5819
Paasche Price Index	1.0061	1.0070	1.0086	1.0247	1.0932	1.0504	1.0068	1.0146	1.0319
Paasche Quantity Index	1.1064	1.2738	1.4181	1.5412	1.6531	1.7226	2.0501	2.4048	2.6696
France									
Laspeyres Price Index	1.0282	1.0453	1.0501	1.0455	1.0360	1.0242	1.0208	1.0068	0.9892
Laspeyres Quantity Index	1.0199	1.0388	1.0645	1.0748	1.0550	1.0980	1.1625	1.2273	1.2693
Paasche Price Index	1.0255	1.0358	1.0338	1.0204	1.0061	0.9905	0.9910	0.9773	0.9769
Paasche Quantity Index	1.0172	1.0294	1.0481	1.0490	1.0245	1.0619	1.1286	1.1913	1.2536
Italy									
Laspeyres Price Index	0.9095	0.9602	0.9814	1.0025	1.0380	1.0614	1.0724	1.0427	0.9749
Laspeyres Quantity Index	1.0676	1.1188	1.1151	1.1149	1.1671	1.2357	1.3554	1.4095	1.4925
Paasche Price Index	0.9068	0.9500	0.9580	0.9713	0.9979	1.0179	1.0326	1.0197	0.9601
Paasche Quantity Index	1.0643	1.1069	1.0885	1.0802	1.1220	1.1851	1.3051	1.3783	1.4699
Spain									
Laspeyres Price Index	1.0186	1.0372	1.0574	1.0715	1.0792	1.0578	1.0114	0.9969	0.9928
Laspeyres Quantity Index	1.0795	1.1618	1.2523	1.3038	1.3664	1.4528	1.5588	1.6939	1.7708
Paasche Price Index	1.0167	1.0287	1.0377	1.0389	1.0369	1.0104	0.9683	0.9525	0.9376
Paasche Quantity Index	1.0774	1.1523	1.2289	1.2641	1.3129	1.3877	1.4924	1.6185	1.6724

Table A.11

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country

Country	Germany				France				United Kingdom			
Variable	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD
Suthnds	940	100,061	187,300	67,855	700	97,023	104,881	26,537	710	67,201	126,892	42,091
Leuthnds	940	21,105	33,634	13,395	700	26,278	36,961	12,509	710	17,958	42,364	21,945
Leusuprice	940	0.58	1.79	0.13	700	0.27	0.22	0.02	710	0.54	1.93	0.98
<i>Quality Characteristics</i>												
Strengthg	940	0.15	0.55	0.03	700	0.133	0.48	0.01	710	0.12	0.47	0.13
Molage	940	20.77	12.65	2.87	700	18.9	10.2	2.87	710	21.23	15.28	2.87
Packsizes	940	88.42	27.74	9.25	700	32.26	9.57	3.54	710	88.39	130.71	80.58
Formcode	940	16.66	19.1	4.32	700	3.27	2.98	1.18	710	8.56	9.57	2.72
Globpenet	940	3.79	1.42	0.32	700	4.24	1.15	0.24	710	4.30	1.10	0.29
<i>Market(Competition) Characteristics</i>												
Gencompet	940	9.86	12.03	4.23	700	2.80	3.16	1.84	710	2.42	2.81	0.99
Thsubsmol	940	21.05	7.64	1.50	700	13.94	4.34	1.16	710	13.51	3.82	1.33
Thsubsolentlag	930	20.46	15.45	0.00	700	15.5	9.88	0.00	710	14.97	10.69	0.00

Table 11 (Continued)
Pharmaceutical Drug Quality and Market (Competition) Characteristics by Country

Country	Italy				Spain			
Variable	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD
Suthnds	750	50,636	72,026	19,584	690	43,078	55,333	16,430
Leuthnds	750	15,267	26,607	8,800	690	10,272	17,515	6,619
Leusuprice	750	0.30	0.30	0.05	690	0.21	0.17	0.02
<i>Quality Characteristics</i>								
Strengthg	750	0.14	0.44	0.05	690	0.21	0.76	0.01
Molage	750	18.97	11.04	2.87	690	17.85	10.33	2.87
Packsizes	750	27.89	9.93	2.01	690	40.13	15.09	2.02
Formcode	750	3.49	3.16	1.26	690	3.51	3.58	0.93
Globpenet	750	4.18	1.15	0.18	690	4.43	0.91	0.28
<i>Market(Competition) Characteristics</i>								
Gencompet	750	3.46	3.78	1.28	690	3.82	5.06	2.29
Thsubsmol	750	15.40	4.72	1.52	690	14.16	5.64	1.21
Thsubsolentlag	750	19.21	12.65	0.00	690	17.39	11.45	0.00

Table A.12

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country

Country	Germany				France				United Kingdom			
Variable	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD
Suthnds	380	176,624	232,607	103,012	380	123,465	105,591	30,273	380	100,552	139,457	48,511
Leuthnds	380	35,317	42,138	19,520	380	35,337	44,564	16,444	380	29,019	53,787	28,876
Leusuprice	380	0.29	0.22	0.05	380	0.27	0.19	0.02	380	0.32	0.25	0.05
<i>Quality Characteristics</i>												
Strengthg	380	0.13	0.32	0.05	380	0.19	0.64	0.00	380	0.18	0.64	0.17
Molage	380	21.66	11.81	2.88	380	20.13	10.97	2.88	380	21.13	12.28	2.88
Packsize	380	88.12	15.69	2.23	380	32.84	8.65	1.95	380	102.05	149.72	92.66
Formcode	380	25.79	24.26	6.14	380	4.20	3.55	1.53	380	11.97	11.54	3.43
Globpenet	380	5.00	0.00	0.00	380	5.00	0.00	0.00	380	5.00	0.00	0.00
<i>Market(Competition) Characteristics</i>												
Gencompet	380	16.81	14.90	5.77	380	3.71	3.81	2.25	380	3.19	3.59	1.28
Thsubsmol	380	19.16	6.85	1.44	380	13.63	4.49	1.11	380	12.91	3.71	1.24
Thsubsolentlag	380	14.08	11.57	0.00	380	11.95	8.63	0.00	380	12.97	8.90	0.00

Table A.12 (Continued)
**Pharmaceutical Drug Quality and Market (Competition) Characteristics
for Global Molecules by Country**

Country	Italy				Spain			
Variable	N	Overall Mean	Overall SD	Within SD	N	Overall Mean	Overall SD	Within SD
Suthnds	380	78,600	87,262	24,399	380	59,079	63,228	20,453
Leuthnds	380	22,462	32,826	11,203	380	14,078	21,154	8,419
Leusuprice	380	0.28	0.24	0.05	380	0.21	0.17	0.02
<i>Quality Characteristics</i>								
Strengthg	380	0.19	0.60	0.07	380	0.20	0.64	0.01
Molage	380	20.32	11.47	2.88	380	19.68	11.30	2.88
Packsize	380	27.04	9.77	2.58	380	40.33	11.26	1.74
Formcode	380	3.77	2.96	1.36	380	4.11	4.37	1.13
Globpenet	380	5.00	0.00	0.00	380	5.00	0.00	0.00
<i>Market(Competition) Characteristics</i>								
Gencompet	380	3.95	3.94	1.57	380	4.63	6.21	2.71
Thsubsmol	380	14.48	3.74	1.43	380	13.44	5.40	1.14
Thsubsolentlag	380	14.61	10.09	0.00	380	14.05	10.31	0.00

Table A.13

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: Germany		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	91,341	94,200	97,565	96,550	94,591	94,139	97,388	102,283	110,876	121,675
	St.Dev.	197,718	192,491	189,559	179,558	171,411	166,979	171,646	179,957	199,644	223,877
	N	94	94	94	94	94	94	94	94	94	94
Leusuprice	Mean	0.5818	0.5809	0.5805	0.5719	0.5678	0.5680	0.5805	0.5963	0.5888	0.5838
	St.Dev.	1.7368	1.7368	1.7254	1.7007	1.7019	1.7015	1.8159	1.9337	1.9505	1.9648
	N	94	94	94	94	94	94	94	94	94	94
Leuthnds	Mean	18,819	19,838	21,193	20,701	19,989	20,007	20,372	22,102	23,299	24,727
	St.Dev.	30,386	29,658	30,389	29,043	28,792	29,638	31,483	36,453	41,151	45,850
	N	94	94	94	94	94	94	94	94	94	94
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1418	0.1439	0.1456	0.1474	0.1488	0.1506	0.1520	0.1533	0.1545	0.1562
	St.Dev.	0.5390	0.5417	0.5441	0.5473	0.5503	0.5549	0.5587	0.5626	0.5667	0.5723
	N	94	94	94	94	94	94	94	94	94	94
Molage	Mean	16.2660	17.2660	18.2660	19.2660	20.2660	21.2660	22.2660	23.2660	24.2660	25.2660
	St.Dev.	12.3812	12.3812	12.3812	12.3812	12.3812	12.3812	12.3812	12.3812	12.3812	12.3812
	N	94	94	94	94	94	94	94	94	94	94
Packsize	Mean	88.6616	86.9820	86.9964	87.6721	88.8467	88.9582	88.7587	88.8862	89.1031	89.3121
	St.Dev.	42.4639	33.0368	30.5640	27.2622	25.0869	23.8694	22.9830	22.4613	21.9649	21.8510
	N	94	94	94	94	94	94	94	94	94	94
Formcode	Mean	16.5000	16.0426	16.2553	16.2447	16.4894	16.7340	16.7128	17.2340	17.3085	17.0745
	St.Dev.	19.028	18.5507	19.1928	18.5829	18.7093	18.8965	18.6689	19.5879	20.4135	20.1015
	N	94	94	94	94	94	94	94	94	94	94
Globpenet	Mean	3.8192	3.8192	3.8617	3.8404	3.8085	3.7872	3.7660	3.7553	3.7340	3.7234
	St.Dev.	1.3675	1.3675	1.3804	1.4165	1.4239	1.4208	1.4400	1.4568	1.4678	1.5127
	N	94	94	94	94	94	94	94	94	94	94

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Molecules by Country by Year

Country: Germany		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	6.8618	7.5852	8.2128	8.7660	9.9681	10.3936	11.0745	11.3936	11.7660	12.5851
	St.Dev.	9.0739	9.8771	10.4572	11.4351	12.3432	12.4721	12.6807	12.7290	13.50548	13.9588
	N	94	94	94	94	94	94	94	94	94	94
Thsubsmol	Mean	21.7979	21.4894	21.3936	21.6170	21.2447	21.2234	20.8404	20.7660	20.6915	19.4575
	St.Dev.	8.8956	8.7838	8.8076	7.6074	7.2047	6.9207	6.6661	6.9645	7.5020	6.6812
	N	94	94	94	94	94	94	94	94	94	94
Thsubsmol- entrylag	Mean	20.4624	20.4624	20.4624	20.4624	20.4624	20.4624	20.4624	20.4624	20.4624	20.4624
	St.Dev.	15.5295	15.5295	15.5295	15.5295	15.5295	15.5295	15.5295	15.5295	15.5295	15.5295
	N	93	93	93	93	93	93	93	93	93	93

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: France		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	101,660	100,599	97,956	98,079	95,477	93,620	94,809	96,060	96,284	95,787
	St.Dev.	105,062	102,405	98,983	101,014	101,152	102,217	105,804	109,388	113,001	115,067
	N	70	70	70	70	70	70	70	70	70	70
Leusuprice	Mean	0.2666	0.2706	0.2740	0.2741	0.2735	0.2742	0.2727	0.2715	0.2691	0.2657
	St.Dev.	0.2267	0.2245	0.2250	0.2248	0.2240	0.2242	0.2249	0.2255	0.2231	0.2259
	N	70	70	70	70	70	70	70	70	70	70
Leuthnds	Mean	25,201	26,121	26,439	26,840	26,327	25,483	25,684	26,524	26,957	27,201
	St.Dev.	28,465	29,733	31,465	33,227	34,938	34,002	36,017	40,896	45,616	51,180
	N	70	70	70	70	70	70	70	70	70	70
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1324	0.1326	0.1329	0.1330	0.1333	0.1332	0.1335	0.1336	0.1337	0.1324
	St.Dev.	0.4812	0.4813	0.4814	0.4814	0.4814	0.4813	0.4814	0.4813	0.4814	0.4809
	N	70	70	70	70	70	70	70	70	70	70
Molage	Mean	14.4000	15.4000	16.4000	17.4000	18.4000	19.4000	20.4000	21.4000	22.4000	23.4000
	St.Dev.	9.8487	9.8487	9.8487	9.8487	9.8487	9.8487	9.8487	9.8487	9.8487	9.8487
	N	70	70	70	70	70	70	70	70	70	70
Packsize	Mean	31.8639	31.8353	31.9500	32.0411	32.1769	32.0760	32.3648	32.6652	32.7235	32.9488
	St.Dev.	9.1641	8.9247	9.0061	9.1370	9.0886	9.5272	9.8104	10.1974	10.4168	10.7817
	N	70	70	70	70	70	70	70	70	70	70
Formcode	Mean	2.7714	2.6857	2.8714	3.1143	3.3000	3.5286	3.7143	3.6286	3.5429	3.5857
	St.Dev.	2.1814	2.0039	2.3277	2.7586	2.9750	3.4963	3.7500	3.5105	3.0960	3.1091
	N	70	70	70	70	70	70	70	70	70	70
Globpenet	Mean	4.3000	4.2857	4.3000	4.2857	4.2857	4.2429	4.2286	4.2000	4.1571	4.1571
	St.Dev.	1.0948	1.1183	1.1209	1.1183	1.1183	1.1602	1.1443	1.1869	1.2469	1.2469
	N	70	70	70	70	70	70	70	70	70	70

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: France		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	1.9143	1.8714	2.0857	2.3143	2.6429	2.8143	3.1143	3.3429	3.8000	4.1286
	St.Dev.	1.4915	1.39275	1.7590	2.1839	2.7295	2.9747	3.4538	3.7836	4.4055	4.6685
	N	70	70	70	70	70	70	70	70	70	70
Thsubsmol	Mean	14.8143	14.0857	14.3143	14.3000	14.2571	13.9857	13.6000	13.6143	13.2714	13.1286
	St.Dev.	5.2483	4.6054	4.2683	4.5248	4.4516	4.5028	4.3218	3.9647	3.6153	3.6828
	N	70	70	70	70	70	70	70	70	70	70
Thsubsmol- entrylag	Mean	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
	St.Dev.	9.9488	9.9488	9.9488	9.9488	9.9488	9.9488	9.9488	9.9488	9.9488	9.9488
	N	70	70	70	70	70	70	70	70	70	70

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: Italy		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	46,682	48,395	50,129	49,193	48,513	49,447	50,817	53,763	53,815	55,612
	St.Dev.	66,011	66,638	69,011	67,751	67,963	70,521	73,589	78,333	79,016	83,040
	N	75	75	75	75	75	75	75	75	75	75
Leusuprice	Mean	0.2894	0.2646	0.2800	0.2891	0.2952	0.3042	0.3100	0.3125	0.3126	0.2984
	St.Dev.	0.2945	0.2611	0.2823	0.3007	0.3024	0.3087	0.3159	0.3179	0.3178	0.3102
	N	75	75	75	75	75	75	75	75	75	75
Leuthnds	Mean	13,075	12,542	13,775	13,861	14,094	15,090	16,159	17,795	18,233	18,049
	St.Dev.	20,816	19,397	21,791	22,168	22,830	25,104	27,843	31,874	34,237	35,113
	N	75	75	75	75	75	75	75	75	75	75
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1322	0.1329	0.1334	0.1346	0.1476	0.1483	0.1484	0.1481	0.1485	0.1486
	St.Dev.	0.3965	0.3987	0.3876	0.3784	0.4751	0.4799	0.4798	0.4797	0.4798	0.4798
	N	75	75	75	75	75	75	75	75	75	75
Molage	Mean	14.4667	15.4667	16.4667	17.4667	18.4667	19.4667	20.4667	21.4667	22.4667	23.4667
	St.Dev.	10.7242	10.7242	10.7242	10.7242	10.7242	10.7242	10.7242	10.7242	10.7242	10.7242
	N	75	75	75	75	75	75	75	75	75	75
Packsize	Mean	27.9435	27.9282	27.9028	27.7540	27.7421	27.8486	27.9149	28.0924	27.9160	27.8151
	St.Dev.	9.9150	9.8735	9.9394	10.0877	10.0829	9.9887	9.9177	10.0440	10.0108	10.0791
	N	75	75	75	75	75	75	75	75	75	75
Formcode	Mean	3.4933	3.4533	3.4400	3.4133	3.3333	3.3733	3.5067	3.6000	3.61330	3.6800
	St.Dev.	3.4656	3.2768	3.0369	2.9459	2.7427	2.7202	3.0330	3.4011	3.4363	3.5723
	N	75	75	75	75	75	75	75	75	75	75
Globpenet	Mean	4.1867	4.1867	4.21337	4.2000	4.2133	4.1867	4.1600	4.1600	4.1467	4.1467
	St.Dev.	1.1472	1.1472	1.1306	1.1508	1.1542	1.1589	1.1745	1.1745	1.1705	1.1705
	N	75	75	75	75	75	75	75	75	75	75

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: Italy		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market(Competition) Characteristics</i>											
Gencompet	Mean	3.2400	3.3200	3.3333	3.2533	3.2267	3.2533	3.4933	3.6400	3.85330	4.000
	St.Dev.	3.2708	3.3978	3.4222	3.4371	3.3715	3.4410	3.8882	4.2542	4.4591	4.6702
	N	75	75	75	75	75	75	75	75	75	75
Thsubsmol	Mean	16.5467	16.4000	15.9733	15.3467	15.4800	15.4533	15.3867	15.0133	14.3333	14.0933
	St.Dev.	5.8663	5.7657	4.8601	4.2569	4.4032	4.4700	4.6438	4.0520	4.1275	3.9837
	N	75	75	75	75	75	75	75	75	75	75
Thsubsmol- entrylag	Mean	19.2133	19.2133	19.2133	19.2133	19.2133	19.2133	19.2133	19.2133	19.2133	19.2133
	St.Dev.	12.7272	12.7272	12.7272	12.7272	12.7272	12.7272	12.7272	12.7272	12.7272	12.7272
	N	75	75	75	75	75	75	75	75	75	75

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: Spain		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	38,772	40,293	41,373	42,429	42,390	42,742	43,766	45,188	46,565	47,256
	St.Dev.	51,009	51,949	52,499	53,422	53,697	54,523	56,228	58,283	60,739	62,791
	N	69	69	69	69	69	69	69	69	69	69
Leusuprice	Mean	0.2072	0.2084	0.2099	0.2120	0.2135	0.2134	0.2087	0.2069	0.2053	0.2057
	St.Dev.	0.1698	0.1692	0.1692	0.1688	0.1676	0.1669	0.1641	0.1658	0.1661	0.1690
	N	69	69	69	69	69	69	69	69	69	69
Leuthnds	Mean	7,822	8,691	9,436	10,112	10,368	10,641	10,847	11,098	11,704	12,004
	St.Dev.	12,392	13,607	14,684	15,781	16,501	17,375	18,189	19,187	21,906	23,155
	N	69	69	69	69	69	69	69	69	69	69
<i>Quality Characteristics</i>											
Strengthg	Mean	0.2072	0.2075	0.2082	0.2099	0.2105	0.2109	0.2112	0.2115	0.2111	0.2122
	St.Dev.	0.7619	0.7620	0.7622	0.7629	0.7631	0.7633	0.7635	0.7636	0.7637	0.7638
	N	69	69	69	69	69	69	69	69	69	69
Molage	Mean	13.3478	14.3478	15.3478	16.3478	17.3478	18.3478	19.3478	20.3478	21.3478	22.3478
	St.Dev.	9.9836	9.9836	9.9836	9.9836	9.9836	9.9836	9.9836	9.9836	9.9836	9.9836
	N	69	69	69	69	69	69	69	69	69	69
Packsize	Mean	40.6834	40.6355	40.6007	40.1174	39.9884	39.8821	39.8462	39.8963	39.8558	39.7986
	St.Dev.	15.1235	15.1269	15.3012	15.1153	15.0211	15.1568	15.1621	15.2691	15.2716	15.2803
	N	69	69	69	69	69	69	69	69	69	69
Formcode	Mean	3.3478	3.3768	3.4058	3.4493	3.4203	3.4783	3.6087	3.6957	3.6522	3.6232
	St.Dev.	3.1381	3.3082	3.3752	3.5253	3.4145	3.4878	3.9266	3.9790	3.9064	3.8810
	N	69	69	69	69	69	69	69	69	69	69
Globpenet	Mean	4.4203	4.4493	4.4928	4.4783	4.4493	4.4203	4.4203	4.4058	4.3768	4.3768
	St.Dev.	0.8644	0.8666	0.8335	0.8679	0.9161	0.9299	0.9300	0.9750	0.9717	0.9717
	N	69	69	69	69	69	69	69	69	69	69

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: Spain		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	3.0580	3.1594	3.1739	3.3043	3.4493	3.6087	3.9565	4.3913	4.9420	5.1304
	St.Dev.	3.1243	3.3678	3.3779	3.6312	3.9090	4.4465	5.2087	6.2006	7.0521	7.6233
	N	69	69	69	69	69	69	69	69	69	69
Thsubsmol	Mean	15.0435	14.3333	14.4348	14.1884	14.8696	14.4348	13.9855	13.7971	13.5507	12.9565
	St.Dev.	6.3765	5.8251	6.1822	5.9267	6.0729	5.8648	5.6944	5.0631	4.9809	4.0960
	N	69	69	69	69	69	69	69	69	69	69
Thsubsmol- entrylag	Mean	17.3913	17.3913	17.3913	17.3913	17.3913	17.3913	17.3913	17.3913	17.3913	17.3913
	St.Dev.	11.5214	11.5214	11.5214	11.5214	11.5214	11.5214	11.5214	11.5214	11.5214	11.5214
	N	69	69	69	69	69	69	69	69	69	69

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country:											
United Kingdom		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	50,900	53,770	58,921	61,324	64,127	67,759	68,702	76,668	82,708	87,136
	St.Dev.	100,046	102,315	109,760	112,259	116,617	124,097	125,245	142,848	154,858	166,074
	N	71	71	71	71	71	71	71	71	71	71
Leusuprice	Mean	0.4178	0.5119	0.8223	0.5085	0.5925	0.4795	0.4738	0.5508	0.5590	0.5078
	St.Dev.	.9723	1.724	4.3158	1.6306	2.1351	0.9227	0.9210	1.5446	1.5928	1.1460
	N	71	71	71	71	71	71	71	71	71	71
Leuthnds	Mean	9,984	11,258	13,124	14,676	16,274	18,514	19,968	22,168	25,455	28,164
	St.Dev.	21,531	23,474	26,867	30,259	33,912	37,465	40,047	47,892	60,288	71,467
	N	71	71	71	71	71	71	71	71	71	71
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1605	0.1125	0.1139	0.1132	0.1131	0.1129	0.1132	0.1114	0.1086	0.1079
	St.Dev.	0.6221	0.4768	0.4768	.4760	0.4704	0.4702	0.4673	0.4449	0.4192	0.4115
	N	71	71	71	71	71	71	71	71	71	71
Molage	Mean	16.7324	17.7324	18.7324	19.7324	20.7324	21.7324	22.7324	23.7324	24.7324	25.7324
	St.Dev.	15.1072	15.1072	15.1072	15.1072	15.1072	15.1072	15.1072	15.1072	15.1072	15.1072
	N	71	71	71	71	71	71	71	71	71	71
Packsize	Mean	124.6009	125.0463	122.1820	109.1184	102.8499	81.8099	58.1690	54.9476	53.4879	51.6353
	St.Dev.	176.9906	179.8889	180.3949	155.8690	153.4981	106.6297	53.1618	46.4842	43.1163	39.3169
	N	71	71	71	71	71	71	71	71	71	71
Formcode	Mean	7.2676	7.4366	7.7887	8.3521	8.8451	9.3662	9.4085	9.2394	8.9155	9.0141
	St.Dev.	7.7367	7.9977	8.5522	9.5620	10.0933	11.1153	10.5919	10.2378	9.8282	9.6651
	N	71	71	71	71	71	71	71	71	71	71
Globpenet	Mean	4.3239	4.3239	4.3521	4.3380	4.3380	4.3099	4.2817	4.2535	4.2254	4.2254
	St.Dev.	0.9968	1.0250	1.0433	1.0683	1.0683	1.1031	1.1487	1.2038	1.1976	1.1976
	N	71	71	71	71	71	71	71	71	71	71

Table A.13 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for All Molecules by Country by Year

Country: United Kingdom		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market(Competition) Characteristics</i>											
Gencompet	Mean	1.9155	2.0423	2.1127	2.3099	2.3944	2.4366	2.5211	2.7887	2.7887	2.8451
	St.Dev.	1.8107	2.0663	2.3758	2.8009	3.1052	2.9215	2.9074	3.4555	3.1934	3.0503
	N	71	71	71	71	71	71	71	71	71	71
Thsubsmol	Mean	13.3802	13.3803	13.7324	14.0282	14.1690	14.0282	13.5775	12.9155	12.7465	13.0986
	St.Dev.	4.5556	4.5556	4.3588	4.2392	4.0602	3.6877	3.2145	3.1018	2.9506	2.8593
	N	71	71	71	71	71	71	71	71	71	71
Thsubsmol- entrylag	Mean	14.9718	14.9718	14.9718	14.9718	14.9718	14.9718	14.9718	14.9718	14.9718	14.9718
	St.Dev.	10.7597	10.7597	10.7597	10.7597	10.7597	10.7597	10.7597	10.7597	10.7597	10.7597
	N	71	71	71	71	71	71	71	71	71	71

Table A.14

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Germany		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	154,306	160,153	167,148	168,119	162,890	164,158	172,419	183,792	204,108	229,144
	St.Dev.	245,310	238,622	233,069	224,878	207,050	205,637	211,184	220,526	252,621	291,580
	N	38	38	38	38	38	38	38	38	38	38
Leusuprice	Mean	0.3080	0.3032	0.3023	0.2981	0.2940	0.2944	0.2913	0.2893	0.2745	0.2519
	St.Dev.	0.1985	0.1949	0.1965	0.2061	0.2141	0.2209	0.2333	0.2408	0.2461	0.2188
	N	38	38	38	38	38	38	38	38	38	38
Leuthnds	Mean	31,065	32,358	34,381	33,675	32,621	33,295	34,350	37,988	40,430	43,005
	St.Dev.	36,526	35,633	36,125	35,027	34,550	36,720	39,544	46,870	53,988	60,798
	N	38	38	38	38	38	38	38	38	38	38
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1168	0.1215	0.1245	0.1282	0.1315	0.1357	0.1391	0.1422	0.1454	0.1494
	St.Dev.	0.2544	0.2683	0.2797	0.2949	0.3087	0.3288	0.3448	0.3605	0.3767	0.3974
	N	38	38	38	38	38	38	38	38	38	38
Molage	Mean	17.1579	18.1579	19.1579	20.1579	21.1579	22.1579	23.1579	24.1579	25.1579	26.1579
	St.Dev.	11.5981	11.5981	11.5981	11.5981	11.5981	11.5981	11.5981	11.5981	11.5981	11.5981
	N	38	38	38	38	38	38	38	38	38	38
Packsize	Mean	85.5251	86.0092	86.2022	87.3814	88.9049	89.0981	88.9529	89.1485	89.7112	90.3038
	St.Dev.	15.9256	15.7505	15.7250	15.7112	15.7485	15.7806	15.8148	15.8579	15.8178	15.8275
	N	38	38	38	38	38	38	38	38	38	38
Formcode	Mean	24.9737	24.6316	25.2105	24.9211	25.0789	26.0263	26.1053	27.1579	27.1842	26.5789
	St.Dev.	24.2359	23.7889	24.8891	23.8864	24.2814	24.3160	23.8234	24.8624	25.9791	25.2315
	N	38	38	38	38	38	38	38	38	38	38
Globpenet	Mean	5	5	5	5	5	5	5	5	5	5
	St.Dev.	0	0	0	0	0	0	0	0	0	0
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Germany		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market(Competition) Characteristics</i>											
Gencompet	Mean	11.3158	13.0000	14.210	15.2368	16.9474	17.6842	18.8684	19.3947	20.1053	21.3684
	St.Dev.	11.7338	12.7513	13.2056	14.5592	15.6377	15.5148	15.2938	15.1239	16.2776	16.5667
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol	Mean	19.3421	19.0263	19.1053	19.8947	19.6316	19.6842	19.2632	19.1316	18.8158	17.7368
	St.Dev.	8.1548	7.9270	8.1067	7.2328	6.8396	6.4352	6.0390	6.1035	6.2379	5.3407
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol- entrylag	Mean	14.0789	14.0789	14.0789	14.0789	14.0789	14.0789	14.0789	14.0789	14.0789	14.0789
	St.Dev.	11.7137	11.7137	11.7137	11.7137	11.7137	11.7137	11.7137	11.7137	11.7137	11.7137
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: France		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	127,328	126,144	123,101	123,032	120,912	118,308	120,800	123,526	125,324	126,174
	St.Dev.	109,921	106,117	101,089	102,219	102,264	100,450	104,124	108,503	114,037	118,120
	N	38	38	38	38	38	38	38	38	38	38
Leusuprice	Mean	0.2636	0.2701	0.2752	0.2761	0.2735	0.2712	0.2701	0.2701	0.2677	0.2644
	St.Dev.	0.2004	0.1962	0.1966	0.1967	0.1961	0.1966	0.1978	0.1987	0.1928	0.1983
	N	38	38	38	38	38	38	38	38	38	38
Leuthnds	Mean	31,951	33,417	34,378	35,163	35,040	33,914	34,752	36,809	38,322	39,620
	St.Dev.	31,438	33,114	36,154	38,829	41,850	40,525	43,508	50,576	57,310	65,306
	N	38	38	38	38	38	38	38	38	38	38
<i>Quality (Market) Characteristics</i>											
Strengthg	Mean	0.1926	0.1931	0.1937	0.1939	0.1937	0.1936	0.1939	0.1940	0.1940	0.1940
	St.Dev.	0.6459	0.6459	0.6459	0.6459	0.6459	0.6459	0.6460	0.6459	0.6460	0.6460
	N	38	38	38	38	38	38	38	38	38	38
Molage	Mean	15.6316	16.6316	17.6316	18.6316	19.6316	20.6316	21.6316	22.6316	23.6316	24.6316
	St.Dev.	10.7186	10.7186	10.7186	10.7186	10.7186	10.7186	10.7186	10.7186	10.7186	10.7186
	N	38	38	38	38	38	38	38	38	38	38
Packsize	Mean	32.7990	32.6109	32.4992	32.4883	32.6507	32.7460	33.0276	33.2668	33.1910	33.1579
	St.Dev.	9.3614	9.2018	9.1312	9.0082	8.8119	8.7658	8.3847	8.3167	8.2380	8.2098
	N	38	38	38	38	38	38	38	38	38	38
Formcode	Mean	3.3684	3.1842	3.5263	3.9737	4.2368	4.5789	4.9474	4.8421	4.6316	4.6842
	St.Dev.	2.5300	2.2763	2.7187	3.2507	3.5446	4.2339	4.5259	4.2140	3.6423	3.6621
	N	38	38	38	38	38	38	38	38	38	38
Globpenet	Mean	5	5	5	5	5	5	5	5	5	5
	St.Dev.	0	0	0	0	0	0	0	0	0	0
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: France		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	2.2105	2.1579	2.55269	3.0000	3.6053	3.8947	4.2895	4.6579	5.1579	5.5263
	St.Dev.	1.7267	1.6362	2.1270	2.6610	3.3574	3.6449	4.1323	4.5398	5.1282	5.4263
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol	Mean	14.2632	13.6579	13.8158	13.7632	13.8684	13.8158	13.4474	13.4737	13.1579	13.0789
	St.Dev.	5.5395	4.8339	4.5432	4.7558	4.6625	4.6374	4.4339	4.0653	3.7742	3.8088
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol- entrylag	Mean	11.9474	11.9474	11.9474	11.9474	11.9474	11.9474	11.9474	11.9474	11.9474	11.9474
	St.Dev.	8.7300	8.7300	8.7300	8.7300	8.7300	8.7300	8.7300	8.7300	8.7300	8.7300
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Italy		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	72,514	75,073	77,957	76,583	75,321	76,959	79,191	83,609	83,220	85,570
	St.Dev.	81,844	81,868	84,434	82,710	83,105	86,145	89,584	95,191	95,360	99,768
	N	38	38	38	38	38	38	38	38	38	38
Leusuprice	Mean	0.2676	0.2428	0.2581	0.2675	0.2729	0.2837	0.2916	0.2977	0.2959	0.2832
	St.Dev.	0.2371	0.1978	0.2140	0.2314	0.2320	0.2424	0.2567	0.2682	0.2742	0.2676
	N	38	38	38	38	38	38	38	38	38	38
Leuthnds	Mean	18,911	18,307	20,100	20,208	20,478	22,082	23,787	26,467	27,179	27,099
	St.Dev.	25,141	23,657	26,719	27,278	28,070	30,883	34,262	39,621	42,924	44,171
	N	38	38	38	38	38	38	38	38	38	38
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1756	0.1770	0.1778	0.1796	0.2046	0.2061	0.2058	0.2057	0.2059	0.2060
	St.Dev.	0.5371	0.5400	0.5234	0.5091	0.6489	0.6556	0.6553	0.6550	0.6550	0.6549
	N	38	38	38	38	38	38	38	38	38	38
Molage	Mean	15.8158	16.8158	17.8158	18.8158	19.8158	20.8158	21.8158	22.8158	23.8158	24.8158
	St.Dev.	11.2391	11.2391	11.2391	11.2391	11.2391	11.2391	11.2391	11.2391	11.2391	11.2391
	N	38	38	38	38	38	38	38	38	38	38
Packsize	Mean	27.3968	27.3100	27.2803	26.9495	26.7784	26.7462	26.8004	27.1335	27.0267	26.9813
	St.Dev.	9.5066	9.4423	9.5875	9.9184	10.0963	10.0612	9.8308	10.0760	10.1157	10.1591
	N	38	38	38	38	38	38	38	38	38	38
Formcode	Mean	3.3158	3.3158	3.4474	3.5000	3.5263	3.6842	3.9474	4.1579	4.2895	4.5526
	St.Dev.	2.1699	2.1699	2.2263	2.3795	2.4576	2.6108	3.0839	3.6057	3.9105	4.1700
	N	38	38	38	38	38	38	38	38	38	38
Globpenet	Mean	5	5	5	5	5	5	5	5	5	5
	St.Dev.	0	0	0	0	0	0	0	0	0	0
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Italy		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	3.2895	3.3684	3.5263	3.5000	3.5263	3.6842	4.1053	4.4474	4.8947	5.1579
	St.Dev.	2.5352	2.8037	3.0733	3.2529	3.3590	3.4882	4.2477	4.8418	5.2029	5.3753
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol	Mean	15.0000	14.9211	14.7632	14.5000	14.7105	14.6842	14.6579	14.5000	13.7105	13.3947
	St.Dev.	4.8990	4.6230	3.8304	3.2777	3.4634	3.5421	3.6854	3.3430	3.3281	3.1153
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol- entrylag	Mean	14.6053	14.6053	14.6053	14.6053	14.6053	14.6053	14.6053	14.6053	14.6053	14.6053
	St.Dev.	10.2074	10.2074	10.2074	10.2074	10.2074	10.2074	10.2074	10.2074	10.2074	10.2074
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Spain		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	51,162	53,068	54,806	56,982	57,673	58,805	60,943	63,471	66,094	67,786
	St.Dev.	59,583	59,411	58,957	59,923	60,683	62,113	64,462	67,196	70,371	73,228
	N	38	38	38	38	38	38	38	38	38	38
Leusuprice	Mean	0.2076	0.2088	0.2104	0.2136	0.2165	0.2187	0.2157	0.2135	0.2116	0.2103
	St.Dev.	0.1714	0.1689	0.1679	0.1670	0.1660	0.1677	0.1680	0.1713	0.1708	0.1702
	N	38	38	38	38	38	38	38	38	38	38
Leuthnds	Mean	10,340	11,348	12,358	13,437	14,006	14,650	15,179	15,607	16,683	17,168
	St.Dev.	14,540	15,768	17,035	18,530	19,658	21,002	22,179	23,549	27,237	28,779
	N	38	38	38	38	38	38	38	38	38	38
<i>Quality Characteristics</i>											
Strengthg	Mean	0.1940	0.1946	0.1961	0.1991	0.1999	0.2005	0.2010	0.2012	0.2013	0.2017
	St.Dev.	0.6483	0.6485	0.6489	0.6506	0.6510	0.6514	0.6518	0.6521	0.6523	0.6527
	N	38	38	38	38	38	38	38	38	38	38
Molage	Mean	15.1842	16.1842	17.1842	18.1842	19.1842	20.1842	21.1842	22.1842	23.1842	24.1842
	St.Dev.	11.0572	11.0572	11.0572	11.0572	11.0572	11.0572	11.0572	11.0572	11.0572	11.0572
	N	38	38	38	38	38	38	38	38	38	38
Packsize	Mean	40.9292	40.7530	40.6194	40.3590	40.1945	40.0689	40.0768	40.1406	40.1108	40.0166
	St.Dev.	11.9422	11.8425	11.6951	11.3057	11.2812	11.2371	11.1980	11.1785	11.1456	11.0794
	N	38	38	38	38	38	38	38	38	38	38
Formcode	Mean	3.6842	3.7632	3.8684	4.0000	3.9211	4.0526	4.2632	4.5000	4.5263	4.5526
	St.Dev.	3.6101	3.8934	4.0281	4.2490	4.1680	4.2487	4.8862	4.9688	4.9415	4.9193
	N	38	38	38	38	38	38	38	38	38	38
Globpenet	Mean	5	5	5	5	5	5	5	5	5	5
	St.Dev.	0	0	0	0	0	0	0	0	0	0
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: Spain		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	3.4737	3.6579	3.6579	3.8947	4.0789	4.4211	4.8947	5.4211	6.2632	6.5789
	St.Dev.	3.7034	4.1085	4.1347	4.4829	4.8120	5.5343	6.5669	7.6463	9.2871	8.5793
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol	Mean	14.0526	13.5000	13.6053	13.4211	14.0789	13.7895	13.3158	13.1579	13.0000	12.5263
	St.Dev.	6.0402	5.5641	5.9436	5.7452	5.8558	5.7664	5.5513	4.8576	4.8267	3.9094
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol- entrylag	Mean	14.0526	14.0526	14.0526	14.0526	14.0526	14.0526	14.0526	14.0526	14.0526	14.0526
	St.Dev.	10.4389	10.4389	10.4389	10.4389	10.4389	10.4389	10.4389	10.4389	10.4389	10.4389
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: United Kingdom		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Suthnds	Mean	80,298	83,879	90,308	93,006	96,537	100,756	100,849	111,846	120,814	127,227
	St.Dev.	122,753	123,225	128,652	128,780	131,682	137,061	134,530	151,547	162,743	173,136
	N	38	38	38	38	38	38	38	38	38	38
Leusuprice	Mean	0.2965	0.3014	0.3060	0.3080	0.3224	0.3308	0.3266	0.3234	0.3238	0.3252
	St.Dev.	0.2224	0.2281	0.2361	0.2446	0.2601	0.2657	0.2571	0.2680	0.2760	0.2764
	N	38	38	38	38	38	38	38	38	38	38
Leuthnds	Mean	17,005	18,936	21,825	24,195	26,628	29,711	31,382	34,813	40,388	45,309
	St.Dev.	27,598	30,002	34,274	38,623	43,236	47,376	49,965	59,890	76,642	91,943
	N	38	38	38	38	38	38	38	38	38	38
<i>Quality Characteristics</i>											
Strengthg	Mean	0.2665	0.1759	0.1767	0.1771	0.1766	0.1770	0.1773	0.1731	0.1676	0.1665
	St.Dev.	0.8392	0.6464	0.6464	0.6451	0.6373	0.6369	0.6329	0.6020	0.5666	0.5559
	N	38	38	38	38	38	38	38	38	38	38
Molage	Mean	16.6316	17.6316	18.6316	19.6316	20.6316	21.6316	22.6316	23.6316	24.6316	25.6316
	St.Dev.	12.0818	12.0818	12.0818	12.0818	12.0818	12.0818	12.0818	12.0818	12.0818	12.0818
	N	38	38	38	38	38	38	38	38	38	38
Packsize	Mean	145.2151	148.0258	146.2829	124.6675	119.4850	93.2642	66.3229	61.2544	58.9442	57.0293
	St.Dev.	202.9629	209.2266	208.3658	173.3241	172.0150	123.1002	65.1457	57.0984	52.4440	46.5931
	N	38	38	38	38	38	38	38	38	38	38
Formcode	Mean	9.9211	10.1579	10.7105	11.6316	12.2368	13.2368	13.2632	13.1053	12.6316	12.8421
	St.Dev.	9.2543	9.6493	10.4103	11.7161	12.3626	13.6232	12.8771	12.3284	11.7068	11.4880
	N	38	38	38	38	38	38	38	38	38	38
Globpenet	Mean	5	5	5	5	5	5	5	5	5	5
	St.Dev.	0	0	0	0	0	0	0	0	0	0
	N	38	38	38	38	38	38	38	38	38	38

Table A.14 (Continued)

Pharmaceutical Drug Quality and Market (Competition) Characteristics for Global Molecules by Country by Year

Country: United Kingdom		Year									
Variable	Measure	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
<i>Market (Competition) Characteristics</i>											
Gencompet	Mean	2.2895	2.5789	2.6579	3.0789	3.2105	3.2895	3.4474	3.8684	3.7632	3.7632
	St.Dev.	2.3005	2.6573	3.0868	3.6271	4.0414	3.7626	3.7032	4.4001	4.0366	3.7592
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol	Mean	12.5263	12.5263	12.9474	13.3421	13.5263	13.4474	13.1053	12.5000	12.3684	12.7895
	St.Dev.	4.4826	4.4826	4.2359	4.1151	3.9232	3.6145	3.1860	3.0202	2.8798	2.8867
	N	38	38	38	38	38	38	38	38	38	38
Thsubsmol- entrylag	Mean	12.9737	12.9737	12.9737	12.9737	12.9737	12.9737	12.9737	12.9737	12.9737	12.9737
	St.Dev.	9.0060	9.0060	9.0060	9.0060	9.0060	9.0060	9.0060	9.0060	9.0060	9.0060
	N	38	38	38	38	38	38	38	38	38	38

Table A.15
**Quality Adjusted (by RE) Standard Unit Price Differentials
for All Molecules, Relative to Spain^a**

Year	Spain	France	Italy	United Kingdom	Germany
1994	-	39.63%	27.09%	80.21%	105.06%
1995	2.25%	42.17%	18.46%	79.93%	100.96%
1996	4.25%	42.12%	24.26%	78.87%	100.62%
1997	6.91%	39.62%	25.36%	72.73%	93.15%
1998	7.84%	39.45%	28.19%	83.87%	89.94%
1999	9.30%	38.94%	31.54%	90.54%	86.88%
2000	8.55%	40.26%	35.24%	86.94%	87.43%
2001	8.30%	40.15%	37.86%	85.04%	88.77%
2002	8.11%	40.03%	39.86%	83.54%	80.51%
2003	8.93%	37.12%	33.99%	81.30%	76.76%

Table A.16
**Quality Adjusted (by FE) Standard Unit Price Differentials
for All Molecules, Relative to Germany^b**

Year	Germany	France	Italy	United Kingdom	Spain
1994	-	30.43%	36.76%	11.62%	50.02%
1995	0.02%	27.80%	39.93%	10.07%	49.10%
1996	1.44%	27.70%	36.90%	10.47%	49.04%
1997	0.01%	26.34%	33.97%	10.24%	47.14%
1998	0.92%	25.35%	31.51%	3.03%	46.34%
1999	1.39%	24.45%	28.63%	2.20%	45.50%
2000	1.99%	24.02%	26.88%	0.08%	45.72%
2001	1.81%	24.61%	26.02%	1.59%	46.11%
2002	6.42%	21.28%	21.62%	1.99%	43.71%
2003	7.81%	21.43%	23.46%	2.72%	42.61%

^a These are the coefficients of country/time effects ($\theta_{j,t}$) in the random effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

^b These are the coefficients of country/time effects ($\theta_{j,t}$) in the fixed effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

Table A.17
**Quality Adjusted (by FE) Standard Unit Price Differentials
for All Molecules, Relative to Spain^a**

Year	Spain	France	Italy	United Kingdom	Germany
1994	-	39.19%	26.53%	76.83%	100.07%
1995	1.86%	41.85%	18.01%	76.67%	96.46%
1996	3.41%	41.88%	23.83%	75.70%	96.24%
1997	5.74%	39.36%	24.92%	69.80%	89.19%
1998	6.38%	39.10%	27.63%	80.70%	86.35%
1999	7.52%	38.63%	30.96%	87.51%	83.48%
2000	6.43%	39.98%	34.72%	84.39%	84.24%
2001	5.86%	39.91%	37.28%	82.62%	85.57%
2002	5.39%	39.83%	39.23%	81.17%	77.64%
2003	5.85%	36.92%	33.38%	78.98%	74.25%

Table A.18
**Quality Adjusted (by RE) Standard Unit Price Differentials
for Global Molecules, Relative to Spain^b**

Year	Spain	France	Italy	United Kingdom	Germany
1994	-	31.87%	21.32%	81.81%	103.44%
1995	3.45%	36.58%	12.63%	76.92%	99.13%
1996	6.98%	37.68%	17.94%	73.35%	95.62%
1997	12.30%	34.21%	17.22%	63.23%	82.23%
1998	16.06%	30.90%	18.65%	67.24%	76.20%
1999	20.52%	27.09%	21.15%	66.06%	71.83%
2000	21.76%	27.95%	24.11%	61.13%	68.77%
2001	22.55%	29.17%	27.65%	55.96%	68.81%
2002	23.94%	29.29%	27.94%	51.86%	58.79%
2003	25.72%	26.75%	23.81%	50.34%	51.59%

^a These are the coefficients of country/time effects ($\theta_{j,t}$) in the fixed effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

^b These are the coefficients of country/time effects ($\theta_{j,t}$) in the random effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

Table A.19
**Quality Adjusted (by FE) Standard Unit Price Differentials
for Global Molecules, Relative to Germany^a**

Year	Germany	France	Italy	United Kingdom	Spain
1994	-	-34.7%	-40.2%	-10.7%	-50.6%
1995	0.7%	-30.9%	-43.3%	-11.4%	-49.5%
1996	1.7%	-29.1%	-39.6%	-11.5%	-48.6%
1997	-1.0%	-25.8%	-35.6%	-10.6%	-44.9%
1998	-1.7%	-25.1%	-32.5%	-5.2%	-42.9%
1999	-0.9%	-25.5%	-29.3%	-3.4%	-41.5%
2000	-2.3%	-23.6%	-26.2%	-4.5%	-40.4%
2001	-2.2%	-22.9%	-24.2%	-7.7%	-40.4%
2002	-7.5%	-18.0%	-19.2%	-4.4%	-36.7%
2003	-11.0%	-15.7%	-18.0%	-0.7%	-33.6%

Table A.20
**Quality Adjusted (by FE) Standard Unit Price Differentials
for Global Molecules, Relative to Spain^a**

Year	Spain	France	Italy	United Kingdom	Germany
1994	-	32.16%	20.88%	80.66%	102.29%
1995	2.83%	36.87%	12.29%	75.52%	98.02%
1996	5.78%	37.97%	17.55%	72.05%	94.50%
1997	10.43%	34.51%	16.82%	62.17%	81.36%
1998	13.60%	31.09%	18.25%	66.09%	75.14%
1999	17.28%	27.32%	20.78%	65.04%	70.88%
2000	17.78%	28.20%	23.81%	60.23%	67.84%
2001	17.88%	29.44%	27.34%	55.01%	67.91%
2002	18.54%	29.55%	27.54%	50.94%	57.93%
2003	19.52%	27.06%	23.45%	49.60%	50.64%

^a These are the coefficients of country/time effects ($\theta_{j,t}$) in the fixed effect quasi-hedonic regression model. Percentages are calculated as $100[\text{Exp}(\theta)-1]$.

Table A.21
**Results for Price Convergence Estimations for All Molecules
(Adjusted by RE)**

Dependent Variable: $\Delta P_{i,k,t}$	Model 1		Model 2	
	Base: SPN	Base: GR	Base: SPN	Base: GR
β^a	0.01	-0.02	-0.19	-0.18
Half-life of Shock (in years)	-	34.3	3.3	3.5
FR ^b	-	-	0.02	0.00
GR ^b	-	-	0.09	-
UK ^b	-	-	0.10	0.00
SPN ^b	-	-	-	-0.09
ITY ^b	-	-	0.07	-0.07
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1) ^c	Yes ^d	Yes ^d
t-star	8.80	-19.89	-8.92	-8.16
P>t	1.000	0.000	0.000	0.000
Molecule/Country Fixed Effects	No	No	Yes	Yes
Time Trend	No	No	No	No
N	2,940	3,210	2,940	3,210

^a β coefficients are estimated by the Levin et al. (1992) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by the Augmented Dickey Fuller unit root test module in StataTM 9.2 (dfuller) and then averaged for each country.

^c The average number of lags for each molecule/country is 1.

^d The number of lags is determined by using the Campbell and Perron top-down approach.

Table A.22
Results for Price Convergence Estimations for All Molecules (Unadjusted)

Dependent Variable: $\Delta P_{i,k,t}$	Model 1			Model 2			Model 3		
	Base: SPN	Base: GR	No Base	Base: SPN	Base: GR	No Base	Base: SPN	Base: GR	No Base
β^a	-0.00	-0.01	0.00	-0.33	-0.14	-0.30	-0.77	-0.68	-0.65
FR ^b	-	-	-	0.16	-0.02	-0.66	0.16	-0.02	-0.90
GR ^b	-	-	-	0.02	-	-0.32	0.02	-	-0.44
UK ^b	-	-	-	-0.17	0.02	-0.25	-0.17	-0.17	-0.81
SPN ^b	-	-	-	-	-0.19	-1.08	-	-0.79	-1.50
ITY ^b	-	-	-	0.06	-0.00	-0.35	0.06	-0.30	-0.94
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)
t-star p>t	-14.19 0.000	-8.52 0.000	0.18 0.575	-30.00 0.000	-15.82 0.000	-30.78 0.000	-94.37 0.000	-27.88 0.000	-41.37 0.000
Molecule/Country Fixed Effects	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	No	No	No	No	No	No	Yes	Yes	Yes
N	2940	3210	3790	2940	3210	3790	2940	3210	3790

^a β coefficients are estimated by Levin et al. (2002) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by Augmented Dickey Fuller regressions (dfuller) in StataTM 9.2 and then averaged for each country.

^c The average number of lags for each molecule/country is 1.

Table A.23
**Results for Price Convergence Estimations for
 Global Molecules (Adjusted by FE)**

Dependent Variable: $\Delta P_{i,k,t}$	Model 1		Model 2	
	Base: SPN	Base: GR	Base: SPN	Base: GR
β^a	0.02	-0.02	-0.14	-0.21
Half-life of Shock (in years)	-	34.3	4.6	2.9
FR ^b	-	-	0.00	0.07
GR ^b	-	-	0.08	-
UK ^b	-	-	0.19	0.06
SPN ^b	-	-	-	-0.08
ITY ^b	-	-	0.07	-0.09
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1) ^c	Yes ^d	Yes ^d
t-star	11.96	-12.69	-5.95	-12.69
P>t	1.000	0.000	0.000	0.000
Molecule/Country Fixed Effects	No	No	Yes	Yes
Time Trend	No	No	No	No
N	1,900	1,900	1,900	1,900

^a β coefficients are estimated by the Levin et al. (2002) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by the Augmented Dickey Fuller regressions in StataTM 9.2 (dfuller) and then averaged for each country.

^c The average number of lags for each molecule/country is 1.

^d The number of lags is determined by using the Campbell and Perron top-down approach.

Table A.24
Results for Price Convergence Estimations for Global Molecules (Unadjusted)

Dependent Variable: $\Delta P_{i,k,t}$	Model 1			Model 2			Model 3		
	Base: SPN	Base: GR	No Base	Base: SPN	Base: GR	No Base	Base: SPN	Base: GR	No Base
β^a	0.01	-0.02	0.00	-0.14	-0.08	-0.19	-0.64	-0.65	-0.62
FR ^b	-	-	-	0.05	0.14	-0.17	0.29	0.04	-0.02
GR ^b	-	-	-	0.20	-	0.12	0.74	-	0.60
UK ^b	-	-	-	0.08	0.04	-0.03	0.15	-0.20	-0.24
SPN ^b	-	-	-	-	-0.20	-0.19	-	-0.74	-0.29
ITY ^b	-	-	-	0.08	0.02	-0.09	0.17	-0.27	-0.38
Lags of $\Delta P_{i,k,t}$	Yes(1) ^c	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)	Yes(1)
t-star P>t	10.78 1.000	-18.85 0.000	0.33 0.630	-7.99 0.000	-6.16 0.000	-13.13 0.000	-25.76 0.000	-21.94 0.000	-27.72 0.000
Molecule/Country Fixed Effects	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	No	No	No	No	No	No	Yes	Yes	Yes
N	1900	1900	1900	1900	1900	1900	1900	1900	1900

^a β coefficients are estimated by Levin et al. (2002) panel unit root test module in StataTM 9.2 (levinlin).

^b Country fixed effects are estimated for each molecule/country by Augmented Dickey Fuller regressions (dfuller) in StataTM 9.2 and then averaged for each country

^c The number of lags for each molecule/country is 1.

Appendix B: Figures

Figure B.1

Summary of EU Pharmaceutical Background

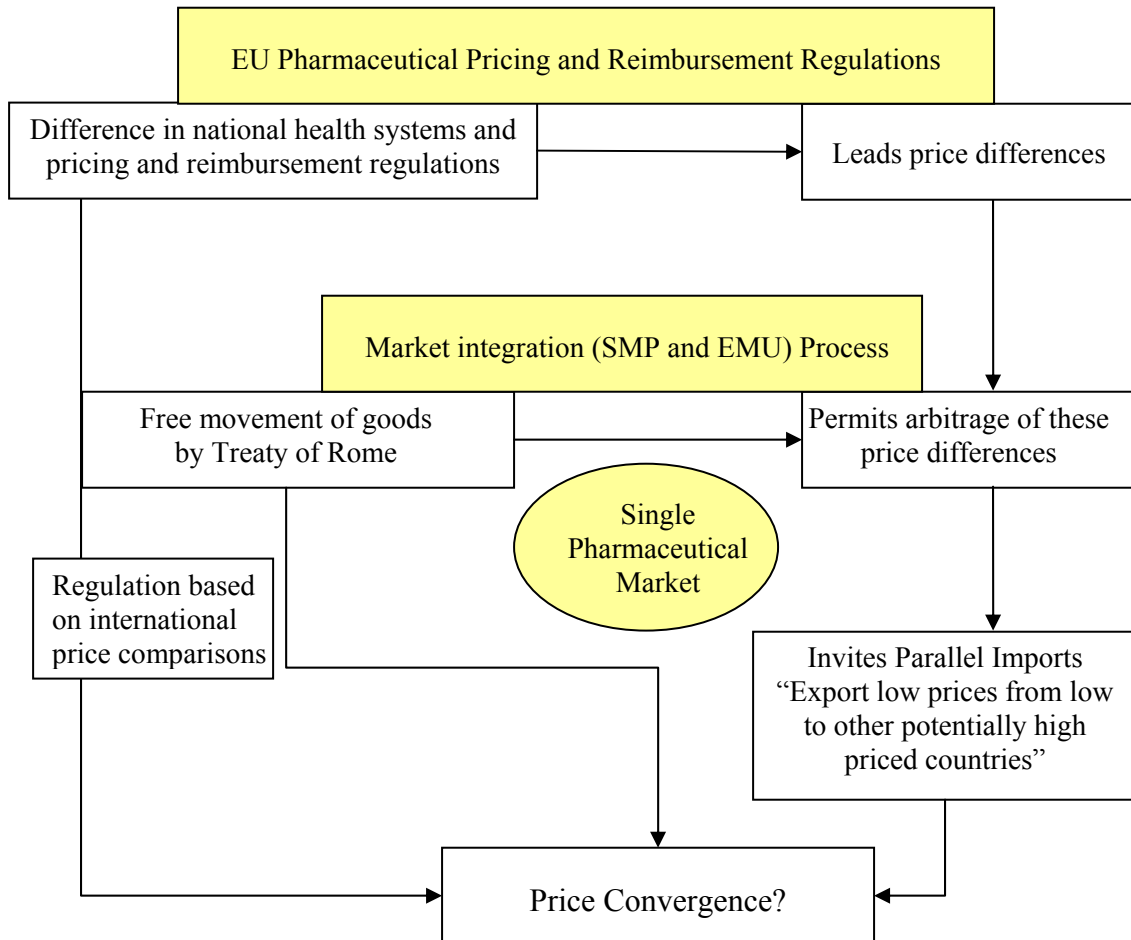
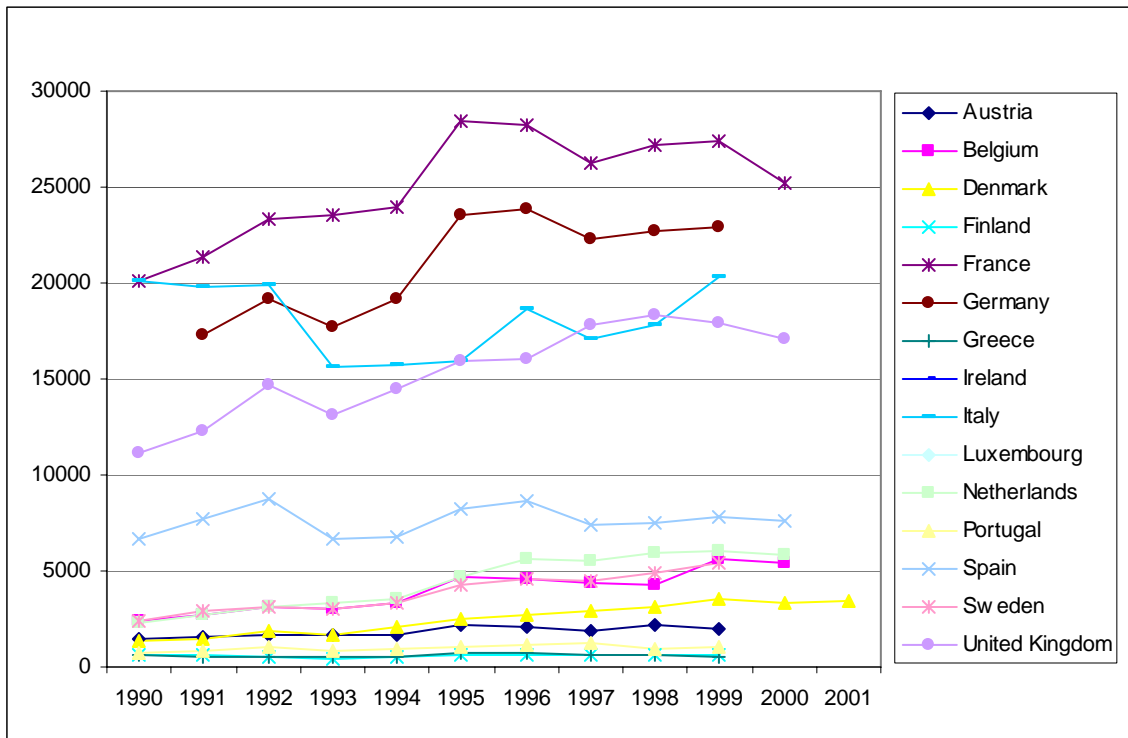
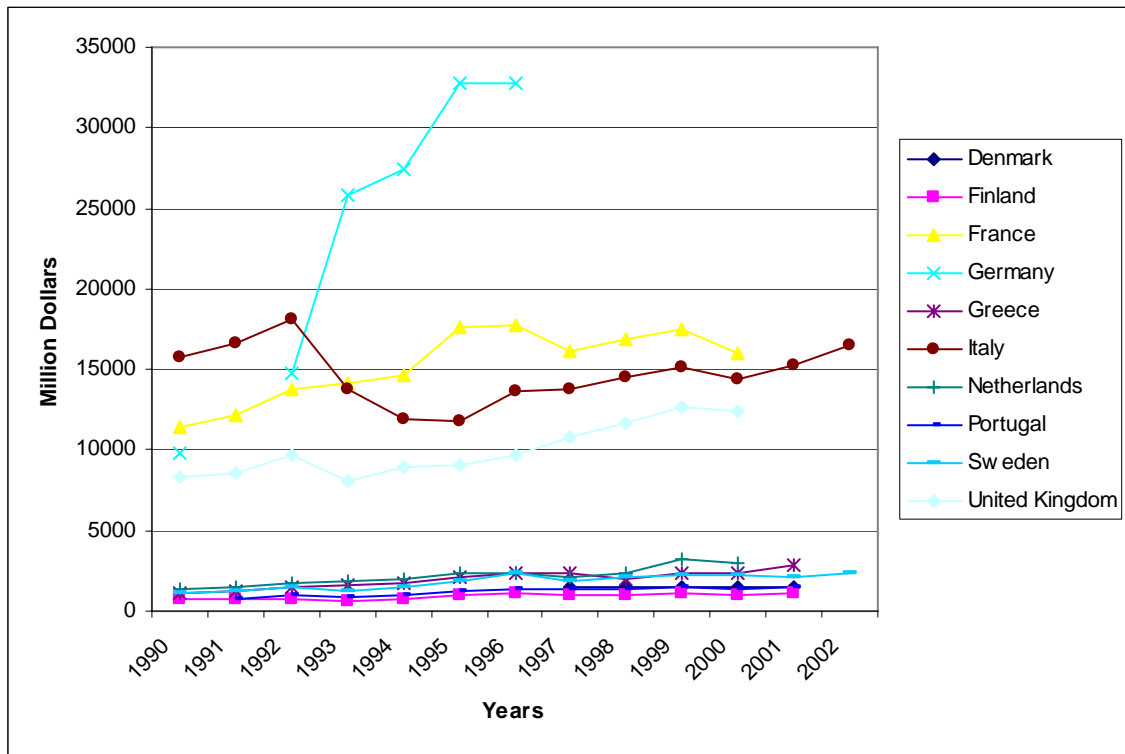


Figure B.2
Pharmaceutical Production in the European Union
(In million dollars at exchange rate)



Source: OECD Health Data (2003)

Figure B.3
Total Pharmaceutical Sales in the European Union
(In million dollars at exchange rate)



Source: OECD Health Data (2003)

Figure B.4
**Bilateral Price Differences for All Molecules Between 1994-2003
 by Laspeyres Index, Relative to Germany**

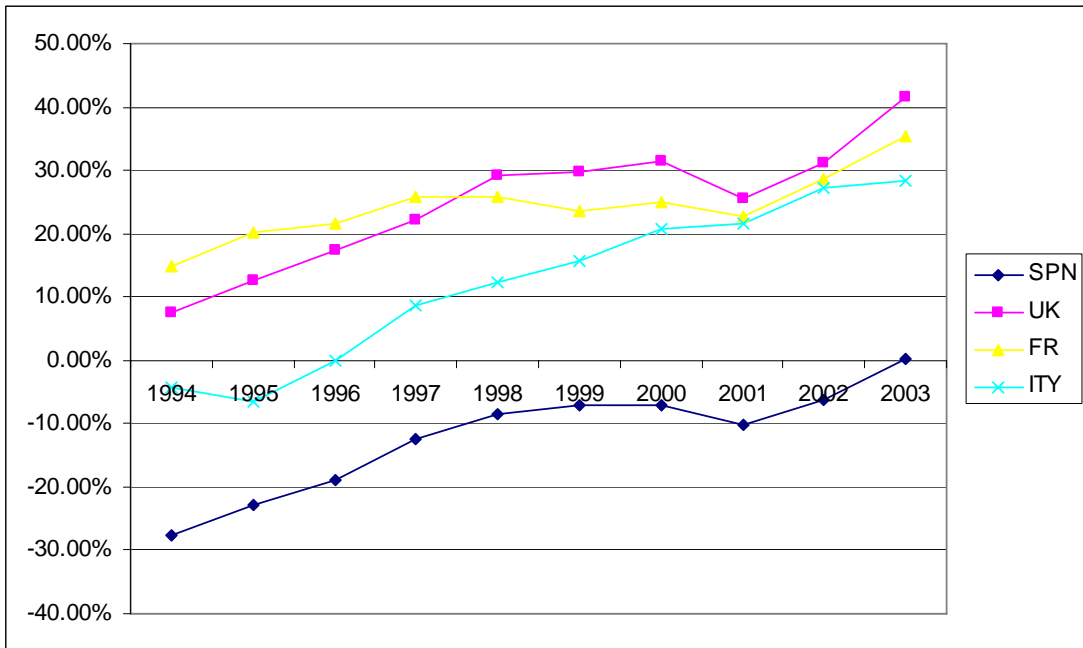


Figure B.5
**Bilateral Price Differences for All Molecules Between 1994-2003
 by Paasche Index, Relative to Germany**

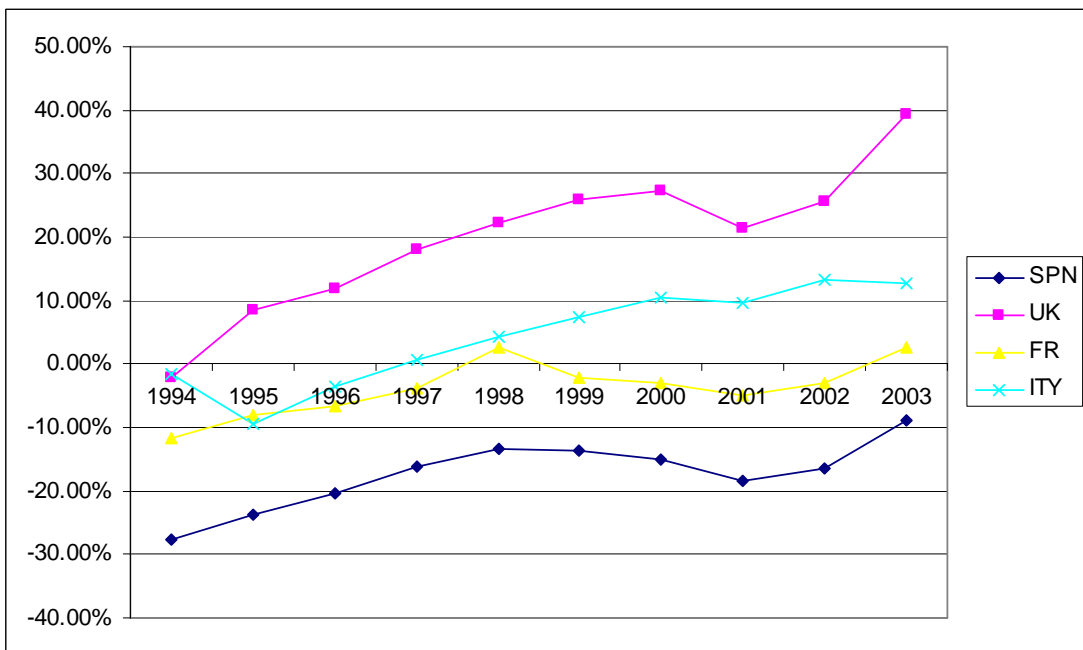


Figure B.6
Bilateral Price Differences for All Molecules Between 1994-2003
by Laspeyres Index, Relative to Spain

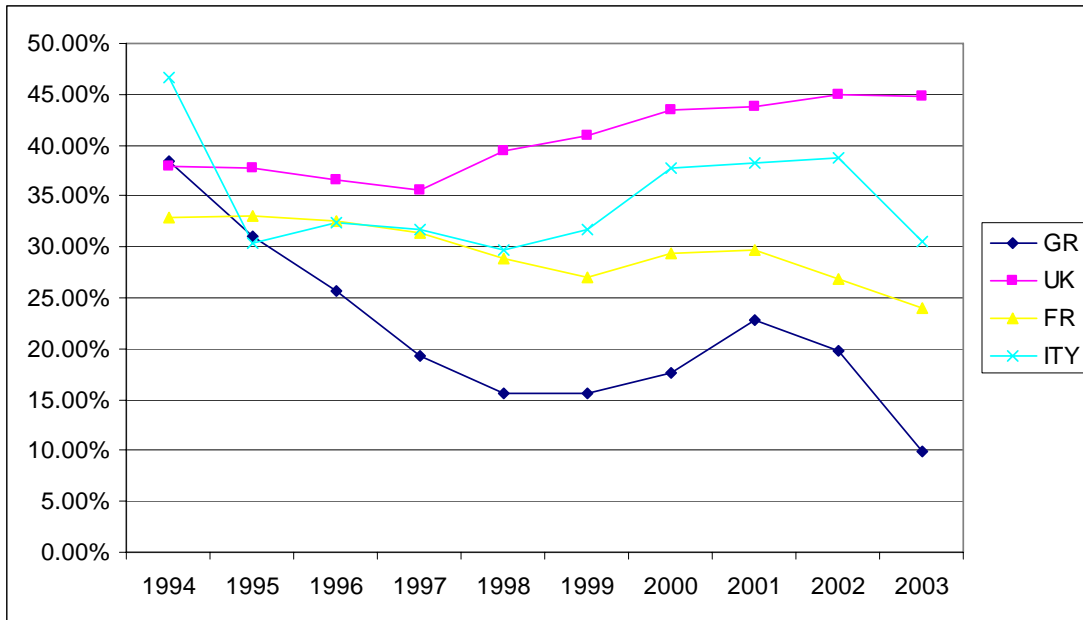


Figure B.7
Bilateral Price Differences for All Molecules Between 1994-2003
by Paasche Index, Relative to Spain

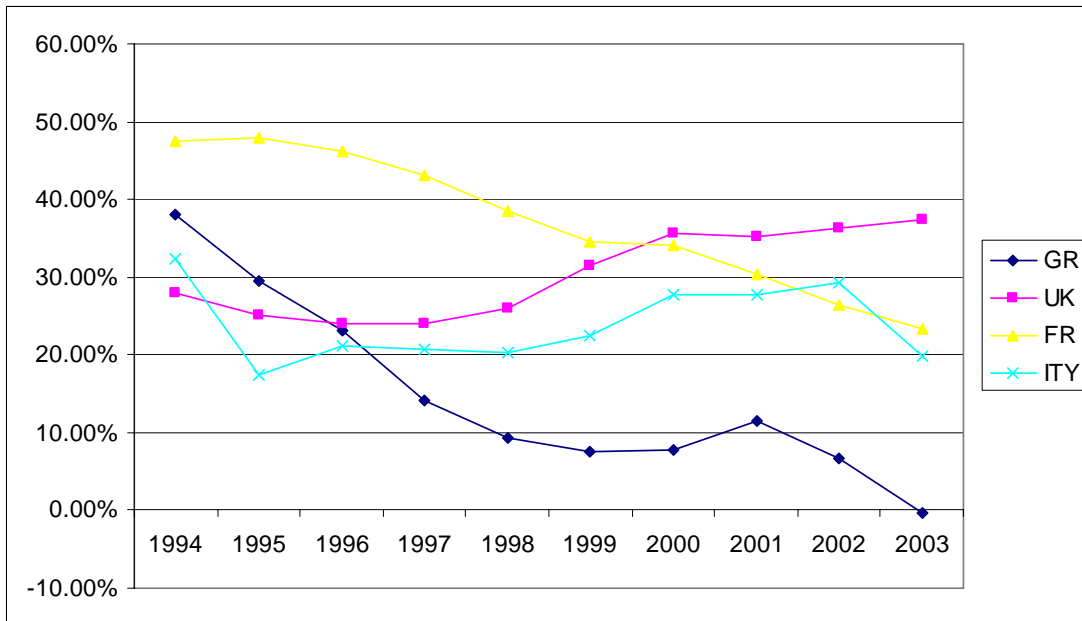


Figure B.8
Bilateral Price Differences for Global Molecules Between 1994-2003
by Laspeyres Index, Relative to Germany

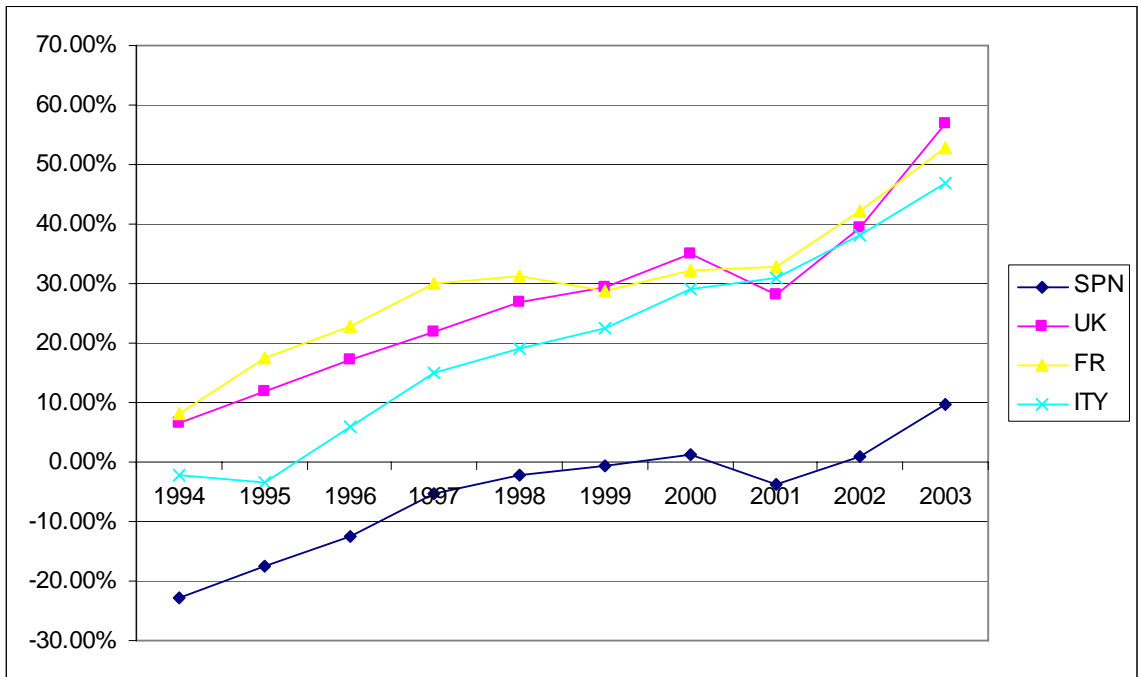


Figure B.9
Bilateral Price Differences for Global Molecules Between 1994-2003
by Paasche Index, Relative to Germany

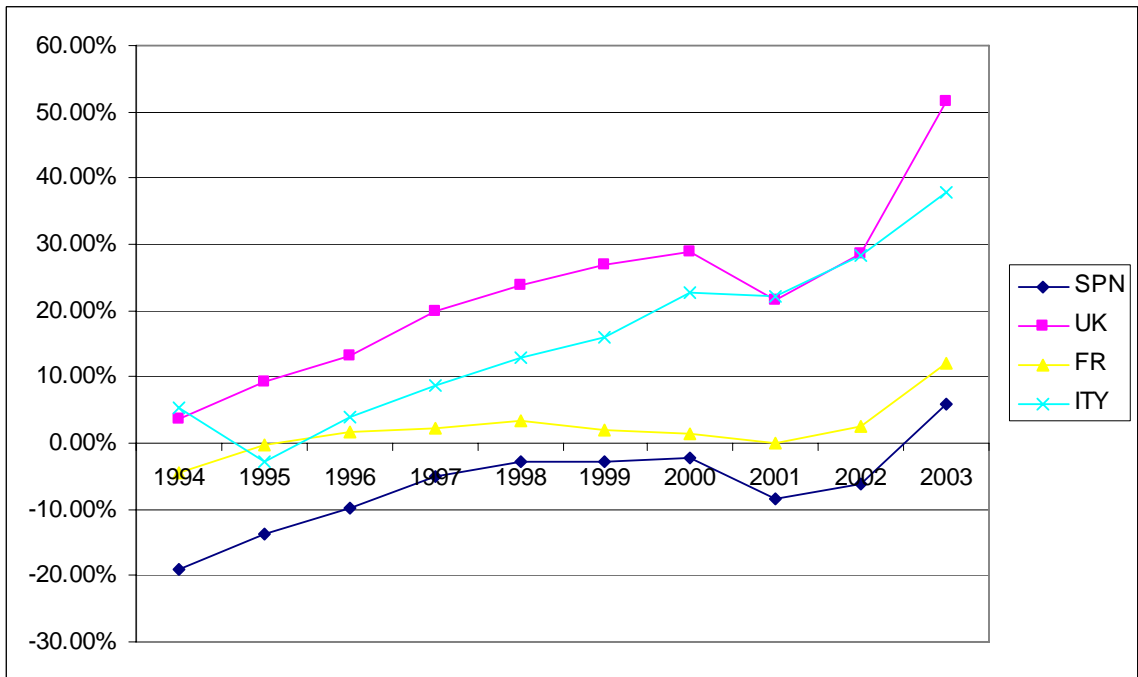


Figure B.10
**Bilateral Price Differences for Global Molecules Between 1994-2003
 by Laspeyres Index, Relative to Spain**

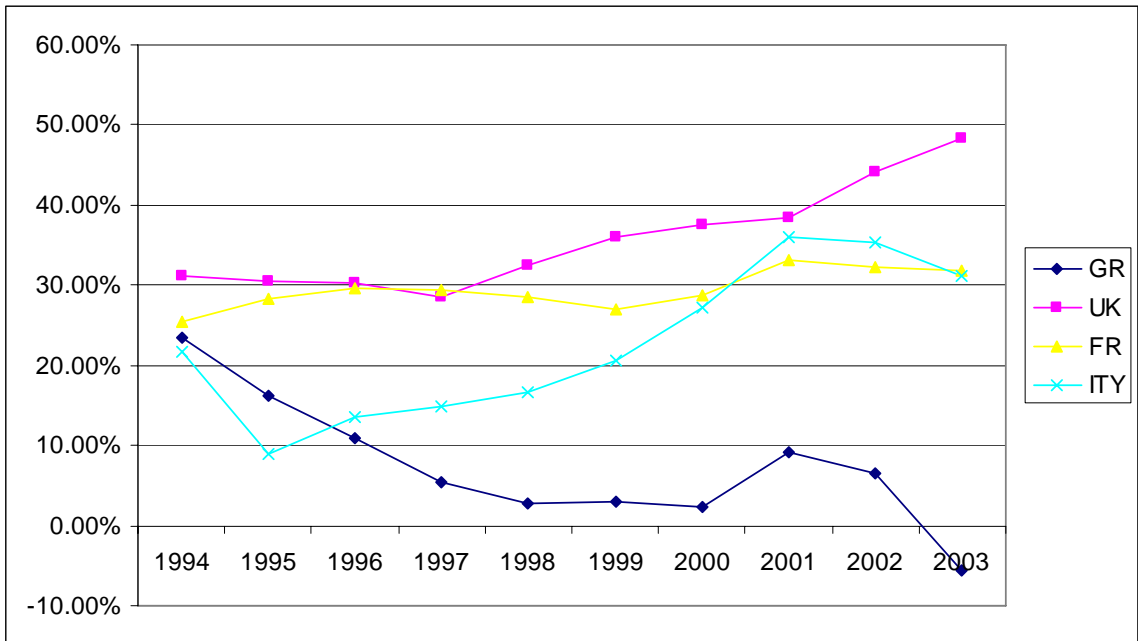


Figure B.11
**Bilateral Price Differences for Global Molecules Between 1994-2003
 by Paasche Index, Relative to Spain**

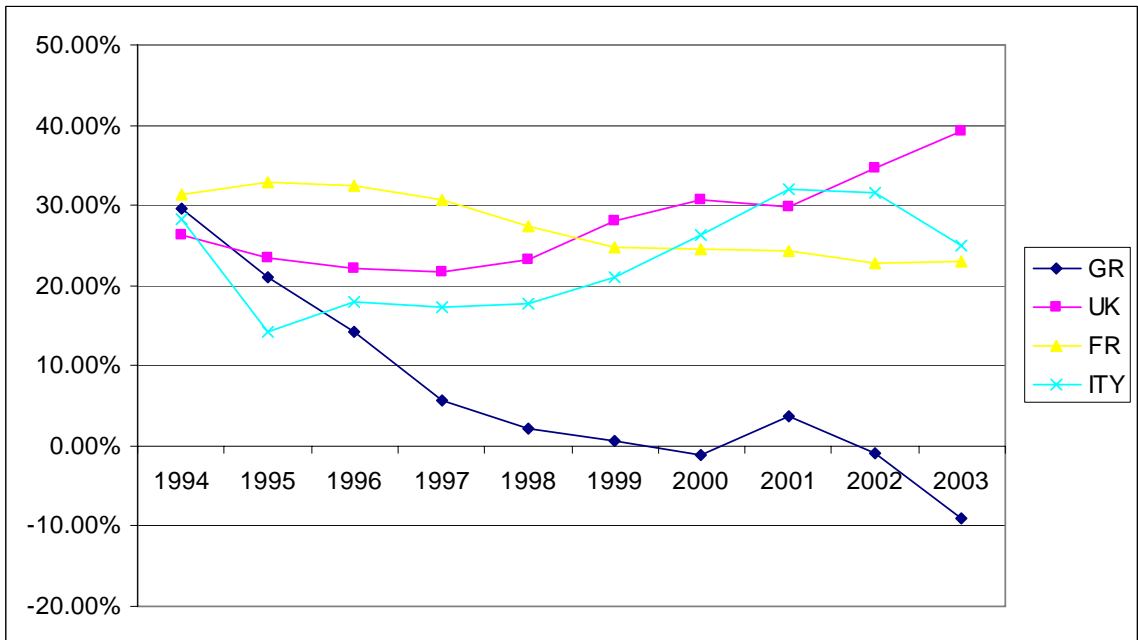


Figure B.12
Country Price Changes for All Molecules by Laspeyres Index, Relative to 1994

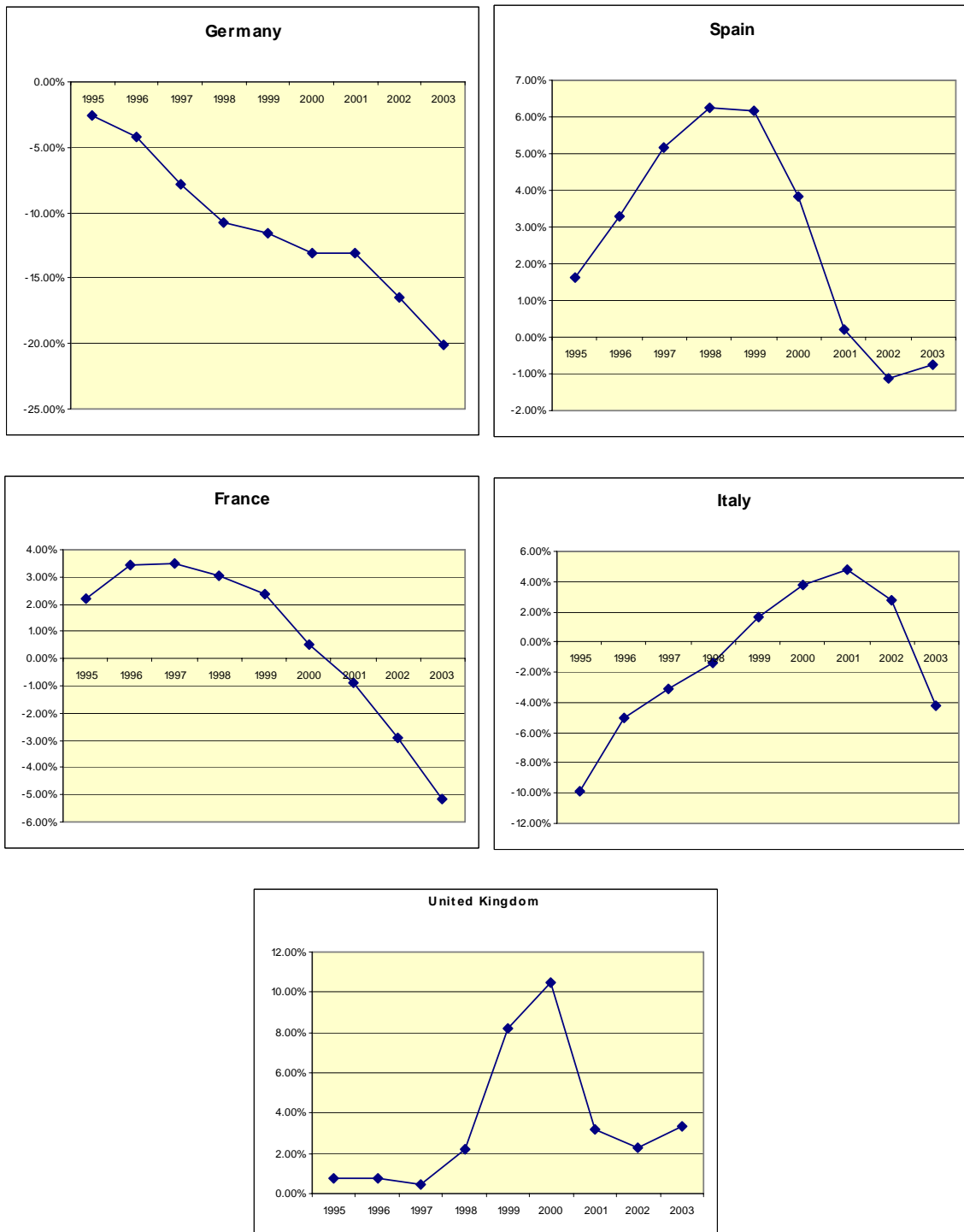


Figure B.13
**Country Price Changes for Global Molecules by Laspeyres Index,
 Relative to 1994**

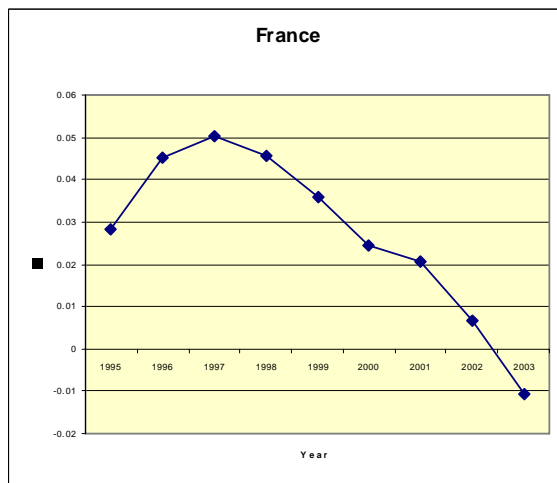
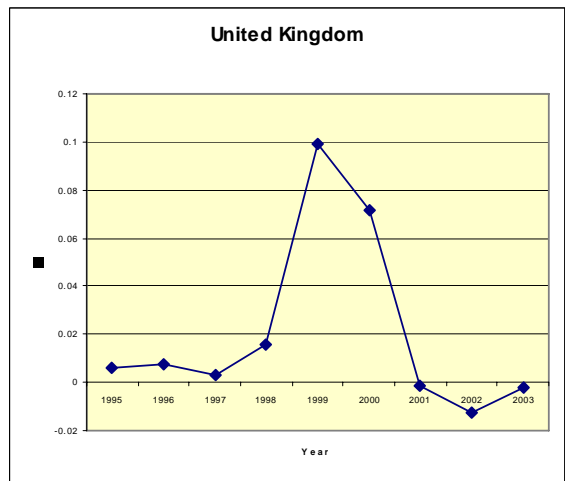
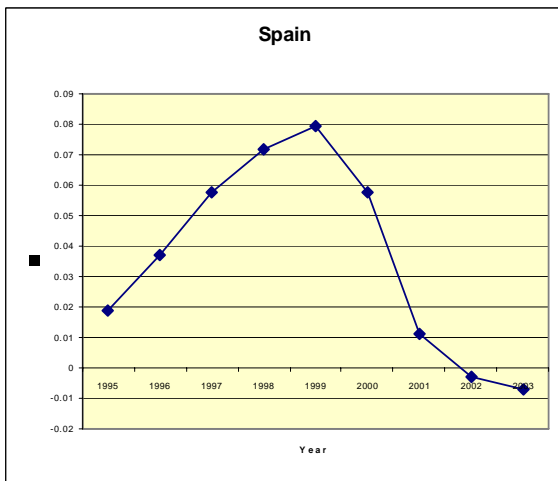
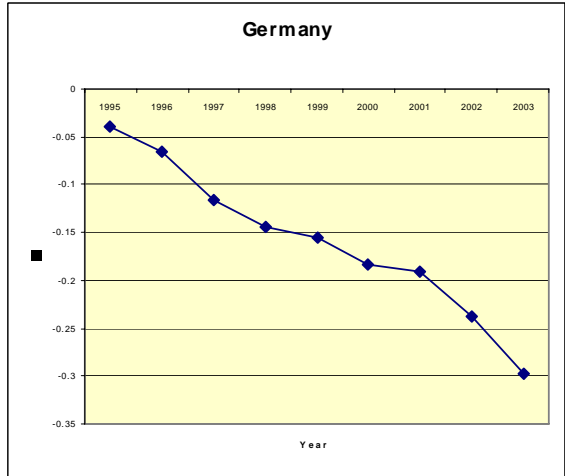
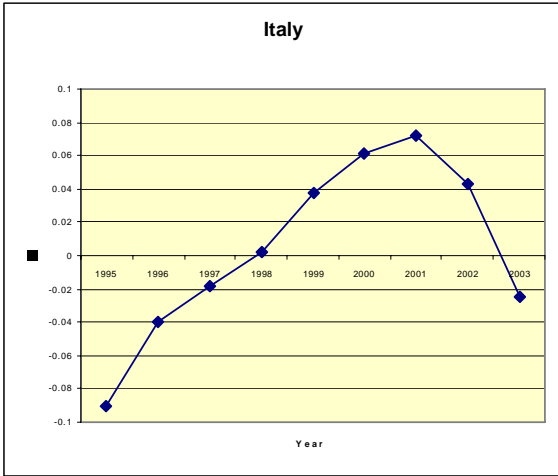


Figure B.14
**Quality Adjusted (by RE) Standard Unit Price Differentials
 for All Molecules, Relative to Spain**

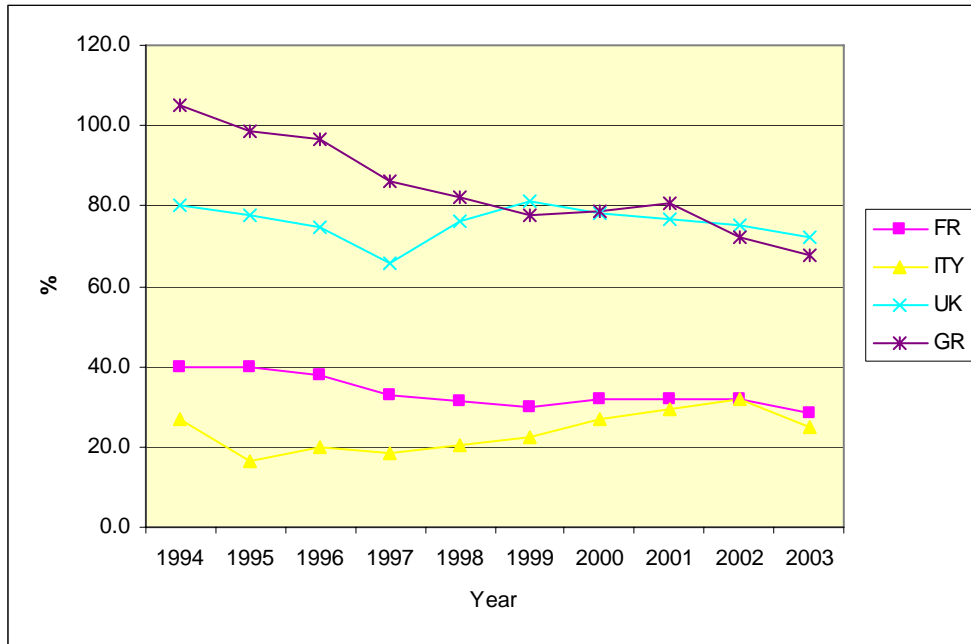


Figure B.15
**Quality Adjusted (by FE) Standard Unit Price Differentials
 for All Molecules, Relative to Germany**

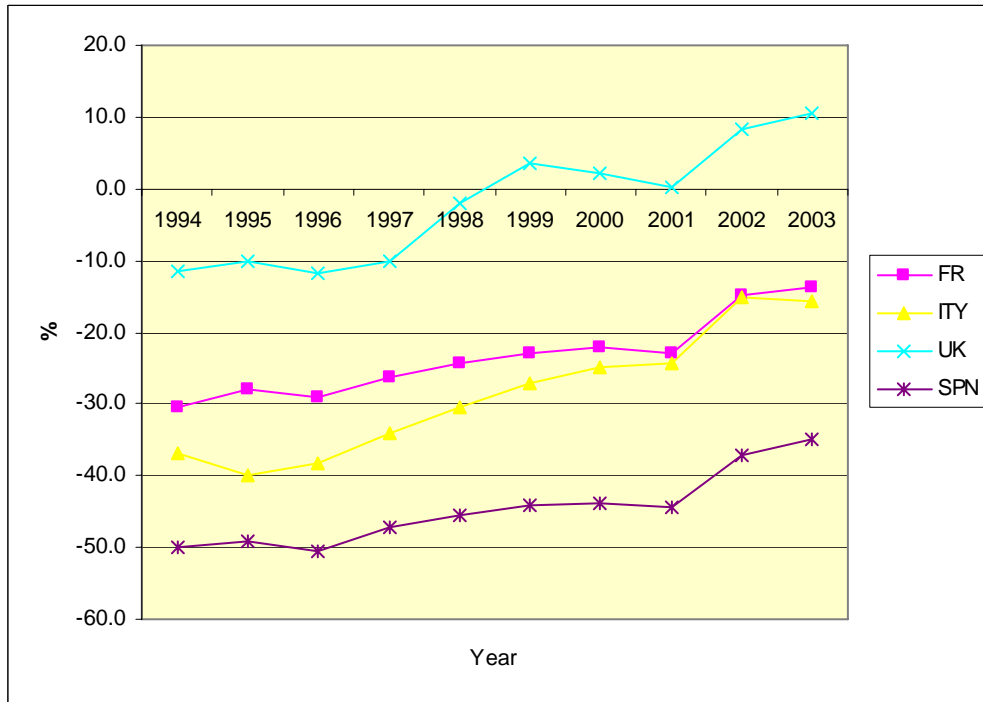


Figure B.16
**Quality Adjusted (by FE) Standard Unit Price Differentials
 for All Molecules, Relative to Spain**

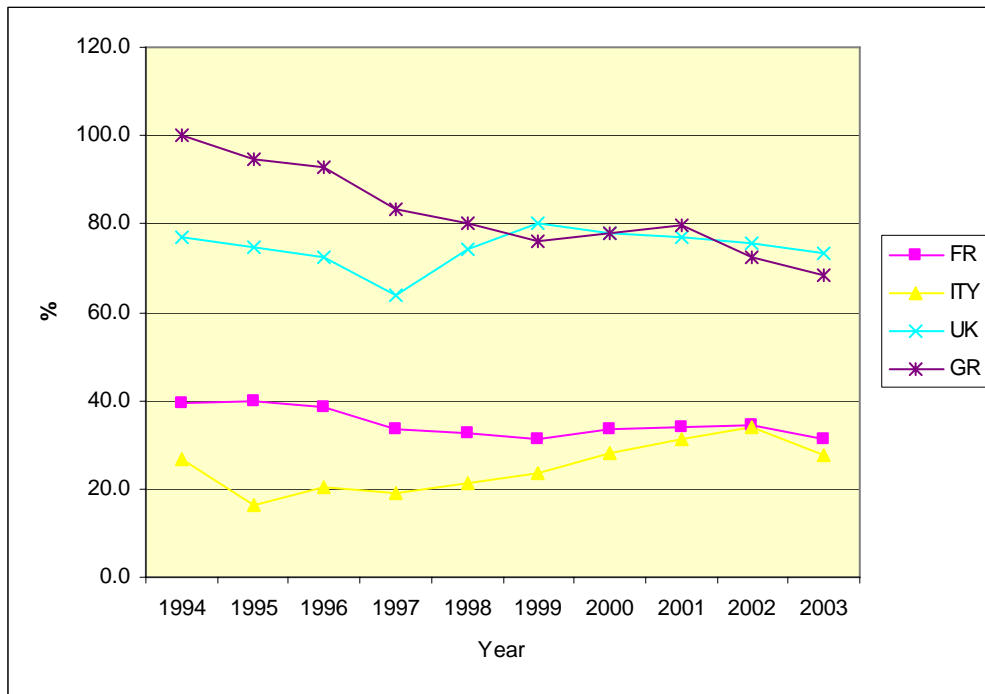


Figure B.17
**Quality Adjusted (by RE) Standard Unit Price Differentials
 for Global Molecules, Relative to Spain**

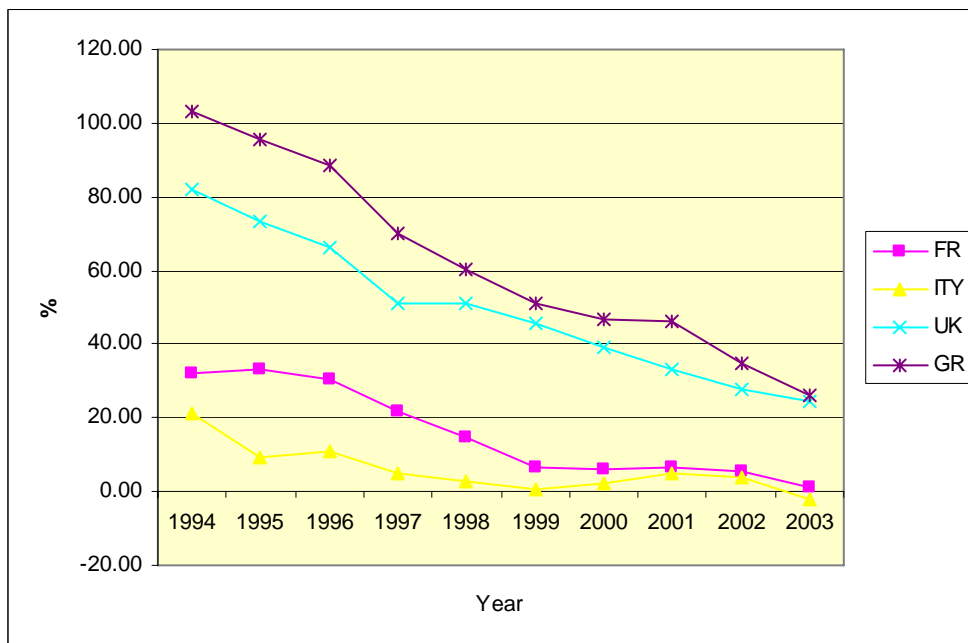


Figure B.18
**Quality Adjusted (by FE) Standard Unit Price Differentials
for Global Molecules, Relative to Germany**

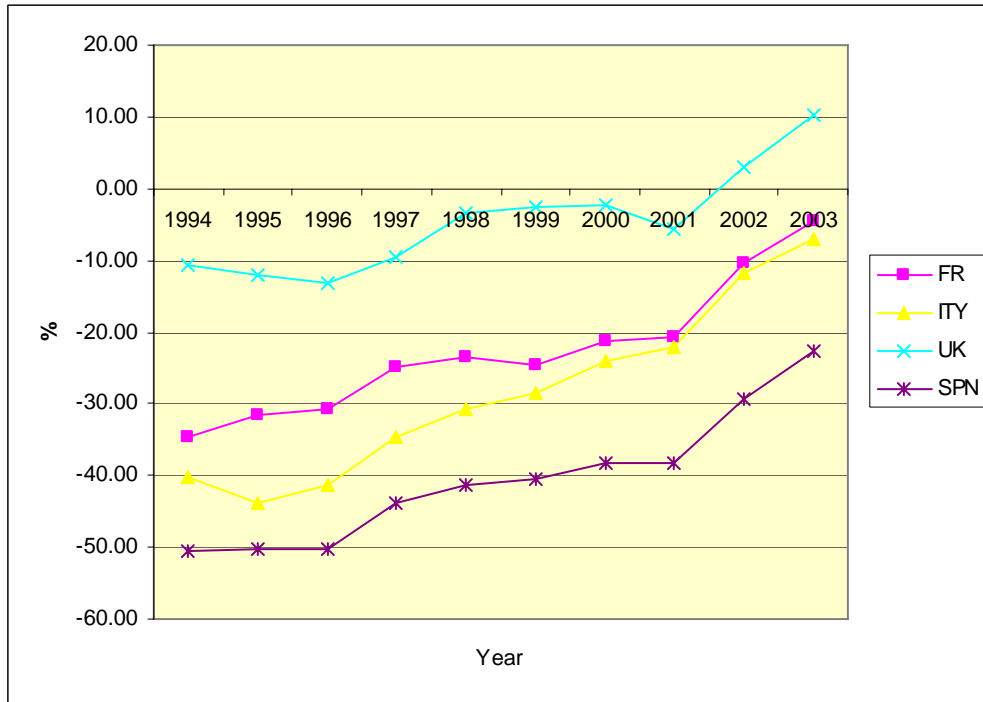
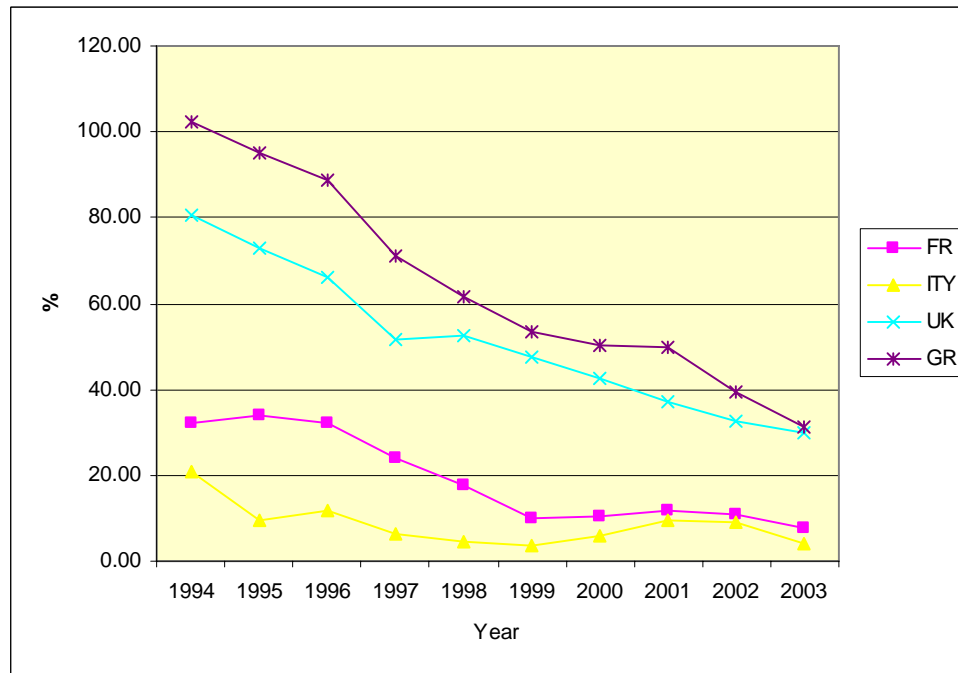


Figure B.19
**Quality Adjusted (by FE) Standard Unit Price Differentials
for Global Molecules, Relative to Spain**



About the Author

Aysegul Timur obtained her undergraduate degree in Business Administration in 1993 and her MBA in 1997 from the University of Istanbul. After holding positions in the information technology industry as a total quality coordinator and a corporate trainer in Turkey, she moved to the USA in 1998.

While teaching at International College as a full time professor in the Business Administration Department, Mrs. Timur entered the Ph.D. program in the Department of Economics at the University of South Florida in 2002. Her major area of research is in Health and International Economics.