PRODUCTIVITY COMMISSION

Price Effects of Regulation:

International Air Passenger Transport, Telecommunications and Electricity Supply

Staff Research Paper

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The views expressed in this paper are those of the staff involved and do not necessarily reflect those of the Productivity Commission. Appropriate citation is indicated overleaf.

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Preface

Service industries represent a growing share both of production in developed economies and international trade. These industries are also subject to a range of regulations, which can constrain firm performance and impose costs on the community. Estimating the potential gains from liberalising service industries requires that such regulations be identified and their effects on service industries assessed.

In a collaborative project, researchers from the Productivity Commission and the Australian National University have quantified regulations affecting trade in banking (McGuire 1998, McGuire and Schuele 2000, Kalirajan et al. 2000, Verikios and Zhang 2001), telecommunications (Warren 2000a, 2000b, Verikios and Zhang 2001), maritime (Kang 2000, McGuire, Schuele and Smith 2000), wholesale and retail distribution (Kalirajan 2000), education (Kemp 2000), professional services (Nguyen-Hong 2000) and foreign investment in services (Hardin and Holmes 1997) for selected economies. Wherever possible, this research has also measured the impact of these barriers on economic outcomes — prices, costs, profits or quantities produced.

This paper seeks to extend this research 'beyond the border' into the effects of regulatory regimes in three important service industries — air passenger transport, telecommunications and electricity supply. The research is motivated by the observation that liberalising trade barriers in certain services sectors may not effectively promote competition, if the domestic regulatory regimes governing the conduct of that competition remain restrictive. The paper involves an extension of research contained in recent working papers published by the OECD, which provide a rigorous assessment of the effects of domestic regulation in these three important services sectors.

The results, while suggestive, are the product of analytical methods that are still being refined and developed. They are being published to facilitate further such improvements, including by other researchers. Feedback on this paper is welcomed.

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Abbreviations and explanations

Abbreviations

AGPS	Australian Government Publishing Service
APEC	Asia Pacific Economic Cooperation
ASA	Bilateral air services agreement
ATM	Asynchronous transfer mode
BRI	Bilateral restriction index
DTRD	Department of Transport and Regional Development
EU	European Union
FDI	Foreign direct investment
GATS	General Agreement on Trade in Services
GDP	Gross domestic product
IC	Industry Commission
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IMF	International Monetary Fund
ITU	International Telecommunications Union
kWh	Kilowatt hour
OAS	Organization of American States
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PC	Productivity Commission
PPP	Purchasing power parity
PTO	Public telecommunications operator
SECV	State Electricity Commission of Victoria

US	United States
WTO	World Trade Organization

OVERVIEW

Key messages

- This study draws on research undertaken by the Organisation for Economic Co-operation and Development (OECD) to quantify the effects of restrictive domestic regulatory regimes in international air passenger transport, telecommunications and electricity supply for up to 50 OECD and non-OECD economies.
- It also draws out the implications of the OECD modelling work, and explores many of the practical issues associated with measuring and assessing the effects of domestic regulation.
- The results are subject to some qualification, primarily arising from the quality of the available data, but the original OECD research and the use made of it here provide a useful methodology for isolating the effects of regulatory regimes from other contributing factors.
- The results for international air passenger transport suggest that the bilateral system of restrictions on the number of flights between countries and the conditions under which they operate collectively increase airfares by between 3 and 22 per cent.
- The results for telecommunications and electricity supply are less robust than those for international air passenger transport, but suggest a weak positive relationship between the restrictiveness of regulatory regimes and prices in these sectors.

Overview

This study represents an early attempt to quantify domestic regulatory regimes in international air passenger transport, telecommunications and electricity supply. In particular, it attempts to estimate the extent to which regulations in these service industries have raised prices. It does so by extending recent research undertaken by the Organisation for Economic Co-operation and Development (OECD) into the effects of domestic regulation in these industries. It uses the OECD's analytical results to derive regulatory tax equivalents — an overall measure of the effect of domestic regulatory regimes on prices in each service sector. And it extends this measurement beyond OECD countries.

Methodology

In order to measure the effects of regulatory regimes, an appropriate reference point is needed against which to assess their effects.

In many service industries, the relevant question is not whether to regulate, but rather what type of regulation is most appropriate, and at what level. For example, in network industries, such as telecommunications and electricity supply, elements of the system are often thought to possess natural monopoly characteristics, and need to be regulated accordingly. But too much or too little regulation can adversely affect economic wellbeing.

There are difficulties in judging 'appropriate' and 'inappropriate' regulation for use in empirical work. Among other things, judgements need to be made about the suitability of the instruments chosen to meet the desired objectives and the appropriateness of the levels at which the instruments are set. International assessments of regulatory regimes are even harder, as governments often pursue different policy objectives and the needs, priorities, values and circumstances can differ between economies.

A first step in measuring the effects of regulatory regimes is to compare them with a pre-determined or benchmark regulatory regime that is considered broadly 'representative', somehow defined, of an 'appropriate' regulatory regime. Such an

approach recognises that some form of regulation may be needed, even if it is captured only stylistically.

This study adopts this approach, by comparing the effects of the actual regulatory regimes in place in various economies against those regimes that the OECD's analytical results suggest would minimise prices in the relevant service industries. This approach does not allow for the possibility that a regulatory regime may be too liberal. While this is a theoretical possibility, the way the regulatory variables are defined and measured in the OECD working papers means that it is unlikely for the regulatory variables considered here. Therefore, the measures derived in this study should estimate the extent to which the regulations considered are too stringent. Yet, given the limited number of restrictions considered in the OECD working papers, the estimates derived in this study are likely to understate the impact of *all* inappropriate regulation.

The approach contrasts with OECD follow-up work, released as this study was being completed, which measured the price impacts of regulatory regimes against the OECD average prices. Either approach is useful for descriptive purposes. But the approach in this paper is preferable if the economic effects of inappropriate regulations are to be formally modelled.

The original OECD working papers econometrically estimated the effects of *individual* regulations in most OECD economies on price, taking into account certain relevant industry and economy-specific characteristics. Included were indicators of some of the key economic regulations existing in the international air passenger transport, telecommunications and electricity supply industries in OECD economies.

In particular, the OECD studies focused on the following regulations.

- For international air passenger transport, its modelling work covered designation requirements (limits on the number of airlines that can provide services), capacity constraints, price controls, and restrictions on the provision of non-scheduled (charter) services. These restrictions generally determine the nature and extent of competition in individual air travel markets, the airfares charged and the degree to which airlines can satisfy customer needs.
- For telecommunications, its modelling work covered restrictions on entry to the industry, the ownership of telecommunication operators and foreign investment. These restrictions influence the nature and extent of competition in the industry, the ability of new firms to enter the market, the prices charged and the level of foreign investment.

- For electricity supply, its modelling work covered restrictions affecting industry structure, the operation of the generation sector and access to essential facilities. These restrictions generally determine the ability of new generators to enter the market, the extent of competition in the generation sector, the prices charged, and the degree to which potential gains in the generation sector can be expropriated by those controlling the transmission system.

As such, the working paper on international air passenger transport focused on regulations affecting *international* trade in aviation services, whereas the telecommunications and electricity supply working papers focused on *domestic* regulation (also including foreign investment in telecommunications).

The methodology used here to estimate price effects of regulation extends the OECD work in two ways. First, it uses the OECD's analytical results to derive regulatory tax equivalents — an *overall* measure of the effects of domestic regulatory regimes on prices in the three services industries. Second, it extends the estimation of tax equivalents beyond OECD economies, based on the econometric results of the OECD sample. In both cases, it places a greater burden on the OECD's econometric results than did the original authors.

The approach of applying OECD econometric results to non-OECD countries has been adopted for practical reasons. Re-estimating the full econometric models to include additional economies would require the investment of considerable time to collect additional data, not just on regulatory regimes, but also on industry performance measures and other market and industry characteristics. Using the methodology adopted here, only information on regulatory regimes in non-OECD economies is generally required.

The resulting price measures should be treated with some caution, owing to limitations associated with the original econometric modelling, the data used and the way in which the impact measures are derived.

Nevertheless, the price measures estimated here are a useful first step towards quantifying the effects of domestic regulatory regimes. By using the OECD's results, they represent one of the first attempts to assess the effects of domestic regulation across service industries and across economies using the same methodology, and controlling for other factors that affect economic outcomes. The accompanying discussion also draws out the implications of the OECD modelling work, and explores many of the practical issues associated with measuring and assessing the effects of domestic regulation, issues that are important in developing better estimates of price effects of regulation.

Key findings

International air passenger transport

Air travel between economies has long been governed by a complex system of bilateral arrangements. Bilateral agreements typically specify the designated airlines, capacity and airfares, as well as regulating a wide range of airline activities, including safety and technical aspects of aviation (PC 1998).

Several economies, most notably those in the European Union, have undertaken substantial liberalisation of their air service arrangements. This process has taken place in a bilateral or regional setting, reflecting the constraints that the bilateral system imposes on unilateral reform. The liberalisation to date has reflected the recognition that inappropriate regulation can have significant effects on airlines and their customers, in terms of higher costs and prices.

The OECD working paper modelled the influence of designation, capacity constraints, price controls and restrictions on charter services on a number of international air routes linking OECD member economies. The OECD results showed that, with some limitations, these restrictions have significant effects on airfares. Applying the OECD results to 35 OECD and non-OECD economies, these restrictions are estimated to collectively increase international airfares by between 3 and 22 per cent. The price measures are likely to underestimate the extent to which all regulation affects international airfares, given the limited coverage of restrictions in the OECD working paper.

Telecommunications

Rapid technological change over the last decade has had a marked effect on the telecommunications industry in most economies; it has led to the creation of new markets and improved existing services. Technological change has also reduced, possibly even eliminated, many of the rationales underpinning the prevailing regulatory regimes, and made viable competition possible in many segments of the industry for the first time. As a result, many economies have modernised their regulatory regimes to better reflect the rapidly changing circumstances of the industry. Regulatory reform commenced in the newly emerging cellular (mobile) and data (internet) markets and has gradually spread to existing services.

Regulatory reform has focused on nurturing and fostering competition in those sectors of the telecommunications industry thought not to possess natural monopoly characteristics, and on preventing incumbents from exploiting any market power

arising from their control over those parts of the network thought still to possess those characteristics. This has involved allowing new entrants to make use of the incumbent's network on 'fair and reasonable' terms, relaxing restrictions on foreign investment, partially or fully privatising government-owned telecommunication operators, and removing pre-existing price and output controls.

The OECD working paper modelled the effects of some of the key regulations on prices in four industry sub-sectors — trunk, international, mobile and leasing. The paper also drew inferences about the effect of regulations from the structure of the markets in the four sub-sectors, as market structure in network industries is often influenced by regulations.

Owing to important methodological concerns, the price impacts obtained for the telecommunications industry should be treated cautiously. Applying the OECD results to additional OECD and non-OECD economies, the price impacts generally suggest that there is a weak, but positive, relationship between regulation and telecommunications prices — economies with regulatory regimes that are more restrictive tend to have higher telecommunications prices. This is especially true for many non-OECD economies, if the various assumptions employed are realistic.

However, the relationship between regulation and price is considerably weaker for certain more affluent European economies that have low telecommunications prices, such as Sweden, Luxembourg, Denmark and Finland.

Electricity supply

The electricity supply industry the world over is a highly regulated industry, with much of the regulation aimed at preventing incumbents from exploiting any market power that they may have as a result of economies of scale, especially in transmission. In many cases, government intervention in the electricity industry extends well beyond regulation of the industry to include government ownership.

Several economies have undertaken substantial liberalisation of their electricity supply industry, with the primary focus being on developing competitive markets in those segments of the industry that do not possess natural monopoly characteristics. To date, most liberalisation has focused on the generation sector.

The OECD working paper modelled the influences of structurally separating electricity generation (a potentially competitive activity) from transmission (a natural monopoly activity), enabling third party access to the transmission grid, establishing a wholesale electricity market, and the effects of liberalisation, privatisation and private ownership in OECD economies. The OECD results

showed that a number of these regulations have significant effects on industrial electricity prices.

Owing to methodological limitations, the price impacts obtained for the electricity supply industry should also be treated with some caution. Applying the OECD results to additional OECD and non-OECD economies suggests that inappropriate restrictions increase industrial electricity prices by between 0 and 35 per cent. Although these estimates may be considered upper estimates of the extent to which these regulations are too stringent, they nevertheless are likely to be minimum measures of total price effects, given the limited coverage of restrictions in the industry.

1 Introduction

Service industries have grown rapidly over the last fifty years and, in most developed economies today, account for a higher proportion of national income than all other industries combined. At the same time, international trade in services has expanded significantly, albeit from a much smaller base.

Service industries are also subject to a diverse range of regulation designed to achieve various economic and social objectives. The rationale for economic regulation of these industries is sometimes strong, and social objectives can also be more compelling (PC and ANU 2000).

For many service industries, the question is not whether to regulate, but rather what type of regulation is most 'appropriate' and at what level. Some regulation is often needed, but too much or too little regulation can adversely affect economic wellbeing.

Appropriate regulation can enhance economic wellbeing by diverting resources into socially desirable outcomes or away from socially undesirable activities. Competition policies (such as the Trade Practices Act in Australia), for example, are designed to prevent firms from exploiting any market power that they may have. Such policies are particularly important in network industries, such as telecommunications and electricity, where control over the natural monopoly segments of the industry can be used to expropriate gains arising elsewhere in the industry (King 2000). Third party access arrangements can facilitate competition by enabling new entrants to gain access to natural monopoly segments on fair and reasonable terms, thereby preventing those controlling those segments from abusing their market power. Similarly, emission controls can reduce the amount of harmful pollutants emitted into the atmosphere.

Conversely, inappropriate regulation can reduce economic wellbeing, either by being more or less stringent than needed to achieve the desired objective. In such cases, regulation can divert resources into activities where they earn a lower or higher return to society than they would in an appropriately regulated market.

Inappropriate regulation can unnecessarily increase costs to producers, who, in turn, may pass them on consumers in the form of higher prices. Alternatively, it can afford producers additional protection from domestic and/or foreign competition,

thereby enabling them to earn higher profits than they otherwise might. Likewise, inappropriate regulation can weaken the incentives to undertake worthwhile investment. Intentionally or unintentionally, regulation can impact on the level and distribution of almost all economic activity, be it production, trade, investment, employment, wages or profitability.

It is important to have good information on the effects of regulation in order to assess its appropriateness. Good information helps to inform the policymaking process with a view to improving regulatory outcomes and accountability. Once the effects of regulation are better understood, policymakers and regulators are better placed to assess whether the intended objectives are being met in the most cost-effective manner and to identify the benefits, costs and desirability of regulatory reform. Measuring the effects of regulation is an important part of this information gathering process.

This raises the question of how to measure the effects of current regulation.

One approach is to assess the effects of regulation against an unregulated world. However, such an approach does not measure *inappropriate* regulation in those service industries where some form of economic or social regulation may be desirable.

Another approach is to assess the effects of regulation against the appropriate level. However, there are difficulties in judging 'appropriate' and 'inappropriate' regulation for use in empirical work. Among other things, judgements need to be made about the suitability of the instruments chosen to meet the desired objectives and appropriateness of the levels at which the instruments are set. International assessments of regulatory regimes are even harder, as governments often pursue different legitimate policy objectives and the needs, priorities, values and circumstances can differ between economies.

Nevertheless, the approach here is to assess the effects of regulation against some pre-determined or benchmark regulatory regime that is considered broadly representative, somehow defined, of the 'appropriate' regulatory regime. Such an approach implicitly acknowledges that some form of regulation is needed, even if the way in which the regulations are actually modelled is somewhat stylistic. From this, the choice of the benchmark regime and the way the regulatory variables are measured can be debated and further refined if necessary.

In assessing the effects of inappropriate regulation, this study draws heavily on some recent OECD work, undertaken as part of its ongoing research into the effects of regulation. The studies focus on three important network industries —

international air passenger transport, telecommunications and electricity supply — for which little cross-country empirical research has been conducted so far.

The OECD working papers econometrically estimated the effects of *individual* regulations on international air passenger transport, telecommunications and electricity prices, controlling for certain relevant industry and economy-specific characteristics.

Included were high-level indicators of some of the key economic regulations existing in OECD economies. International air passenger transport has been governed by an arcane system of bilateral restrictions that limit effective competition and constrain the efficient provision of international air services. Regulation in the telecommunications and electricity supply industries has been motivated by natural monopoly characteristics in at least some components of the industry. OECD countries have reformed these regimes at different rates, and the OECD research sheds light on how different regulatory regimes have contributed to different economic outcomes across these economies. While the indicators broadly capture many of the key regulations in these sectors, they are unable to measure many of the real-world complexities that also affect economic outcomes.

This study seeks to measure the extent to which inappropriate regulation in international air passenger transport, telecommunications and electricity supply may have raised prices. It does so by extending the OECD research into the effects of regulation in these industries in two important respects. It uses the OECD's analytical results to derive regulatory tax equivalents — an overall measure of the effect of domestic regulatory regimes on prices in each service sector. And it extends this measurement beyond OECD countries. In both cases, it places a greater burden on the OECD's econometric results that did the original authors.

The regulatory tax equivalents compare the effects of the regulatory regimes in place in various economies, with those regimes that the OECD's analytical results suggest would minimise prices in these three network industries. Thus, this approach does not allow for the possibility that any regulatory regime actually implemented may be too liberal. While this is a theoretical possibility, the way the regulatory variables are defined and measured in the OECD working papers means that it is unlikely for the regulatory variables considered here. Therefore, the measures derived in this study estimate the extent to which the regulations considered are too stringent. Yet, given the limited number of restrictions considered in the OECD working papers, the estimates derived in this study are likely to understate the impact of *all* inappropriate regulation.

The approach contrasts with OECD follow-up work, released as this study was being completed, which measured the price impacts of the regulatory regimes

against the OECD average prices. Either approach is useful for descriptive purposes. But the approach in this paper is preferable if the economic effects of inappropriate regulations are to be formally modelled.

The regulatory tax equivalents estimated in this paper for the international air passenger transport, telecommunications and electricity supply industries are derived and discussed in chapters 2, 3, and 4, respectively. These chapters also draw out the implications of the OECD modelling work, and explore many of the practical issues associated with measuring and assessing the effects of domestic regulation, issues that are important in developing better estimates of price effects of regulation.

2 International air passenger transport

Air passenger transport is an internationally traded service. Air travel between economies has become an important mode of transport in most economies and the industry has grown rapidly in recent times. Air passenger transport is also an integral part of other economic activities, such as international tourism. It is therefore important that the service is provided efficiently without compromising safety.

International air transport is also one of the most regulated industries. For over half a century, a system of bilateral air service arrangements (ASAs) among economies has regulated various aspects of aviation production and trade, largely outside the multilateral framework of trading rules. The bilateral system developed as a mechanism to facilitate trade in air transport, because unlike trade in goods, international air flights require the cooperation of economies in providing the necessary infrastructure and air traffic rights. However, the bilateral system has also created various limits on competition and trade in aviation services.

In recent years, many economies have substantially liberalised air service arrangements or made a commitment to do so.[1] This development reflects a recognition of the effects of restrictions on airlines and users, especially in terms of higher costs and prices. Under the constraints of the bilateral system, reforms have been undertaken within a bilateral or regional framework, but substantial restrictions still remain.

A recent OECD study (Gonenc and Nicoletti 2000) developed an index methodology to measure bilateral restrictions in international air passenger transport and, using econometric estimation, examined the effects of such restrictions on airfares.[2] The OECD analysis covered a selected group of OECD air travel markets, but its methodology and empirical findings can be generalised to other economies.

This chapter uses the modelling work of Gonenc and Nicoletti to:

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[1] For example, the Australian Government has made a commitment to further liberalise Australia's restrictions on a bilateral and multilateral basis (Costello and Anderson 1999).

[2] The OECD released a follow-up paper (Gonenc and Nicoletti 2001) as this study was being completed. Apart from a minor extension (discussed later) and some additional commentary, the two papers are identical, including the index methodology and econometric results used here.

- derive an *overall* measure of the impact of each country's restrictions on international air passenger transport on business, economy and discount airfares in each of the 13 OECD countries included in their study; and
- extend the coverage of countries to include an additional 22 OECD and non-OECD economies, on the assumption that the effects in OECD economies are broadly representative of those in non-OECD countries.

This chapter first discusses current regulatory arrangements and constructs an index measure of restrictions for a range of economies, drawing on the OECD methodology to quantify restrictions at the route level. By measuring restrictions in various bilateral agreements, it is then possible to gain a clearer view of the overall pattern of restrictions and the extent of liberalisation in each economy. The chapter then develops preliminary estimates of the price impacts of restrictions, as a measure of the extent to which restrictions have raised service prices above a minimum price benchmark. The methodology used in estimating those price impacts draws on the OECD econometric results of route price effects, but also derives an overall price measure for each economy.

2.1 Current regulatory arrangements

The bilateral system establishes various air service rights (box 2.1) to allow air flights between economies, in recognition of countries' exclusive sovereignty over their air space. Past attempts to create a multilateral agreement on aviation services resulted in a multilateral exchange of first and second freedom rights only,[3] while all the remaining rights must be negotiated on a bilateral basis. Bilateral negotiations typically lead to an exchange of third and fourth freedoms which are subject to various controls (see below), while the remaining freedoms are often prohibited. The 'freedoms of the air' and their restrictions effectively define the relevant markets to which airlines can provide aviation services.

The bilateral system operates within a positive list approach — a particular service cannot be provided unless it is explicitly permitted. ASAs generally determine the number of airlines, capacity, routes, flight frequency, airfares and airline ownership and control, with provisions for a range of other matters, including safety and aviation security issues. The nature of these restrictions varies across agreements.

[3] This is through the International Air Services Transit Agreement of 1945 (IASTA), which was established at the Chicago Convention in 1944. The IASTA currently has some 100 member economies, including Australia.

Reciprocity forms the basis of bilateral negotiations. Most arrangements are formal agreements, but economies also impose restrictions through less formal arrangements, including Memoranda of Understanding and/or exchange of letters.

The bilateral system of air transport regulations is largely outside the multilateral framework of trading rules. The General Agreement on Trade in Services (GATS) does not apply to most international air transport services.[4] A consequence of this is that ASAs permit discriminatory treatment of service providers from third countries, as the most favoured nation principle[5] does not apply.

Box 2.1 **Freedoms of the air**

First freedom	the right of an airline from one economy to fly over the territory of another economy without landing
Second freedom	the right of an airline from one economy to land in another economy for non-traffic purposes, such as repairs and maintenance, while en route to another economy
Third freedom	the right of an airline from one economy to carry traffic from its own economy to another economy
Fourth freedom	the right of an airline from one economy to carry traffic from another economy to its own economy
Fifth freedom	the right of an airline from one economy to carry traffic between two other economies provided the flight originates or terminates in its own economy
Sixth freedom	the right of an airline from one economy to carry traffic between two other economies via its own economy. This is a combination of third and fourth freedom
Seventh freedom	the right of an airline to operate flights between two other economies without the flight originating or terminating in its own economy
Cabotage	the right of an airline of one economy to carry traffic between two points in another economy

Source: DTRD (1998).

4 GATS coverage is limited to policy measures affecting ground handling and similar services, including aircraft repair and maintenance services, computer reservation services and the selling and marketing of air transport services (WTO 1998).

5 Under the GATS, the most favoured nation principle requires that World Trade Organisation members treat the services and service suppliers of any member no less favourably than they do like services and service suppliers of any other country.

Main provisions in bilateral agreements

Most ASAs contain provisions to determine the terms and conditions of air flights between two countries. These provisions govern fundamental aspects of aviation production and trade, including conditions of entry, the ability to determine output and the freedom to set prices.

Designation

Under most ASAs, airlines must be designated or authorised to provide international air travel services. The justification for designation requirements is that each country should exercise its air traffic rights through its own flag airlines. The International Civil Aviation Organisation (ICAO) has classified designation policies into the following:

- single designation — each economy permits only one airline to provide the service between it and other destinations;
- multiple designation with route limitations — the bilateral partners permit more than one airline to provide the service, but on specific routes only one airline is allowed to operate; and
- multiple designation — each economy may designate more than one airline to operate the service (without specific route limitations).

Designation requirements limit the number of airlines providing services on particular routes and prevent entry by third countries' carriers. Barriers to entry in air transport reduce competition between airlines and create the potential for anti-competitive behaviour and higher prices.

Capacity

An important bilateral arrangement is the restriction on airlines' capacity and market shares in providing the service on a route. Capacity controls can involve limits on the number of seats, the frequency of services and/or the types of aircraft used. The ICAO has identified four broad types of capacity arrangements.

- Predetermination — an agreement on capacity reached by both economies before airline operations begin. Predetermination can involve a specified capacity share between airlines, maximum (or minimum) frequencies of flights, or geographic allocation of capacity.
- Bermuda 1 — capacity regulations similar to those in the 1946 agreement between the United Kingdom and the United States. Under this arrangement,

airlines act separately to determine capacity with *ex post* government monitoring and review (if an airline contests the capacity provided by an another airline).

- Free determination — liberal provisions in which both economies agree not to impose unilateral restrictions, except for general safety and technical reasons.
- Hybrid approach — provisions which cannot be classified under any of the above categories, or combinations of the above categories.

Capacity constraints may enable incumbent airlines to maintain higher load factors and prices than otherwise, by preventing the more efficient airlines from expanding existing services or entering new routes. However, capacity regulations may also restrict the growth in capacity and have other effects. When capacity regulations operate in combination with other constraints, such as restrictions on the routes and cities airlines can fly, the net effect could be to limit the efficient operation of airlines and raise the cost of providing the service. The effects of regulations in international aviation services are discussed in detail in PC (1998).

Over time, several economies have moved away from predetermination and towards free determination. A recent development is the application of competition policy instruments designed to counter predatory business practices, involving the use of general competition laws (abuse of dominant position) or of specific regulations to combat predatory practices in air transport (WTO 1998).

Price regulation

Most bilateral arrangements establish a mechanism to determine airfares:

- double (dual) approval process — proposed airfares require the approval of both economies before they can take effect;
- country of origin method — a party may disapprove airfares only for flights from its own territory; and
- double disapproval process — airfares would be allowed unless they are disapproved by both economies, reducing government involvement and providing airlines the flexibility to set fares.

Price regulation limits competition on the basis of prices such that airfares may not be set at the minimum efficient levels reflecting airlines' costs. Price coordination on the route can also arise, especially when barriers to entry are present.[6]

[6] Fare regulation may not be fully effective and, in several markets, official prices can differ greatly from the prices actually charged as a result of airlines' pricing strategies (WTO 1998).

Non-scheduled services

Non-scheduled services (including charter services) can provide a significant source of competition to scheduled (regular) services. In regions such as Europe, charter services have strongly established themselves as direct competitors to scheduled services, especially in the discount segment of the market (Button, Haynes and Stough 1998). Non-scheduled services are often provided on an irregular or inflexible basis, but can be much less expensive than scheduled services. Non-scheduled services are often taken up by leisure travellers on inclusive holiday packages.

Bilateral agreements may not authorise the operation of non-scheduled services. In some regions, such as Europe, the regulation of non-scheduled services has traditionally been liberalised through regional agreements.[7]

Other restrictions

Several other restrictions also operate to limit trade in international air passenger transport. These restrictions tend to reinforce the bilateral nature of existing regulatory arrangements. They often lack the sound economic justification that underpins the direct regulation of airline technical standards to ensure safety and security.

Restrictions on foreign ownership of airlines are of major importance in aviation services. Ownership restrictions underpin the system for designation and authorisation of airlines (PC 1998). In bilateral arrangements, designation often requires a test that designated airlines are 'substantially owned and effectively controlled' by the country or nationals of that country. At the national level, foreign ownership restrictions specify the maximum limit of ownership and control foreigners can have and prevent foreigners from establishing in another economy or mergers of airlines across national boundaries. While foreign ownership restrictions operate as barriers to competition, they also limit access to international capital and constrain airline performance in fundamental ways.

The absence of fifth and seventh freedom rights prevents competition from third countries' carriers on air travel routes. The use of fifth freedom rights depends on the approval of the third country which represents the intermediate or beyond point

[7] For example, the Multilateral Agreement on Commercial Rights of Non-scheduled Air Transport in Europe, which was established in 1956, substantially liberalised charter activities between 18 European economies (WTO 1998).

for international flights. Fifth freedom traffic has been a sizeable component of total traffic in some economies, especially Asian economies (Oum and Yu 2000).

International airlines face restrictions on providing domestic services in another country (cabotage) under the bilateral system. Cabotage restrictions have traditionally been justified as a means of protecting national air space and security. In some parts of the world, cabotage restrictions have been removed.

In international air transport, the regulation of airline technical standards has an important role in ensuring that air services are provided without compromising safety and security. Under current arrangements, individual economies are responsible for the regulation of safety and ensuring that their safety standards conform with the international standards set by the ICAO. In general, safety regulation is administered separately from the bilateral system, but some economies have chosen to incorporate additional safety requirements in bilateral agreements.

2.2 Measuring restrictions

A feature of the existing bilateral system is the considerable variation in the restrictions applying to various bilateral agreements and air travel markets. This variation exists at a national level as well as across economies. Air service liberalisation has also been uneven, reflecting the partial and agreement-specific nature of bilateral reform and different rates of progress across economies.

To compare the extent of air transport restrictions across economies, it is desirable to devise a method of converting qualitative information about restrictions into a quantitative measure. For air transport, such a quantitative measure would need to take into account different bilateral (or regional) arrangements that discriminate against third countries and the extent to which liberalisation has occurred.

Index methodology

This section develops a quantitative index measure of bilateral restrictions in international air passenger transport for a selected group of economies. An economy's index is measured as an *average* of the bilateral indexes — each bilateral index (*BRI*) is a summary measure of the restrictions operating symmetrically for a given country pair.[8] The economy index indicates the average

[8] Some ASAs could be considered to have asymmetric arrangements, especially in the exchange of air traffic rights. In some agreements between the United States and Asian economies, US airlines have extensive fifth freedom rights, whereas Asian carriers face limits on access rights in the United States (Oum and Yu 2000). These aspects of ASAs are not covered in this study.

number of restrictions per bilateral agreement that each economy maintains. The higher the economy index, the more restrictive on average its regulatory regime is considered to be.

OECD bilateral index

Construction of the bilateral index draws on the approach developed in the recent OECD study (Gonenc and Nicoletti 2000) to quantify restrictions across various bilateral agreements. The OECD index methodology can be broadly described as follows.

- Information on airline designation, capacity, fare and charter services restrictions was compiled from two ICAO documents (ICAO 1988 and 1995). These sources were supplemented by OECD information sources on recent reforms in OECD member economies.
- The above restriction categories contained specific arrangements that were given scores ranging from least to most restrictive. The arrangements identified in the OECD paper were based on the ICAO classification as discussed in section 2.1.
- The restriction categories were weighted according to their contribution to the variance of the regulatory data, where the weights were obtained using factor analysis (discussed below).
- The bilateral index score was then derived as a summary score of the restrictions identified in a particular bilateral agreement, using the scores and factor analysis weights.

Table 2.1 shows the coverage of restrictions, the index scores and the restriction weights that were developed in the OECD study to compare bilateral regulatory regimes across air travel routes. In this chapter, those OECD index scores, weights and coverage of restrictions are applied to measure restrictions in additional OECD and non-OECD agreements, with some minor differences. Specific aspects of the OECD methodology and its application in this chapter are discussed below.

The OECD study computed bilateral index scores for 100 country pairs from 13 OECD countries[9], focusing on designation, capacity, fare and charter services requirements, which were also analysed for price effects (section 2.3). Reflecting the limited coverage of restrictions, the index results can be interpreted as a minimum measure of current barriers to trade in international air passenger transport.

9 The OECD bilateral index covers routes originating or terminating in Australia, Canada, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Spain, the United Kingdom and the United States.

Table 2.1 **Bilateral index for international air passenger transport**

Restriction category	*Specific score*[a]	*Factor loadings*[b]	*Weights*[c]	*Weighted score*
Designation requirements		0.88	0.24	
Single destination	1.00			0.24
Multiple destination with route limitations	0.67			0.16
Multiple destination	0.33			0.08
No requirements	0.00			0.00
Capacity regulation		0.89	0.24	
Predetermination	1.00			0.24
Hybrid	0.67			0.16
Bermuda 1	0.33			0.08
Free determination	0.00			0.00
Price regulation		0.93	0.27	
Double approval	1.00			0.27
Country of origin approval	0.67			0.18
Double disapproval	0.33			0.09
No requirements	0.00			0.00
Non-scheduled services		0.85	0.22	
No formal traffic rights for charter services	1.00			0.22
Explicit traffic rights for charter services	0.00			0.00
Regulatory (maximum) score[d]				**0.97**
Market structure score[d]				**0.03**
Total score[d]				**1.00**

a The OECD paper initially assigned a discrete score from 0 to 3 for designation, capacity and fare regulations and a score between 0 and 1 for charter regulation. The OECD paper then converted the initial scores into values so that each restriction category has a score between 0 and 1 (equal weights). **b** Factor loadings indicate the correlations of each restriction category to the 'regulatory factor' in the OECD factor analysis. **c** The weights were derived by dividing the squared factor loadings by the sum of squares. **d** This chapter computes only the regulatory score, while the OECD paper used the total score, which included a small component attributable to market structure variables using factor analysis (see also table 2.4 at the end of this chapter).

Source: Gonenc and Nicoletti (2000) and table 2.4.

In addition to the bilateral index at the route level, the OECD study also developed a regulatory index at the country level, using broad indicators to characterise cross-country differences in air transport regulatory regimes. The country regulatory index was a summary measure (with weights based on factor analysis) of indicators for the existence of domestic and international aviation reform, government ownership of airlines and the time elapsed since liberalisation (ie 'maturation' effects of reform). However, the partial coverage of bilateral agreements and the judgmental nature of some indicators raise some difficulties in extending this index

to non-OECD countries[10] and the country regulatory index is not examined further in this study.

Information sources

In deriving index estimates for additional OECD and non-OECD agreements, the key information sources are two ICAO documents which provide detailed information on over 3000 ASAs worldwide up to 1995 (ICAO 1988 and 1995). The ICAO documents classify the restrictions into specific arrangements as discussed in the previous section. Most of the listed arrangements are formal agreements.

While the ICAO sources are extensive, their coverage of air service arrangements varies considerably for the economies studied and, for several reasons, the information may not reflect the actual policies currently operating. First, economies may choose not to register the informal and confidential arrangements with the ICAO, particularly the allocation of capacity. Second, the ICAO sources exclude plurilateral and regional air service arrangements in their coverage. Third, several new or revised agreements have taken effect since 1995. To partly address these problems, supplementary information has been gathered from:

- APEC Transportation Working Group (1999) for information on APEC bilateral arrangements;
- US Department of State (2001) for information on US 'open skies' agreements;
- OAS Trade Information Unit for information on air transport policies in South American economies;
- DTRD (1998) and PC (1998) for information on Australia's ASAs; and
- Button, Haynes and Stough (1998) for information on European air transport arrangements.

[10] The indicator for international aviation reform provided for 'open skies' agreements with the United States and regional aviation agreements only, but excluded other bilateral agreements that OECD members currently have. Extending this indicator suggests that most non-OECD countries would be treated on the same scale, even though they have different bilateral arrangements. In contrast, countries that have liberalised on a regional basis would be considered highly liberal, even though they still maintained bilateral restrictions against third countries.

Applying the indicator for domestic reform to non-OECD countries would also require judgments on whether deregulation has improved market outcomes. According to this indicator, some countries, such as Australia, were considered restrictive on the basis that domestic policy reform had not led to a change in market structures. However, the possibilities of new entry into the domestic market also depend on other factors, including the size of the market and cabotage restrictions (Forsyth 1998). In addition, policy reform can also lead to greater competition among incumbent airlines, quite independently of the effects created by new entry.

The index estimates cover 875 routes spanning 35 economies[11] in the Asia Pacific, American and European regions where detailed information could be gathered from the above sources. For each economy, the coverage of bilateral arrangements is limited to the existing air service links between those 35 economies under study, rather than every bilateral arrangement that each economy maintains. The number of arrangements compiled for each economy varies from 12 to 35 (table 2.3 at the end of this chapter).

As noted above, the economy index represents the average level of restrictions per agreement or country pair, rather than the total number of restrictions in all bilateral agreements each economy maintains. Averaging restrictions across bilateral agreements/country pairs provides a measure standardised for differences in the coverage of bilateral arrangements across economies. Such differences could give rise to a lack of comparability among economies if the total number of restrictions were used as an overall index measure.

Economies in a regional grouping are not treated as a single entity, even though their intra-regional arrangement reflects a common aviation policy. The different bilateral arrangements maintained by regional economies towards third countries suggest that such differences need to be accounted for in individual country pairs (rather than computing a regional average for individual agreements).

Index weights

An important issue in constructing a summary index of restrictions is how to determine the relevant weights. An unweighted index treats the restrictions equally, even though they could have varying economic importance and outcomes. Studies on services restrictions have sought to overcome this problem in three ways. One approach is to devise a weighting scheme based on judgments as to the relative restrictiveness of restriction categories (Findlay and Warren 2000). For example, the restriction weights can be designed to reflect the relative importance of the modes of supply.[12] Alternatively, given the subjective nature of the weights derived in the first method, econometric estimation can be useful in revealing the relative weights when components of the index or individual restriction categories are entered separately into the econometric estimation of the effects of restrictions on

[11] In addition to the 13 economies included in the OECD study, an additional 22 economies have been included here — Argentina, Austria, Belgium, Brazil, Chile, Denmark, Finland, Greece, India, Indonesia, Malaysia, Mexico, Norway, Luxembourg, Portugal, Sweden, Switzerland, Turkey, the Philippines, Singapore, Thailand and Uruguay.

[12] In industries where commercial presence is the predominant mode of supply, foreign direct investment restrictions would receive a higher weight than, say, restrictions on the movement of people.

economic performance (Kalirajan 2000 and Nguyen-Hong 2000). This is not possible if there is high correlation among various restriction categories (termed multicollinearity), or where there is a lack of in-sample variation in some restriction categories. Finally, statistical methods, such as factor analysis, can be used to derive weights based on characteristics of the restriction data.

Factor analysis, of which the principal components technique is an application, can simplify a complex set of data by combining many correlated variables into a smaller number of (unobserved) dimensions or factors. The factors have a statistical property in that they account for most of the variance in the restriction categories and market structure variables, and in this sense, represent a 'best fit' of the variables under study. A factor is a linear combination of variables that is most associated with that factor, is expressed by a set of 'factor loadings' (the correlations of the observed variables with a factor), and is uncorrelated with other factors. For example, the 'regulatory factor' identified in the OECD study comprises a linear combination of designation, capacity, fare and charter regulatory variables that are highly correlated with the regulatory factor, but not with other market structure factors. For a non-technical explanation of factor analysis, see Kline (1994).

In the OECD study, the restriction weights reflect their contribution to the cross-country variance in the restriction data. A restriction category that has the most variation across different countries/agreements receive the highest weight. The OECD use of factor analysis to derive weights reflected the consideration that:

> Factor analysis has two main advantages over other techniques for aggregating data ... First the approach is data based, with the weights assigned to each variable reflecting the cross-country variability of regulation or market structures, rather than arbitrary assumptions. Second, the resulting indicators account by construction for most of the variance originally found in the data. These properties are particularly desirable when the indicators are used to gauge the potential impact on economic performance of differences in regulation and market structures (Gonenc, Maher and Nicoletti 2001, p. 84).

The OECD factor analysis used principal components to extract the factors — each factor accounting successively for the largest amount of variance in the regulatory and market structure variables and not being correlated with other factors. A standard practice is to retain the number of factors that cumulatively explain a substantial part of the overall variance. Rotation techniques were then used to produce the 'factor loadings'.[13] Since the squared factor loading indicates the

[13] Because principal component analysis produces indeterminate solutions (ie different loadings for the same variance), the factors are 'rotated' using the varimax technique, which produces either high or near zero loadings and, hence, attributes each regulatory variable exclusively to one factor.

proportion of the variance of the restriction category explained by the factor, the normalised squared loadings (the squared loadings divided by the sum of squares) were used as weights to construct the summary measure of regulations (Nicoletti, Scarpetta and Boylaud 2000 and Gonenc and Nicoletti 2000).

As a data-driven method, factor analysis can be useful as it avoids the subjective elements involved in deriving index weights. However, the method has a number of limitations. Results of the factor analysis can be sensitive to data revisions, changes in sample sizes or the presence of outliers. Difficulties also arise in giving a meaningful economic interpretation of the unobserved factors (Nicoletti, Scarpetta and Boylaud 2000, pp. 18–9).

The OECD factor analysis for air transport combined both regulatory and market structure data, whereas other OECD studies on regulations covered only regulatory data (see, for example, Nicoletti, Scarpetta and Boylaud 2000). The OECD bilateral index therefore included some minor scores attributable to market structure variables. To avoid interpretation issues associated with the inclusion of measures of market structure in the regulatory index, this chapter computes the index score using only the regulatory weights and indicators. Table 2.4 at the end of the chapter provides the full results of the OECD factor analysis.

The OECD bilateral index with factor analysis weights is strictly not a measure of the *restrictiveness* of the regulatory regime. This is because high cross-country variation in restrictions may have little or no relationship with the restrictiveness or the relative economic importance of particular restriction categories. The extent to which a policy measure restricts trade and activity depends on several factors, including the nature and the type of the regulation and its effective application in practice. For example, the restrictions captured in the OECD bilateral index differ greatly in scope. Charter services restrictions affect primarily the discount segment of scheduled services market, while others have wider application. In addition, fare regulation received the highest weights in the OECD factor analysis, but there is some evidence that fare regulation may not be fully effective in several markets (section 2.1). Apart from these problems, it is conceivable that the use of factor analysis could lead to paradoxical results — in the sense that the more important restrictions, if they are applied widely and consistently across countries, could also have low cross-country variation and thus low factor analysis weights.

For the purposes for comparing patterns of restrictions across economies in this chapter, the index estimates derived using the OECD factor analysis weights provide only an indicative ‘summary’ measure of the restrictions. Indeed, the OECD factor analysis weights are broadly similar to those weights if the restrictions were treated equally (table 2.1).

Index results

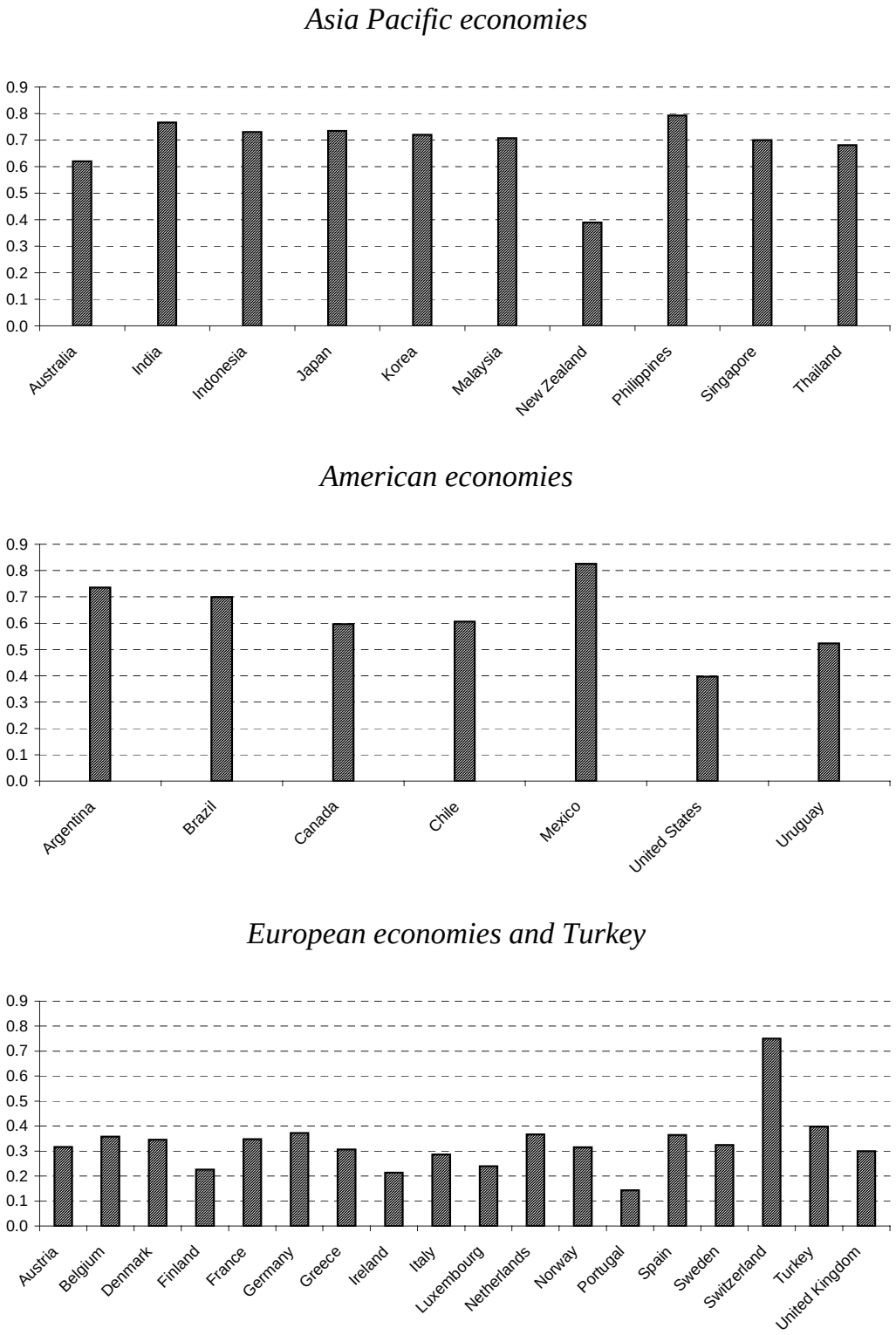
Figure 2.1 shows the index results for 35 economies in the Asia Pacific, American and European regions. The index scores indicate a simple average of the bilateral index scores computed for each economy. The bilateral index comprises only restrictions on designation, capacity, fare and charter services in international air passenger transport for a particular country pair, using the OECD methodology shown in table 2.1.

The index results indicate substantial variation in the application of measured restrictions across economies. Several economies impose a high level of restrictions on international air passenger transport, while others have undertaken substantial liberalisation and in several cases, additional reform measures not covered in this study. The uneven pattern of bilateral restrictions is a direct consequence of the bilateral system, which has generally permitted the use of agreement-specific barriers while limiting the scope for wider multilateral reform.

Most Asia Pacific economies maintain a high level of bilateral restrictions. However, some economies have recently adopted liberalisation measures in their bilateral and plurilateral arrangements.

- New Zealand has adopted liberal arrangements in a number of its bilateral agreements. The 'open skies' elements in New Zealand bilateral agreements also provide additional liberalisation not covered in this study, including seventh freedom rights, cabotage and relaxation of foreign ownership restrictions.
- A single aviation market has been established between New Zealand and Australia. The arrangement removes the restrictions covered in the index, but also adopts other significant reforms, including the relaxation of foreign ownership restrictions, fifth freedom rights and cabotage restrictions.
- In November 2000, a plurilateral 'open skies' agreement was agreed between the United States, New Zealand, Singapore, Chile and Brunei, building on previous bilateral open skies agreements (discussed below) between the United States and those economies. In addition, the member economies announced that the new arrangement reduces foreign ownership restrictions and is open to accession by other economies (US Department of State 2001).

Figure 2.1 **Restriction indexes for international air passenger transport**
average score



Data source: See table 2.3 at the end of chapter for index scores.

Most American economies tend to have restrictive bilateral arrangements. The United States has the most liberal regime, but some other American economies have also liberalised to some extent.

- The United States' liberalisation of air service arrangements has been pursued via bilateral 'open skies' agreements. To date, the United States has negotiated over 30 open skies agreements with economies in Europe, Asia Pacific and Central and South American regions. Although some differences exist in US open skies agreements, they generally remove restrictions on the number of designated airlines and airfares, and grant third, fourth and fifth freedom traffic. However, the United States' open skies agreements retain restrictions on foreign ownership and cabotage rights and on the origins of airlines serving each route.
- Central and South American economies have also undertaken liberalisation to different extents. Member economies of the Andean Pact (Colombia, Peru, Venezuela, Bolivia and Ecuador) established an 'open skies' air transport regime in 1991. The Fortaleza Agreement, concluded in 1997 between Argentina, Brazil, Bolivia, Chile, Paraguay and Uruguay, provides a more limited reform, involving mainly provisions relating to designation and price regulations.

Economies in the European Union (EU) have the lowest scores, reflecting the substantial liberalisation achieved in establishing a single aviation market from April 1997. Among several reform measures, EU airlines no longer face restrictions on designation, capacity, airfares, charter services, foreign ownership and cabotage (the right to provide domestic aviation services), and are now able to provide service anywhere in the region. However, individual EU members still maintain existing ASAs with non-EU economies, reflecting the closed nature of EU regional arrangement. The index scores for EU economies in figure 2.1 show the existing bilateral restrictions that are still operating in non-EU agreements. The EU single aviation market has been extended to include Norway. International air passenger transport in Switzerland is still subject to existing bilateral agreements.

2.3 Price impacts

The regulatory restrictions in ASAs are likely to have significant effects on airlines and users. Entry restrictions and the allocation of traffic rights to airlines influence the nature of competition among airlines on particular routes and create the potential for the exercise of market power. Moreover, the restrictions can affect airline costs by constraining airline operation and the ability to develop efficient networks. A combination of restricted competition and higher costs are likely to result in higher prices than there would otherwise be.

Regulations are qualitative in nature and measuring their effects is not straightforward. Prices of services in restricted and unrestricted situations depend on a number of factors other than regulations. These factors would need to be isolated before the effects of regulations could be assessed.

Empirical studies on aviation services have adopted different approaches to assessing the effects of regulations. An approach has been to estimate, by econometric methods, possible influences of regulations on prices or efficiency, correcting for market concentration and cost characteristics in relevant air travel markets. Studies applying this approach to international air routes and airfares include Gonenc and Nicoletti (2000), Savage, Smith and Street (1994) and Dresner and Tretheway (1992). Studies using this method to examine airline costs and efficiency include Oum and Yu (1995 and 1998), which were able to identify several factors affecting productivity differences among the world's major airlines, including the effects of air service liberalisation. Another approach is to examine the effects of restrictions in a spatial modelling framework to explicitly take into account demand, cost and airline network characteristics. Applying this approach, Gregan and Johnson (1999) modelled the effects of the entry of a new carrier on prices, costs and air travel routes under different liberalisation scenarios for Australia.

These studies have provided empirical evidence of the effects of restrictions on prices and efficiency. The OECD air transport study found that bilateral restrictions have significant and positive effects on airfares in major OECD routes. This is also supported by similar findings in Savage, Smith and Street (1994) for Australia's international routes and Dresner and Tretheway (1992) for North Atlantic travel routes. Also on Australia's international routes, liberalisation and entry of new carriers were likely to have downward effects on airfares (Gregan and Johnson 1999). In relation to efficiency, Oum and Yu (1995 and 1998) found that the liberalisation measures implemented in Europe since 1987 resulted in substantial productivity improvements for European airlines. Surveys of other studies concerning the effects of liberalisation in air services can be found in IC (1997) and WTO (1997).

This chapter uses the results of the OECD air transport paper (Gonenc and Nicoletti 2000) to provide estimates of the price effects of restrictions for additional OECD and non-OECD routes. The OECD paper is the most recent study that has attempted to measure bilateral restrictions in a detailed and systematic way (section 2.2). This chapter applies the OECD's route-level econometric results on the effects of bilateral restrictions for the 13 countries covered in Gonenc and Nicoletti (2000) to obtain price impact measures for each of the 35 countries considered here, thus avoiding the more ambitious approach of remodelling air transport restrictions for

those countries not included in the original sample. Such a remodelling exercise would need to overcome several constraints, including the large data requirements associated with such econometric estimation. The approach adopted here provides initial indications of the price impact of restrictions, which can be further developed and refined over time.

OECD model of airfares

The OECD study (Gonenc and Nicoletti 2000) applied econometric methods to examine possible influences of regulations, market structure and economic characteristics on costs and efficiency of airlines and airfares. Empirical tests were made at three levels of aggregation:

- in cross-country estimation, the country regulatory index and environmental variables were regressed on measures of airline efficiency;
- in cross-route estimation, the bilateral index and environmental variables were regressed on airfares and a measure of capital productivity (load factor); and
- in cross-route estimation, the index values of *individual* restriction categories were entered separately to determine their effects.

The cross-route estimation of airfares that included the bilateral index as a separate independent variable is of primary interest to this study. Airfares vary considerably across air travel routes, reflecting route-specific characteristics and bilateral restrictions between two countries. The cross-route estimation also accounted for different market segments on each route (eg time sensitive business travel versus less time sensitive tourist travel), with separate regressions for business, economy and discount fares.

Results of the other OECD models generally confirm the findings of cross-route estimation. Restrictive regulatory regimes at the national level are likely to result in inefficiency of national airlines, and at the route level, individual bilateral restrictions could also raise airfares. While these models shed additional light on the particular mechanisms by which prices could be higher under a restrictive regime (eg by reducing efficiency), particular aspects of these models mean that extending them to other countries is problematic. In the cross-country regressions, the country regulatory index only partially captured bilateral arrangements, as noted earlier. In the cross-route regressions of individual restriction categories, high multicollinearity between variables created difficulties in evaluating separate effects of individual regulations and led to the exclusion of some key restrictions in the final regressions. Accordingly, the results are not examined further in this study.

Model specification and variables

In its basic form, the OECD cross-route estimation involved regressing a measure of airfares ($\dot{p}$) on the bilateral index (*BRI*) and a set of environmental variables (denoted as *E*):

$$\dot{p} = \alpha + \beta BRI + \gamma E + \varepsilon \qquad (2.1)$$

where α, β and γ were coefficients that were estimated econometrically.

The independent variables represented the key factors that were expected to affect airfares via their influence on marginal costs and mark-ups.

The estimation therefore captured the *combined* cost-raising and competition-reducing effects of restrictions on airfares. Some restrictions, such as capacity constraints, could be expected to raise airline costs, while others may improve airline profitability by limiting potential competition.[14] The single bilateral index variable was a summary measure of designation, capacity, fare and charter restrictions and measured all influences on price, whether via mark-up or marginal costs.

One environmental variable was the market concentration of airlines providing service on the route. The *route-specific* market structure variable represented the possible influence of actual competition on mark-ups. On many air travel routes, a small number of airlines dominate and the costs of entry can be significant even in the absence of formal regulatory restrictions. Consequently, reduced competition may permit incumbent airlines to raise prices through collusive behaviour. The variable used was a summary measure of the number of airlines and alliances and their capacity concentration on the route, where the airlines included main carriers, challengers and third country (fifth and seventh freedom) carriers.

Another environmental variable was the market structure of the international aviation industry in route-end economies. This was an indicator of potential entry. The hypothesis was that the lower was market concentration in route-end economies, the greater was the likelihood of entry and downward pressure on prices. The variable was a summary measure of the number of airlines and their market concentration at the national level, averaged over both route-end economies.

[14] Potential profitability does not always translate into higher average earnings if it is dissipated through inefficiency or the pursuit of non-commercial objectives. Worldwide profitability of international airlines has been relatively low compared to other industries, and while some are highly profitable, others have recorded losses for several years (PC 1998). Modelling work by Gregan and Johnson (1999) showed that price falls under liberalisation result from reductions in both profits and costs.

In air transport, government-owned airlines have traditionally been involved in the provision of aviation services, often possessing a monopoly or 'national carrier' status or some related advantages over privately-owned airlines. On the other hand, the lack of market disciplines on the operation of government business enterprises means that they could be less efficient than private firms. To capture possible effects from the presence of government-owned airlines on a route, the OECD study included the route market shares of airlines with greater than 30 per cent government ownership as an environmental variable.

On the cost side, the propensity of the population for air travel was included to proxy economies of scale in airline services. The hypothesis was that the higher the potential size of the market, the lower unit costs and airfares would be. The variable was measured as the proportion of the population who were air travellers, averaged over both route-end economies.

Airport conditions also affect airfares. Airport dominance by incumbent carriers could lead to anti-competitive practices to foreclose competitors or raise rival costs (eg by strategically raising flight frequencies). The limited supply or congestion of airport slots, which could arise under existing access rules and prices, may create difficulties in airport access and raise airline costs (as diseconomies of scale). The variable used was a simple sum of the shares of airport slots held by the largest carrier (airport dominance) and binary scores for reported congestion at arrival and departure airports (slot availability) for both route-ends.

The last environmental variable used was the purchasing power parity of currencies (PPP). The actual fare data had been converted to US dollars using nominal exchange rates, and hence, did not reflect differences in price levels and hence purchasing powers (real income levels) across countries. The inclusion of a PPP measure of relative price levels as a separate independent variable in the air passenger transport study contrasts with the approach in telecommunications and electricity (chapters 3 and 4), where the price measures were adjusted for PPP directly.

The original OECD equation also included a variable measuring the average aircraft size of both route-end economies to account for economies of density. On denser routes, airlines can use the most economic aircraft size and achieve other economies though higher load factors. However, the OECD study reported a multicollinearity problem with this variable and subsequently omitted it in the final regression.

The OECD's dependent variable ($\dot{p}$) in the cross-route regression needs some explanation. It measures the deviations of actual airfares (p_a) from the airfare value predicted by stage length (the kilometre distance between take-offs and landings) ($\hat{p}_a$), expressed as a proportion of the predicted airfare ($\hat{p}_a$). That is:

$$\dot{p} = \frac{p_a - \hat{p}_a}{\hat{p}_a}$$

where:

for the business sector $\hat{p}_a = 623 + 0.45km$

for the economy sector $\hat{p}_a = 548 + 0.31km$

for the discount sector $\hat{p}_a = 109 + 0.12km$

km route length between city pairs (expressed in kilometres).

Thus equation (2.1) can be rewritten as:

$$\dot{p} = \frac{p_a - \hat{p}_a}{\hat{p}_a} = \alpha + \beta BRI + \gamma E \qquad (2.2)$$

The equations used to estimate predicted airfares ($\hat{p}_a$) came from supplementary regressions of actual airfares on stage lengths over all routes. Thus, the OECD price measure ($\dot{p}$) took on positive (negative) values if actual airfares were higher (lower) than the predicted airfares based on route length.

The OECD undertook this transformation to overcome a multicollinearity problem when stage length was initially included as an environmental variable:

> Given current regulatory arrangements at the international level, the likelihood that a route is governed by restrictive bilateral air service agreements increases with stage length … [and] this leads to strong collinearity between stage length and the regulatory and market indicators used in the analysis (Gonenc and Nicoletti 2000, p. 22).

In traditional studies, the predicted value of airfares is sometimes used to compare airfares across routes, but has a limitation in that any omitted variables, if they are correlated with stage length, will produce biased estimates of the parameters in the predicted fare equations (Dresner and Tretheway 1992). However, stage length is not the main parameter of interest and, by scaling the dollar fares to be comparable to other independent variables, the method is likely to improve the quality of the regression.

The estimation of equation (2.2) involved ordinary least squares (OLS) regression on a cross-sectional data set of 100 international routes connecting the major airports in 13 OECD economies. Estimation was separately made for business, economy and discount fares. The reference year of the data for the independent variables was 1996-97, while the reference year of fare data was September 1999.

An aspect of the OECD cross-route model was that it did not have the standard specification usually adopted in the econometric studies on airfares (see, for example, Savage, Smith and Street 1994). Because fares also depend on output (passengers), and fares and output are jointly determined, a two-stage least squares procedure would be required to overcome the endogeneity problem between airfares and the propensity for air travel variable (if that is an appropriate measure of airline output on the route). The OECD paper recognised this, but argued that the time lag chosen in the reference year between fare data and independent variables would avoid this problem.

Another potential limitation is the possible presence of group effects in OLS cross-sectional estimation of international routes across economies. Moulton (1986) suggested that when explanatory variables were drawn from a population with grouped structures, such as economies or regions, a single stage OLS cross-sectional estimation could lead to correlation of estimation errors, since unobservable economy-specific behaviour would generate group effects on firms in that economy. Such effects may or may not be present, but would require different estimation procedures, including fixed or random effects specification. The OECD studies on telecommunications and electricity (discussed in chapter 3 and 4) applied different estimation procedures to address the problem of group effects.

Model results

Results of the OECD cross-route estimation for business, economy and discount fares are shown in table 2.2. The OECD paper reported the *standardised* coefficients to compare the relative importance of different variables, while table 2.2 shows the *estimated* coefficients to facilitate calculation of price impacts.[15]

The findings of the OECD cross-route estimation can be summarised as follows.

- The bilateral restrictions captured in the index have a positive and statistically significant effect on all types of airfares. This effect is strongest for business fares, but is less significant for economy and discount fares. This suggests that those restrictions captured in the index raise airfares.
- Route-specific market structures, however, do not have a significant effect in all fare regressions. This could lend support to the hypothesis that potential, rather than actual, competition is a key determinant of airfares on air travel routes.

[15] Standardised (beta) coefficients are the coefficients when all variables are normalised by subtracting the mean and dividing by the standard deviation. The standardised variables therefore have mean 0 and standard deviation of 1. The properties of the model (t-statistics, R-square, F values and other aspects of the regression) remain the same for estimated and standardised coefficients.

Table 2.2 **Results of OECD route level regressions**

	Business fares	*Economy fares*	*Discount fares*
Explanatory variables[a]			
Constant	-1.04***	-0.76**	0.40
	3.25	*2.31*	*1.09*
Bilateral index	0.37***	0.21**	0.17*
	3.75	*2.07*	*1.53*
Route-specific market structure	0.00	0.00	0.01
	0.10	*0.05*	*0.20*
Market structure at route-ends	-0.53***	0.13	0.90***
	-2.14	*0.51*	*3.19*
Airport conditions at route-ends	0.32**	0.37**	0.01
	1.97	*2.02*	*0.26*
Government control over route carriers	0.34***	0.01	-0.15*
	3.75	*0.72*	*-1.41*
Propensity for air travel at route-ends	0.01*	-0.16***	-0.47***
	1.52	*-2.63*	*-7.14*
Purchasing power parity at route-ends	0.63***	0.55**	-0.24
	2.41	*2.02*	*-0.82*
Statistics			
No. of observations	100	100	100
Degrees of freedom	92	92	92
Adjusted R-squared	0.30	0.23	0.40
F-value	7.00	5.11	10.37

a t-statistics are in italics. *** statistically significant at 1 per cent level. ** statistically significant at 5 per cent level. * statistically significant at 10 per cent level.

Source: Gonenc and Nicoletti (2000).

- Results of other environmental variables are less consistent across different fare regressions. These variables tend to change signs or become insignificant when a different fare regression is used. It is harder to reach definitive conclusions about the regression results of these variables.

The explanatory power (adjusted R-squared) for the three fare regressions ranged from 0.2 to 0.4. The OECD follow-up work (Gonenc and Nicoletti 2001) noted that the low fit of some models (such as for business and economy fares) reflected the very high volatility in the fare data used and that some important effects had not been captured by the explanatory variables.

Some of the OECD cross-route results differed from the findings of previous studies. Savage, Smith and Street (1994) and Dresner and Tretheway (1992) found that restrictions tended to raise international airfares in the discount segments, but detected no significant effect on 'economy' and business fares. The explanation in those studies was that airline competition involves both price and quality dimensions. Under increased competitive pressures from liberalisation, airlines

might move to segregate business and non-business traffic and compete on the basis of service quality on economy and price-insensitive business travel. Studies of domestic deregulation observed similar experiences (see, for example, Borenstein 1992, Evans and Kessides 1993 and Morrison and Winston 1989). Those studies tended to find that domestic deregulation led to a greater variability in airfares, as discount fares tended to fall over time, and in some cases, business and economy fares actually increased.

Air service liberalisation can also lead to a greater range and supply of discount fares. Studies of domestic deregulation often found that cheaper discount fares tended to be more readily available in deregulated markets (Forsyth 1998 and the references cited therein). This effect has not been captured in the above OECD airfare equations.

In relation to the results on business and economy fares, the OECD follow-up work (Gonenc and Nicoletti 2001) further noted that unexplained factors were sizeable in many individual countries in its sample and the inclusion of proxies for qualities in extending the analysis would provide a more complete picture of the effects of liberalisation.

Further, the highly significant coefficient estimates of the bilateral index variable on business and economy fares are difficult to interpret given the way the index variable was measured. Certain regulations included in the index variable, such as those affecting charter services, would tend to impact more the discount segment of the scheduled services market, rather than business and economy fares.

While the OECD discount fare model reported a smaller and less significant effect of restrictions on airfares, it had a better fit and potentially captures more fully all the restrictions studied here.[16] The OECD discount fare results are also consistent with findings of previous studies on the effects of air service liberalisation.

Calculating impacts of restrictions

This section develops a measure of the price impacts of restrictions to international air passenger transport and applies it to 35 economies. Before proceeding, it is worthwhile to consider some conceptual limitations in the estimates of price effects developed later in this chapter. Data issues are discussed later in this section.

[16] However, fare regulation may not be fully effective in relation to discount fares.

Identifying benchmark price

The estimation of price impacts requires an assessment of the price at which services would be provided under an appropriate regulatory regime. Ideally, the appropriate benchmark would be a regulatory regime which is likely to bring efficient market outcomes, in terms of lower prices and competitive service delivery, consistent with meeting certain regulatory objectives (eg safety). If it is not possible to devise such a benchmark, an alternative approach which 'approximates' the appropriate regulatory regime is needed.

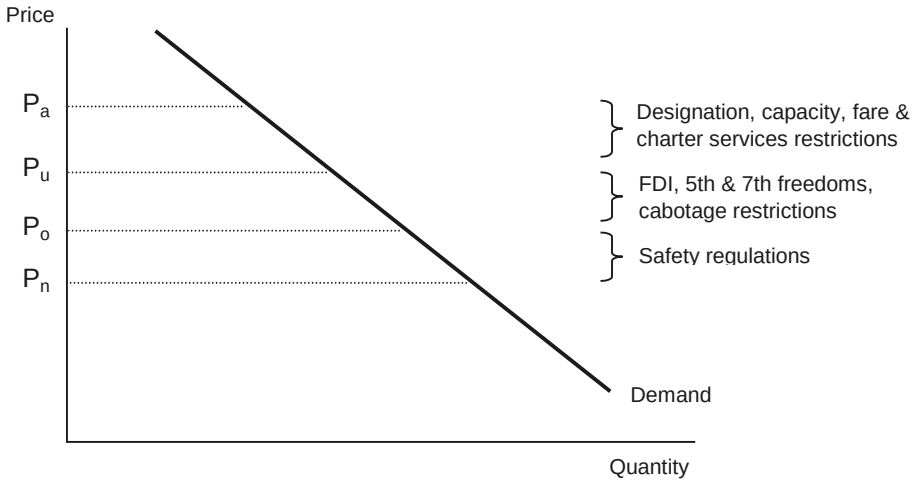
In international air passenger transport, a distinction should be made between regulations that operate as barriers to competition and entry, such as the restrictions covered in this study, and those that address well-founded objectives, such as safety regulations. The complex web of bilateral restrictions in air transport has primarily been a mechanism to protect national 'designated' airlines, including via other policy measures not covered in this chapter, such as those applying to foreign direct investment (FDI), fifth and seventh freedom rights and cabotage.

One definition of the optimal benchmark price could be the price that would prevail with only safety regulations, or alternative policies designed to achieve certain 'legitimate' objectives. For air transport, the limited coverage of regulations in the OECD study does not permit this optimal benchmark price to be identified.

This chapter assesses price impacts by comparing the effects of the *measured* restrictions against alternative regimes which the OECD cross-route model suggest would minimise prices. Reflecting the inappropriate nature of the bilateral restrictions covered, the minimum price also represents the price expected if those particular restrictions were not in place.

Figure 2.2 depicts a simple price model to clarify issues in estimating price impact measures. The model assumes that all regulations in air transport have upward price effects, starting from the price in the absence of *all* regulations, P_n and, for simplicity, the supply curve is horizontal at that price. The price impact derived in this chapter compares the price increase relative to the price at which the *measured* restrictions were not in place (ie $(P_a - P_u)/P_u$). This price impact measure is different from price estimates relative to the absence of *all* regulations (eg $(P_a - P_n)/P_n$). If safety regulations are desirable, but the resulting operational and technical requirements to maintain safety raise airline costs and prices, the 'appropriate' price impact would be the price increase relative to the benchmark price with only safety regulations (ie $(P_a - P_o)/P_o$).

Figure 2.2 **Stylised example of price impact measures**



The above stylised example suggests that the price impact derived in this chapter, while capturing some inappropriate policies, would be a lower bound of the optimal price impact, to the extent that inappropriate restrictions not covered may have some upward effects on prices. The lack of a comprehensive coverage of regulations in the OECD modelling does not permit estimating an optimal price measure, as implied in the above example. This problem generally highlights the need for a detailed and comprehensive listing of restrictions, as an important first step in quantifying regulations in a particular service sector (Findlay and Warren 2000).

The OECD model results suggested that bilateral (or regional) liberalisation was likely to reduce airfares, but they did not necessarily imply the same result would be obtained from unilateral liberalisation. As discussed in section 2.2, the reform to date has taken place in either a bilateral (reciprocal) or plurilateral setting. However, the effects of liberalisation could be different if a unilateral approach were implemented. Under the existing bilateral system, unilateral liberalisation by one economy, while others continued to restrict entry and capacity, could lead to adverse market outcomes for that economy's aviation industry without providing other benefits to consumers (PC 1998).

The OECD follow-up work (Gonenc and Nicoletti 2001), which was released while this paper was being completed, also provided a price measure to gauge the potential impact of liberalisation. Their price measure compared the effects of restrictions against the average OECD price, in contrast to the minimum price benchmark used in this chapter. While the revised study did not report findings for the effect of restrictions separately, the key results for selected routes were as follows:

- the combined effect of restrictions and market structures on airfares was comparable to the combined effect of all other route characteristics;
- on certain routes (such as northern European routes), liberalisation and privatisation of airlines gave business fares that were between 20 and 40 per cent lower than the OECD average; and
- on several Atlantic and Europe-Asia routes, restrictive ASAs, government control of airlines and airport conditions raised fares by more than 20 per cent above the OECD average.

Other empirical issues

An assumption of the price estimates is that air travel routes represent separate markets where substitution possibilities between routes are low and the route service and prices could then be determined by the bilateral arrangement between two countries for that particular route. This assumption may not hold for several air travel routes. A possible effect of liberalisation is the diversion of air traffic from highly restrictive routes to liberalised routes. Maillebiau and Hansen (1995) and Dresner and Oum (1999) presented empirical evidence that a liberal bilateral arrangement affected air travel traffic and airfares in neighbouring countries' restrictive routes. Indeed, it has also been argued that US 'open skies' agreements, which generate competitive pressures on neighbouring countries by a possible diversion of traffic, have led to the spreading of US open skies agreements with those countries.

For several air travel routes, the role of third country airlines using sixth freedom rights is also an important source of competitive pressures to incumbent airlines. Sixth freedom rights represent a combination of third and fourth freedom rights and can operate to circumvent the restrictive point-to-point bilateral agreement to some extent.[17] This effect has not been taken into account in the cross-route model.

Some of the restrictions not covered could also affect the OECD model results and estimates of price effects. For example, the absence of fifth and seventh freedom rights could limit the number of third countries' airlines on air travel routes and may result in higher route market concentration than otherwise. In the OECD cross-route estimation, the route-specific market structure variable captured the presence of third countries' carriers, while the regulatory variable did not include restrictions on fifth and seventh freedom rights. Results of the OECD estimation, however,

17 For example, Singapore Airlines is able to use third and fourth freedom rights under UK-Singapore and Singapore-Australia agreements to operate flights from the United Kingdom to Australia.

suggested that the route-specific market structure variable did not have a significant effect on airfares.

Notwithstanding these difficulties, this chapter proceeds to derive price impacts for a selected range of economies to provide initial indications of the effects of restrictions relative to our benchmark. That said, the full extent of the price increases cannot be estimated with complete certainty, since unexplained influences on airfares are likely to be present in each economy.

Formula

Estimating a single price measure for each of the 35 OECD and non-OECD economies involves deriving first, the route-specific price effects, and then averaging those route effects for a given economy.

Computing the route-specific price effects requires:

- classifying the bilateral restrictions applying to each route according to the criteria set out in section 2.2;
- deriving a bilateral index for each route using the methodology described in section 2.2;
- multiplying the estimated coefficients from the OECD fare regressions (β) (table 2.2) by the bilateral index variable (BRI) to give the fare-raising effect of the restrictions included in the index on the transformed measure of price (βBRI);
- estimating the predicted airfare for each route from its stage length using the same equations as used by the OECD;
- estimating the 'unrestricted' airfare that would exist on each route in the absence of the restrictions included in the bilateral index (using equation (2.7) derived below); and
- estimating the fare-raising impact on the untransformed measure of price from the actual and 'unrestricted' airfares (using equation (2.8) derived below).

The first four of these steps were described in section 2.2. The last two steps are described below.

The price impact measure estimated here for all of the restrictions included in the *BRI* is the percentage increase in airfares attributable to those restrictions, relative to the airfares that would exist if those restrictions were not in place (denoted as p_u). In the absence of measured restrictions, $BRI = 0$. Therefore:

$$\frac{p_u - \hat{p}_u}{\hat{p}_u} = \alpha + \gamma E \tag{2.3}$$

where $\hat{p}_u$ is the predicted value of airfares in the absence of the measured restrictions.

From (2.2) and (2.3), the change in airfares (expressed as deviations from predicted values) resulting from the bilateral restrictions is given by:

$$\Delta\dot{p} = \frac{p_a - \hat{p}_a}{\hat{p}_a} - \frac{p_u - \hat{p}_u}{\hat{p}_u} = (\alpha + \beta BRI + \gamma E) - (\alpha + \gamma E) = \beta BRI \tag{2.4}$$

Equation (2.4) can be simplified to:

$$\frac{p_a}{\hat{p}_a} - \frac{p_u}{\hat{p}_u} = \beta BRI \tag{2.5}$$

Assuming that the predicted airfares based only on route length remain the same in the absence of restrictions (ie $\hat{p}_a = \hat{p}_u$)[18], then

$$p_a - p_u = \hat{p}_a \beta BRI \tag{2.6}$$

and

$$p_u = p_a - \hat{p}_a \beta BRI \tag{2.7}$$

Thus, the price impact of the measured bilateral restrictions on a route is:

$$Route\ level\ price\ impact = \left(\frac{p_a - p_u}{p_u}\right) = \left(\frac{\hat{p}_a \beta BRI}{p_a - \hat{p}_a \beta BRI}\right) \tag{2.8}$$

The price effect for an economy is computed as a simple average of its route price effects:

$$Price\ impact = \frac{\sum_{r=1}^{N} p_r}{N} \tag{2.9}$$

where N is the number of routes measured for price effects in an economy.

18 This is unlikely to hold in practice as the equations used to estimate the relationship between airfares and stage length are based on actual prices in the presence of restrictions and not the prices that would exist on those routes in the absence of the restrictions included in the bilateral index.

The averaging of route price effects is unweighted, rather than weighted by the pattern of air traffic across routes. Simple averaging can produce higher estimates than weighted averaging of price effects, as routes with higher traffic receive the same weights as lower volume routes. However, weighted averaging may introduce its own bias, since restrictions may have the effect of reducing the volume of traffic on a route. This problem is similar to issues in tariff averaging for international comparisons in goods trade.

Data issues

Computing price effects requires data on fares and stage length to be collected for all additional routes on which bilateral restrictions are measured. Following the OECD study, this chapter extracts fare data for each additional route included here from the on-line ticket systems for business, fully flexible economy and APEX (21 days advance booking) discount fares. The fares are those offered in the country of origin by the national or the largest carrier on each route, based on flight traffic information contained in ICAO (1998). The fares represent the price of a single one-way ticket expressed in US dollars.

The fare data for the additional routes included here are for February 2001, as it is not possible to obtain comprehensive historical data as at September 1999, the date of the fare data in the original OECD study.

Several aspects of the fare data suggest limitations in estimating price impacts. A range of fares is usually available for each type of fare and the fares offered by the major carrier on the route may not be representative of the market price. On-line ticket fares could also be higher than the fares offered by travel agent companies, which may provide discounts and other benefits (IC 1997). Where recent liberalisation has led to a reduction in airfares for additional OECD and non-OECD travel routes, but such developments have not been incorporated into the index, the use of actual fares will introduce bias in the estimates of price effects. To minimise this problem, the index estimates have incorporated the most recent regulatory arrangements where that information could be gathered.

Like the OECD study, the stage lengths (in kilometres) for the additional routes included here are obtained from ICAO (1998).

Most city pairs featuring in the OECD study and used here are capital cities, but some allowances are also made for different patterns of air traffic in particular countries. For example, Los Angeles is used for international air travel between the United States and Asia Pacific and south American economies, while New York is used for all other routes.

Summing up on price impact methodology

The methodology and data used to measure price impacts have several limitations. These difficulties suggest that care should be exercised in using a representative price impact measure of restrictions and that such estimates are tentative only. The OECD cross-route model results suggest that price impacts will be highest for business fares, but are lower for economy and discount fares.

Taking into account these considerations, this chapter adopts the price effect estimates on discount fares as the most representative measure of price impacts of the existing regulatory arrangements. The discount fare model had a better fit and captures more fully the effects of all four restrictions studied. The discount fare estimates can be interpreted as a minimum measure of the price increases induced by all inappropriate restrictions. However, the possible presence of unexplained influences in actual prices, competitive as well as anti-competitive, means that the extent of bias is uncertain.

The results are consistent with the findings of previous studies. While previous studies differ in modelling methodology, they suggest that price reductions from liberalisation tend to occur on the discount segment and are of moderate magnitude. Dresner and Tretheway (1992) suggested that liberalisation led to a reduction of average discount fares of 35 per cent on US international routes. On Australia's international routes, Savage, Smith and Street (1994) gave an estimate of price reduction of 16 per cent on discount fares, while Gregan and Johnson (1999) found that fare reduction would be between 2 and 8 per cent.

Price effects for 35 economies

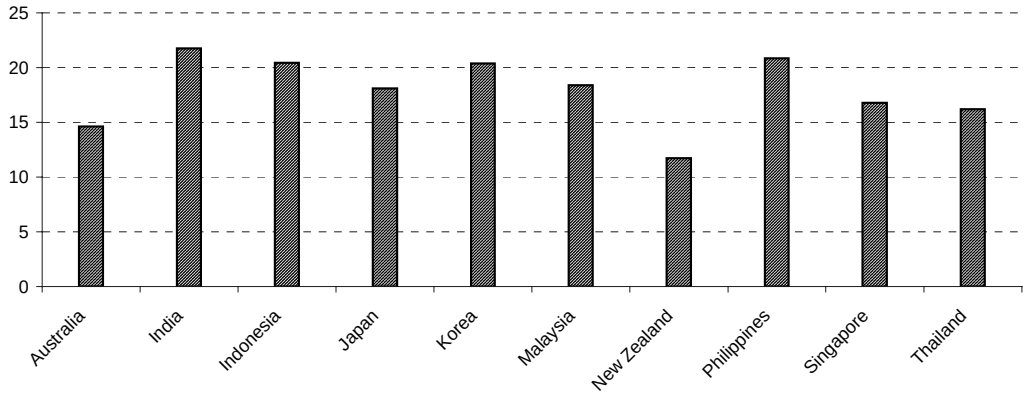
Figure 2.2 shows estimates of the price effects of restrictions on international air passenger transport in 35 economies. Each country's price effect has been represented as a simple average of route price effects. The estimates indicate the effects of restrictions on discount fares, which can be interpreted as the minimum measure of the increases in prices due to inappropriate regulation. Table 2.3 shows price estimates for different types of airfares.

The price impacts of restrictions in international passenger transport vary between economies — ranging from 3 to 22 per cent for discount fares. The estimates indicate that price effects of restrictions are significant in several economies.

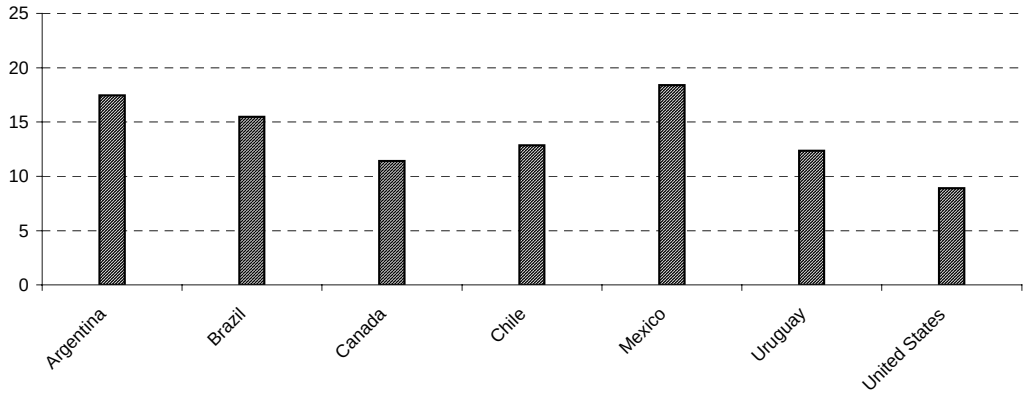
Asia Pacific economies tend to have relatively higher price effects, ranging from 12 to 22 per cent. This reflects a more restrictive system of air passenger transport regulations and the limited liberalisation achieved to date.

Figure 2.3 **Price impacts for international air passenger transport**
per cent

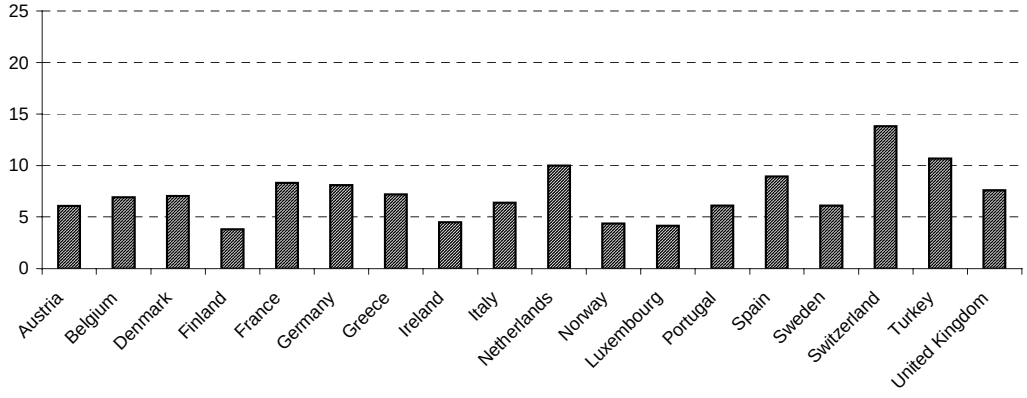
Asia Pacific economies



American economies



European economies and Turkey



Data source: see table 2.3 at the end of chapter for index scores.

American economies have price impacts between 9 to 18 per cent. Of these, the United States has the lowest price impacts, reflecting the liberalisation measures adopted in its open skies agreements.

European economies have lowest price effects. Most economies, except Switzerland the Netherlands and Turkey, record price effects below 10 per cent. These low price impacts reflect the remaining bilateral arrangements between EU member economies and non-EU economies.

2.4 Conclusion

A complex system of bilateral restrictions has governed trade in international air passenger transport in most economies. The bilateral system creates various barriers to entry and competition, but it also operates to constrain the development of efficient aviation services. Empirical evidence suggests that these restrictions have raised service prices.

This study has developed a methodology to quantify restrictions in international air passenger transport. Its key aspects are the emphasis in quantifying regulations at the bilateral agreement level and the application of available evidence, which was provided in the OECD air transport study, to generalise the results to other economies. The methodology attempts to capture the complex and varied nature of bilateral restrictions in detail, while minimising data requirements to estimate price impacts of restrictions.

The results show that most economies in the Asia Pacific and American region continue to maintain a restrictive system of bilateral arrangements. Liberalisation of bilateral restrictions in these economies is expected to result in significant reductions in prices.

Several economies, such as the United States, New Zealand and European economies, have achieved substantial liberalisation of air service arrangements. These liberalisation measures promote competition among airlines which is of considerable benefit to consumers and other economic activities.

The quantitative measures of restrictions and their price effects derived in this chapter are tentative estimates of existing barriers to trade in international air passenger transport. The estimates provide a basis from which future studies can be undertaken to assess empirically the effects of removing bilateral restrictions in OECD and non-OECD economies.

The measurement of trade barriers in air transport can be improved upon in several ways. The coverage of restrictions in air transport can be expanded to include additional agreements to improve comparability between economies and to incorporate other important restrictions not covered in this study. Such attempts facilitate the creation of a comprehensive inventory of restrictions which can also be classified and distinguished according to different modes of supply (see Findlay and Nikomborirak (1999) for an application to air transport). Other important forms of restrictions, such as those applying to foreign direct investment, can be also be analysed for their effects on economic performance. Improvements in modelling methodology and better data on economic performance measures, such as airfares, can refine estimates of price impacts in this chapter.

Table 2.3 **Index results and price effects**

	Number of agreements/ routes	*Bilateral restriction index*[a]	*Price impacts (%)*[b]		
			Business	*Economy*	*Discount*
Asia Pacific economies					
Australia	24	0.62	146.0	54.8	14.6
India	20	0.77	164.4	81.3	21.8
Indonesia	16	0.73	139.7	53.0	20.4
Japan	29	0.73	121.1	41.4	18.1
Korea	18	0.72	181.5	89.9	20.4
Malaysia	22	0.71	199.1	95.6	18.4
New Zealand	15	0.39	82.1	66.8	11.7
Philippines	20	0.79	207.5	70.1	20.9
Singapore	30	0.70	141.5	57.5	16.8
Thailand	25	0.68	124.5	71.3	16.2
American economies					
Argentina	12	0.74	161.7	62.0	17.5
Brazil	19	0.70	195.5	63.9	15.5
Canada	29	0.60	114.5	56.9	11.4
Chile	17	0.61	125.2	49.5	12.9
Mexico	19	0.82	224.7	92.2	18.4
Uruguay	32	0.52	96.9	38.5	12.3
USA	32	0.40	52.9	33.2	8.9
European economies					
Austria	28	0.32	47.2	20.6	6.1
Belgium	31	0.36	63.3	22.0	6.9
Denmark	30	0.34	53.1	21.1	7.0
Finland	22	0.23	33.6	11.5	3.8
France	32	0.35	57.0	20.8	8.3
Germany	32	0.37	56.5	20.3	8.1
Greece	26	0.31	72.1	24.9	7.2
Ireland	23	0.21	32.2	20.1	4.5
Italy	25	0.29	49.9	18.5	6.4
Luxembourg	23	0.24	36.9	15.0	4.2
Netherlands	31	0.39	104.0	20.2	10.0
Norway	28	0.32	62.1	16.4	4.4
Portugal	21	0.14	45.5	20.3	6.1
Spain	31	0.36	68.0	25.4	8.9
Sweden	29	0.32	45.5	20.3	6.1
Switzerland	32	0.75	102.5	42.6	13.8
Turkey	20	0.56	98.8	32.2	10.7
United Kingdom	32	0.30	46.3	21.5	7.6

[a] Unweighted average of the route-level bilateral restriction indexes for each economy based on the number of agreements/routes shown in the preceding column. Ranges from 0 to 0.97, with a higher score indicating more restrictions. [b] Percentage increase in airfares compared to the benchmark regime.

Table 2.4 **Factor analysis results of regulations and market structures**

Rotated factor loadings and weights[a,b]

Variables[c]	*Factor 1: Route regulation*		*Factor 2: Route market structure*		*Factor 3: Role of third country carriers*		*Factor 4: Role of challenger airlines*	
	Factor loadings	*Weights*	*Factor loadings*	*Weights*	*Factor loadings*	*Weights*	*Factor loadings*	*Weights*
Regulations								
Designation	**0.88**	0.24	0.15	0.01	-0.02	0.00	0.06	0.00
Capacity	**0.89**	0.24	-0.04	0.00	0.07	0.00	0.06	0.00
Fare	**0.93**	0.27	-0.12	0.01	0.08	0.00	0.17	0.02
Charter services	**0.85**	0.22	0.02	0.00	0.25	0.03	0.15	0.01
Market structures								
Seat capacity concentration	-0.04	0.01	**0.97**	0.33	0.19	0.02	0.08	0.00
Seat capacity share of largest carrier	0.04	0.01	**0.96**	0.32	0.11	0.01	-0.05	0.00
Number of route carriers	0.02	0.00	**0.90**	0.29	0.24	0.03	0.24	0.03
Seat capacity share of third party carriers	0.06	0.00	0.22	0.02	**0.95**	0.46	-0.06	0.00
Number of third party carriers	0.23	0.02	0.24	0.02	**0.92**	0.44	-0.06	0.00
Number of challengers	0.17	0.01	0.05	0.00	0.02	0.00	**0.95**	0.48
Seat capacity of challengers	0.14	0.01	0.13	0.01	-0.12	0.01	**0.93**	0.46

[a] Numbers rounded to 2 decimal places. [b] Extraction method: principal component analysis; rotation method: varimax technique; rotation converged in 6 rotations. [c] The measurement of these variables is explained in section 2.3.

Source: Gonenc and Nicoletti (2000).

3 Telecommunications

The telecommunications industry is a large and dynamic industry. In Australia, the value added of the telecommunications industry was almost $19 billion in 2000, or 3 per cent of GDP (ABS 2000). The industry provides vital services to business and consumers alike, and its efficiency is increasingly essential to maintaining international competitiveness in a global marketplace.

Historically, the industry has been subject to high levels of government intervention and regulation. Typically, a single government operator was the sole supplier of telecommunication services, with little or no private sector involvement and little or no effective competition. The industry was also subject to a plethora of regulations, controls and directives that went to the core of its operations (eg price and output controls). These interventions were often justified on the grounds that the industry possessed natural monopoly characteristics — arising from the high cost of establishing a telephone network coupled with the low cost of carrying calls — and was subject to 'network' externality effects.[1]

Over the past few decades, the telecommunications industry has undergone significant changes, both in terms of the services it provides, the structure of the industry and the way it is regulated. These changes were largely a consequence of rapid technological development brought about by major advances in the electronics, computer and telecommunications industries. The emergence of this new technology has virtually eliminated many of the inherent natural monopoly conditions that were once present in the telecommunications industry, allowing multiple suppliers to offer services to consumers and enabling facilities-based competition in many parts of the industry.

As a result, many economies began to reform the way the industry was regulated, including, among other things, winding back unnecessary or outdated regulation, partially or fully privatising the industry, facilitating access for new operators to those parts of the telecommunications network still deemed to have natural monopoly characteristics, and reforming the pricing mechanisms used in the industry.

[1] For a comprehensive overview of telecommunications economics, see Albon, Hardin and Dee (1997) or PC (1999, appendix B, pp. 217–59).

These regulatory changes have occurred at different rates. Consequently, the structure and organisation of telecommunications markets, the nature and extent of regulation and the degree of competition vary widely throughout the world. Partly as a result, economic outcomes, such as telecommunication prices, also vary widely across economies.

The impact of market structure, regulation, ownership and competition on prices in the telecommunications industry is an important public policy consideration. In identifying the need for a broad international study, Boylaud and Nicoletti (2000) noted that 'most empirical evidence concerning the economic effects of different kinds of regulatory arrangements in the telecommunications industry is economy-specific and concerns the experience of the United States'. Yet, without the aid of international studies, it is unclear precisely how relevant the findings for a particular economy are for other economies.

As part of a broader suite of OECD research into the effects of regulation, Boylaud and Nicoletti (2000) looked at the effects of regulation and market structure in telecommunication services for 24 OECD member economies. They econometrically estimated the effect of *individual* regulations on various measures of performance, most notably price, but also labour productivity and quality, over the seven years from 1991 to 1997.

This chapter uses the work of Boylaud and Nicoletti (2000) for *individual* regulations to:

- derive an *overall* measure of the impact of telecommunications regulations on telecommunications prices for the entire industry for each of the 24 OECD members included in their study;
- derive price impact measures of regulation for four major sectors in the telecommunications industry — trunk, international, mobile, and leasing services; and
- extend the coverage of economies to include an additional 23 non-OECD economies, on the assumption that the effects in OECD economies are broadly representative of those in non-OECD economies.

To simplify the process of collecting data for non-OECD economies, all of the price impacts derived in this chapter are for 1997, the last year of the OECD study.

3.1 Reform in the telecommunications industry

In order to better understand the approach taken by Boylaud and Nicoletti (2000) and, hence, its strengths and weaknesses, it is worthwhile considering the recent evolution of the telecommunications industry.

Telecommunications is a large, but heterogenous, service industry that has benefited substantially from rapid technological change over the last decade. As a result, the industry now produces a whole range of new products and services that were not even conceived of when the previous regulatory environment was formulated. Its services now include:

- fixed voice services (eg local, domestic and international long distance telephony, and enhanced voice services);
- mobile services (eg mobile access, calls, and messaging services);
- internet services (eg dial-up and web hosting);
- data services (eg leased-lines, asynchronous transfer mode (ATM) services, public data network services); and
- content services (eg pay-TV, online information and entertainment) (PC 2001).

In essence, the industry consists of five main sectors: local; trunk (domestic long distance); international; mobile (cellular) telephony; and all other services, primarily leased-line, although pay-TV, internet and data services are also important in most developed economies (eg the United States).

Regulation of the telecommunications industry grew up around the series of wires, cables, switches and exchanges forming the telephone network that provided local, trunk and international telephone calls. Most aspects of the industry — ownership, entry, pricing and output choices — were highly regulated on the grounds that the industry possessed natural monopoly characteristics and that there were externalities associated with telephone networks.[2] In most economies, a government-owned public telecommunications operator (PTO) had a legal monopoly on providing all telecommunications services to consumers, subject to numerous operational and price controls.

[2] Network externalities are the external benefits flowing to other network users from each additional connection made to the network. For example, the value of having a telephone increases as more telephones are connected to the network. Understandably, these external benefits are unlikely to be taken into account by a potential user considering whether to connect to the network. Hence, it is argued that, there may be an underprovision of network services in an unregulated market. Negative externalities, such as congestion, can also occur with networks.

In the absence of competition, most PTOs were generally not as efficient as they could be, and were often slow to adopt new technology and to respond to customer demands (eg the provision of mobile telephony and internet access).

Technological change eventually undermined the rationale for many of the regulations, by reducing or eliminating the very problems that led to the regulation in the first place. Consequently, several economies, including the United States[3] and the United Kingdom, began to liberalise their telecommunications industry. But elsewhere, regulation has been slow to respond to changing circumstances.

Liberalisation primarily focused on allowing new domestic companies to enter the market and on relaxing restrictions on foreign operators and/or foreign investment. Sometimes, reform extended to privatising the PTO. The removal of the barriers on entry into the industry and restrictions on pricing has challenged the monopoly positions of many PTOs.

By 1997, most OECD economies had liberalised their market, and had either privatised or partially privatised their PTO, or had plans to do so. At the same time, regulation was also being used in these economies to facilitate competition (pro-competitive regulation), to enable new entrants to access the telephone network on fair and reasonable terms (third party access), and to prevent incumbents from abusing any residual market power that they may have (anti-trust policy).

Of the 47 economies assessed in this chapter, only Japan, the United Kingdom, New Zealand and the United States had liberalised the provision of trunk and international long distance services before 1990. At the same time, a small group of economies — France, Japan, Sweden, the United Kingdom and the United States — allowed competition in their emerging cellular mobile sectors.

By 1998, only six OECD economies — the Czech Republic, Greece, Hungary, Poland, Portugal and Turkey — had not liberalised their trunk and international long distance markets. Several non-OECD economies have recently announced their intention to liberalise the industry (eg Thailand), while a number of other economies currently have no intention of doing so (eg Uruguay). However, by 1998, all 47 economies assessed in the chapter had liberalised their mobile sector.

Regulatory reform has gone hand-in-hand with structural reform of the industry and the way in which it operates. Thus, it is virtually impossible to separate the effects of regulatory reform from those arising from changes in market structure. Following

[3] The 1983 break-up of AT&T as a result of anti-trust action was also a major catalyst for reform in the United States.

Boylaud and Nicoletti (2000), this chapter uses the term regulation to include characteristics that are typically thought of as pertaining to market structure.

3.2 OECD modelling of the impact of regulations

The OECD working paper, *Regulation, market structure and performance in telecommunications* (Boylaud and Nicoletti 2000), assessed the effect of individual regulations and selected non-regulatory environmental variables on measures of performance in the telecommunications industries of 24 OECD economies. Given the heterogeneous nature of telecommunications services, Boylaud and Nicoletti focused their analysis on four major sectors in the industry in which substantial change in regulation, market structure and/or performance had taken place:

- trunk (domestic long distance);
- international (international long distance);
- mobile (cellular); and
- leased-line services (referred to in this chapter as 'leasing'), which cover the provision of point-to-point communication channels or circuits for the exclusive use of an individual subscriber, such as for the internet.

Leasing is included as it is important for the provision of new voice and data communications technologies.

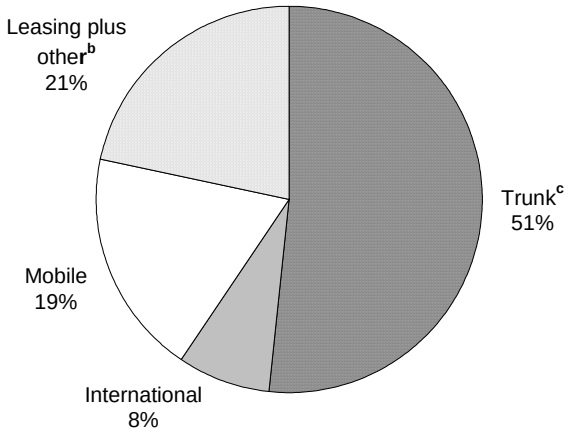
However, Boylaud and Nicoletti did not include an important sector, local telephony, as:

> … some services (such as local fixed voice telephony) are still largely monopolistic in a vast majority of countries while others (such as value added services) have generally been competitive throughout the nineties. Analysis of these services would not yield insights on the relationship between competition and performance. (Boylaud and Nicoletti 2000, p. 8)

Ongoing monopoly provision of local telephony reflects a belief that, if there is an element of natural monopoly remaining in the telecommunications network, it is likely to be in the customer access network — that part of the network connecting each subscriber to the network (Albon, Hardin and Dee 1997, pp. 23–9, 77–91). This part of the network is critical for providing local telephone calls, and for local origination and termination of trunk and international calls.

Figure 3.1 shows the size of each sector within the telecommunications industry.

Figure 3.1 **Telecommunications revenue by sector, 1997[a]**



a Average of all 24 OECD member economies included in Boylaud and Nicoletti (2000). **b** All other telecommunications revenue not accounted for by local, trunk, international and mobile. **c** Includes local telephony.

Data source: Boylaud and Nicoletti (2000, p. 43).

In all, Boylaud and Nicoletti (2000) estimated 42 different equations, primarily corresponding to different sectors, different measures of performance and/or different model specifications. The precise nature of the models estimated varied between sectors and can be summarised as follows.

First, each econometric model focused on one of three alternative performance measures:

- price;
- labour productivity; and
- service quality.

These equations were estimated separately rather than as a system of equations.

Second, each model was estimated using up to three different model specifications — *random effects specification*, *fixed effects specification* and *robust specification*. Each of these specifications employs different assumptions about how economy-specific differences affect the model being estimated, an important consideration in analysis of differences across economies. These estimation techniques are discussed in more detail in Boylaud and Nicoletti (2000).

Third, two alternative measures of price were used for the international sector.

Fourth, each model estimated included slightly different combinations of variables.

Given that the focus of this chapter is on the effects of *all* of the regulations on price, only those equations relevant to estimating the price impacts are discussed here to make the discussion more manageable.

In all, Boylaud and Nicoletti (2000) included 24 OECD economies — Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.[4] They did not include some OECD members — the Czech Republic, Hungary, Korea, Mexico, Poland and the Slovak Republic — many of which joined the OECD after 1991. There was limited coverage of economies in Asia, and no coverage of economies in South America, Africa and Eastern Europe.

An additional 23 economies are included in this chapter to extend the geographical coverage — Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Taiwan, Thailand, Uruguay and Vietnam.[5]

Modelling the impact of regulations on prices

Boylaud and Nicoletti estimated a linear relationship between the standardised price (Z) and various regulatory and non-regulatory environmental variables (denoted here by R and E respectively).[6] Non-regulatory factors affecting price need to be included to avoid problems associated with omitted variable bias that would render the resulting estimates unreliable.

In its most basic form, Boylaud and Nicoletti (2000) estimated the model:

$$Z = \alpha + \alpha_c + \beta R + \gamma E + \varepsilon + \varepsilon_c \qquad (3.1)$$

where:

Z standardised price (discussed below);

4 A limited number of economies were sometimes omitted from each sectoral model.

5 Most of the data used for the five OECD members not included in Boylaud and Nicoletti (2000) — the Czech Republic, Hungary, Korea, Mexico and Poland — were sourced from the same dataset used for the 24 OECD economies (Nicoletti, G., OECD, Paris, pers. comm., 2 February 2001). The remaining data for these five OECD economies were obtained in the same way as for non-OECD economies.

6 The distinction between regulatory and non-regulatory variables used here is based on that adopted in Boylaud and Nicoletti (2000). In practice, some of the environmental variables are actually influenced by regulation.

α common intercept across all economies;

α_c economy-specific intercept (fixed effect models only, otherwise $\alpha_c = 0$);

R vector of regulatory variables (discussed below);

E vector of non-regulatory environmental variables (discussed below);

β, γ vectors of estimated coefficients;

ε common error term across all economies; and

ε_c economy-specific error term (random effects models only, otherwise $\varepsilon_c = 0$).

Boylaud and Nicoletti estimated a third model, the robust specification, which was a variant of the random effects specification that also corrected for systematic differences in the scale of some variables across economies — termed heteroskedasticity. While recognising the potential for heteroskedasticity in their data, Boylaud and Nicoletti were unable to rule conclusively on the appropriateness of their robust models.

In order to pool their sectoral data so that they could estimate an industry-wide relationship, Boylaud and Nicoletti transformed their sectoral measures of price (P) expressed in different units into standardised prices (Z) by:

$$Z = \frac{P - \overline{P}}{\sigma}, \; Z \sim N(0,1) \qquad (3.2)$$

where:

$\overline{P}$ mean of the actual sectoral prices across all economies and time periods;

σ standard deviation of the actual sectoral prices across all economies and time periods; and

$N(0,1)$ normal distribution with a mean of 0 and a standard deviation (and variance) of 1.

The standardised price can be thought of as the price difference in each economy from the mean measured in standard deviations. Thus, if $Z = +1$, prices are one standard deviation higher than the mean price. Conversely, if $Z = -1$, prices are one standard deviation lower than the mean price.

None of the remaining variables was standardised.[7]

[7] This failure to standardise the regulatory and non-regulatory environmental variables is essentially immaterial, as the estimated coefficient on a standardised variable is mathematically related to that on the unstandardised variable.

Regulatory variables

In their econometric models, Boylaud and Nicoletti (2000) included five variables characterising the 'regulatory' environments that existed in the telecommunications industry in OECD economies:

- the market share of new entrants;
- an index of government control of the PTO;
- the degree of internationalisation of domestic markets;
- the time to liberalisation; and
- the time to privatisation.

Some of these variables indirectly measure regulations from the market structure, as regulations affect market structure in the telecommunications industry. However, market structure is also a function of non-regulatory factors, such as the size and composition of the market, and the technology used.

Barriers to entry can have significant effects on the performance of an industry, by restricting new entrants and the degree of competition in the market. When barriers to entry are high, telecommunications prices are likely to be higher than if barriers to entry are low. To test for this, Boylaud and Nicoletti (2000) included a *market share of new entrants* variable as an indicator of market structure and the extent of actual competition, and as a crude proxy for the ease of entry, which is an outcome of liberalisation in telecommunication services.[8]

The *index of government control* variable[9] indicates, in broad bands, the extent of public ownership of the PTO. Several economies have partially or fully privatised their PTO, though governments often retain the largest equity stake or hold special voting rights. Government-owned PTOs may be more inefficient than their private sector counterparts or pursue non-economic goals, and hence be expected to charge higher prices. Conversely, privately owned PTOs may be more likely than their public sector counterparts to exploit any market power that they may have. The government control variable scored different ownership structures according to the percentage of government ownership and/or the presence of special voting rights.

8 For all sectors other than the mobile sector, the *market share of new entrants* variable ranges between 0 and 100. However, owing to the absence of time series data for the mobile sector, Boylaud and Nicoletti replaced the *market share of new entrants* variable for the mobile sector with a dummy variable equalling 1 if entry could legally occur and 0 otherwise (Nicoletti, G., OECD, Paris, pers. comm., 27 March 2001).

9 Labelled by Boylaud and Nicoletti (2000) as the 'index of state control'.

Many OECD economies retain some restrictions on foreign direct investment (FDI) in the industry that may affect telecommunications prices. Some restrictions are explicit (*de jure*). For example, foreign-owned firms may be explicitly prohibited from owning more than a certain equity share of the PTO. Other restrictions arise indirectly as a consequence of other policies (*de facto*). For example, government control of, or special voting rights over, the PTO may affect the extent of new investment, whether domestic or foreign, as well as the operation and performance of the PTO.

Boylaud and Nicoletti used the *degree of internationalisation of domestic markets* variable — the number of foreign telecommunications operators participating in joint ventures or other cooperation agreements with domestic operators in the domestic market in 1995 — to approximate the entry restrictions faced by foreign firms and the extent of foreign investment. The number of foreign operators is expected to be higher, the lower are the restrictions on entry. How well this variable represents restrictions on foreign entry is questionable, since it does not explicitly capture levels of foreign investment or market shares. For example, a single joint venture is treated exactly the same, irrespective of whether it accounts for 1 per cent or 100 per cent of the market. Yet the economic effects are likely to be very different. In addition, the data were collected for 1995 only, and may not give an accurate picture of the market environment existing in 1997.

The announcement of new entry, or a change in the ownership structure of the PTO, may influence the level and mix of inputs, outputs and prices well in advance of the actual changes coming into effect. To test for the possibility of anticipated responses to announced changes, Boylaud and Nicoletti included a *time to liberalisation* variable and a *time to privatisation* variable, which respectively measured the number of years to liberalisation and privatisation.[10] As each of these variables changes by a uniform amount each year prior to liberalisation or privatisation, their inclusion implicitly tested for a particular response pattern — that the effects were linear over time in the lead-up to the policies being implemented. These variables did not allow for nonlinear responses prior to liberalisation or privatisation, one-off effects associated with the policies being implemented, or the effects after liberalisation or privatisation has occurred.

Owing to a lack of data or insufficient variation in the data across economies, Boylaud and Nicoletti (2000) were unable to include other regulatory variables, despite clearly recognising their potential to affect prices. For example, price

[10] The *time to liberalisation* and *time to privatisation* variables measured the negative of the number of years to liberalisation and privatisation, respectively. For example, if liberalisation (privatisation) was scheduled to occur in 2000, the *time to liberalisation* (*privatisation*) variable equalled –3 in 1997. Once liberalisation (privatisation) occurred, the variable was set to zero.

regulations, governance mechanisms of PTOs (eg corporatisation of the PTO), and the effect of regulatory agencies were excluded. As a result, the regulatory variables included in their model, and those used in this chapter, will understate the effect of all telecommunications regulation on telecommunications prices.

Table 3.1 provides a description of how these variables (and all the other non-regulatory variables) were measured. All of the data used here for the 24 OECD economies are sourced from Boylaud and Nicoletti (2000). The regulatory data for the non-OECD economies (tables 3.3 and 3.4 at the end of this chapter) are sourced from the International Telecommunications Union (ITU), except for information on foreign participation, which are sourced from Noam and Singhal (1996). The market share of new entrants is not readily available for non-OECD economies, so a proxy based on the number of new entrants is used.[11]

Most of the regulatory variables included in the price models used in this chapter to derive price impact measures were statistically significant at the 20 per cent level, with many being significant at the much higher 5 per cent level (table 3.2). Although some of the regulatory variables were not statistically significant, Boylaud and Nicoletti included all variables in their estimated equations and, hence, all of the regulatory variables are used to derive the price impacts.

The regulatory variables considered here are high level indicators of regulatory environments prevailing in OECD economies, as they do not capture many of the real-world complexities that affect telecommunications prices. For example, they do not measure how restrictive these polices actually are or the extent to which they affect behaviour (ie how binding they are).

Non-regulatory environmental variables

In addition to regulation, non-regulatory factors are also likely to impact on the price of telecommunications services.

Boylaud and Nicoletti (2000) included three non-regulatory environmental variables in their models — a measure of capital intensity, a measure of input costs and a price rebalancing indicator (table 3.1). Their paper contained little justification for the inclusion of the capital intensity measure or the input cost measure or why they were chosen in preference to the numerous other factors identified in the

[11] The *market share of new entrants* variable for non-OECD economies is calculated as the number of new entrants in each economy multiplied by the maximum market share of new entrants in the OECD divided by the maximum number of new entrants in non-OECD economies (7.38, 6.84 and 11.00 per cent for each new entrant in the trunk, international and mobile sectors, respectively).

telecommunications literature.[12] However, their inclusion makes sound economic sense, as the prices charged are likely to depend, in large part, on the costs of providing the service. Yet, owing to data limitations, the *economic structure* (input cost) and *technology* (capital intensity) variables included in the econometric modelling related to the industry as a whole, rather than the economic structure and technology existing in the trunk, international, mobile and leasing sectors, although they would often be related to the sector-specific measures.

The omission of other economy-wide non-regulatory environmental variables, such as income levels and population density, does not necessarily bias their results, if the omitted variables only affect price differences between economies (the intercept) in the fixed effects model, and not the relationship between price and the regulatory and non-regulatory variables included in their model (the coefficients). However, the omission of these non-regulatory environmental variables may bias the random effects model.

The *technology* variable used by Boylaud and Nicoletti (2000) — total fixed telecommunications investment per mainline — is a proxy for capital intensity in the industry. The type, take-up rates and age of technology used in an economy are important determinants of call costs in such a capital-intensive industry. Similarly, the *economic structure* variable — total operating expenditure per mainline — was included as a measure of input costs on the grounds that prices will generally reflect the cost of inputs, such as labour, maintenance and other (non-capital) operating costs in the industry. Given the way the models are specified, these variables are implicitly assumed to be independent of the regulatory regime in place. However, in reality, both of these variables might, to some extent, be influenced by the regulatory regime and the competitive environment that follows. For example, a requirement to provide a uniform minimum standard of service to all (or most) consumers regardless of cost would be expected to increase total investment and annual operating expenditure. More generally, regulation can affect the type and mixture of services produced and the inputs used to produce them.

[12] For example, Guldmann (1991) found line density to be one of the most important influences on unit costs between different localities with a country (cited in PC 1999, p. 108).

Table 3.1 **Variables used in the OECD's telecommunication models**

Variable	*How measured*
Dependent variables	
Price: trunk	Unweighted sum of business and residential OECD tariff baskets, where each tariff basket reflects a notional weighted-sum of listed local and long distance call prices made over varying distances, and times of the day and week (expressed in US PPP$)
Price: international	Average revenue from international services per outgoing international telephone minute (expressed in US PPP$ per outgoing minute)
Price: mobile	Average revenue from mobile services per mobile subscriber (expressed in US PPP$ per subscriber)
Price: leasing	OECD tariff basket of national leased line charges based on the cost of renting a 64 kilobyte per second line, excluding taxes (expressed in US PPP$ per year)
Independent regulatory variables	
Common regulatory variables	
Internationalisation of domestic market	Number of foreign telecom operators participating in joint ventures or other cooperation agreements with domestic operators in the domestic market in 1995 [Ranges from 0 to 9]
Index of government control	Index of government ownership and control of the PTO [Ranges from 0 to 1 on a stepped scale[a]]
Sector-specific regulatory variables	
Market share of new entrants: all sectors other than mobile	Market share of new entrants [Ranges from 0 to 100]
Market share of new entrants: mobile	Dummy variable [1=entry legally allowed; 0=otherwise]
Time to liberalisation	Negative of the number of years to entry liberalisation (years following liberalisation are given a zero value) [Ranges from –14 to 0]
Time to privatisation	Negative of the number of years to privatisation (years following liberalisation are given a zero value) [Ranges from –10 to 0]
Independent environmental variables	
Technology: capital intensity	Total fixed telecommunications investment per mainline (included as a measure of technology) (expressed in US PPP$ per mainline)
Economic structure: input costs	Total operating expenditure per mainline (included as a measure of economic structure) (expressed in US PPP$ per mainline)
Price rebalancing indicator	Distance of price structure from that in the UK in 1998[b] (included as a measure of economic structure)

a 1.0: 100% public, 0.8: 50% to 100% public, 0.7: 33% to 50% public, 0.5: Less than 33% public and special voting rights, 0.3: 10% to 33% public, 0.2: 0% to 10% public and/or special voting rights, and 0: 100% private.
b Calculated as (100-1/4(SUM(ABS($PDIST_{Xit}$-$PDISTX_{uk98}$)), where $PDIST_{Xit}$ is the price over X kilometres in economy *i* at time *t*, where X=local, 27, 110 and 490 kilometres.

Source: Boylaud and Nicoletti (2000, tables 6, 8 and 9).

A *price rebalancing indicator* was included to account for deviations between underlying costs and prices for individual telecommunications services. Boylaud and Nicoletti (2000, p. 17) explained the inclusion of the rebalancing term:

> A "price rebalancing indicator" has been constructed to proxy the extent to which the price structure deviates from underlying costs. The indicator … is an important control in assessing the effects of regulation and market structure on prices, since an observed decline in prices could be partly due to a tariff readjustment, perhaps imposed by the regulatory authority, rather than to entry liberalisation or competitive pressures *per se*.

The indicator reflects the sum, over various distances (local, 27, 110 and 490 kilometres), of the difference between UK trunk prices in 1998 and the equivalent price over each distance in the economy concerned. Boylaud and Nicoletti (2000) used the 1998 prices in the United Kingdom over these distances as their benchmark, on the grounds that 'after a relatively long period of market competition, [UK] prices broadly reflect the underlying cost structure' (p. 17).

However, while treating the *price rebalancing indicator* as a non-regulatory environmental variable, Boylaud and Nicoletti recognised that the price rebalancing term may actually be a consequence of regulation. For example, the need for price readjustment might arise as a direct consequence of prices having been set by a regulatory authority, or as a result of insufficient competition in the industry arising from government imposed restrictions preventing entry into the market.

The non-regulatory environmental data for non-OECD economies are listed in tables 3.3 and 3.4 at the end of this chapter, while Boylaud and Nicoletti (2000) present the corresponding data for OECD economies.

The dependent variable: price

Boylaud and Nicoletti (2000, p. 16) used price as a measure of performance because 'differences in prices are assumed to reflect in part efficiency gaps as well as other market distortions (such as the exercise of market power) and carry important implications for consumer welfare'.

The heterogeneous nature of telecommunications products and services means that prices vary widely. Prices are often two-part, consisting of a fixed charge that does not vary with use and a variable component that does. The variable component will often vary with, among other things, the type of service used, the length of use, the distance, and the time of day and week. Given this, some form of average price across the range of services provided in each sector is needed in order to undertake empirical work.

A number of different 'average' price measures could be used for each sector.

An average 'price' for each sector could be obtained by dividing the total revenue collected in that sector by some measure of output by the sector (eg international call minutes).[13] Such a price measure implicitly takes into account customer preferences for the various services provided by that sector, as reflected in different call patterns, and the full range of discounts received by customers. The average price is, thus, representative of the weighted average price actually incurred by customers. Boylaud and Nicoletti used this approach to derive measures of 'actual' prices in the mobile[14] and international[15] sectors.

However, owing to the absence of corresponding revenue figures, Boylaud and Nicoletti were unable to derive comparable price measures for all sectors in the telecommunications industry. While the main data sources (ITU 2000, OECD 1999a and the *OECD telecommunications database*) publish detailed international data on certain aspects of the industry, they do not contain revenue by sector on a consistent basis across economies.

For the trunk and leasing sectors, where revenue estimates were not available, and to provide an alternative measure of price for the international sector, Boylaud and Nicoletti used the tariff baskets published by the OECD to measure prices in those sectors. The tariff baskets represent a weighted average of listed prices faced by consumers in each economy for different products and services in each sector used at different times of the day and week. The weights are the same across all economies, irrespective of the actual call patterns across economies. Although the weights represent a hypothetical calling pattern, they are considered broadly indicative of demand patterns throughout the day and week and were derived after considerable public consultation and are reviewed on an ongoing basis (Teligen 2000).

Understandably, such tariff baskets suffer from a number of limitations:

> … the available price data concern standard rates, which are not always a good indicator of market outcomes, especially in those countries and services more exposed to competition, where discounts are widely applied. Some estimates of price discounts in OECD countries suggest that they can reach up to 25 per cent of standard rates. (Boylaud and Nicoletti 2000, p. 19)

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13 As technology measures the quantities for billing purposes and that the ITU reports these quantities on a standardised basis, the reliability of prices estimated this way primarily depends on the accuracy on the revenue measures. If measured correctly, the resulting estimate will represent the weighted average price incurred by consumers.

14 The 'price' measure used for the mobile sector actually measures the average revenue per mobile subscriber and not the price per call or minute.

15 This price measure was used for one of their international models. An alternative price measure — an OECD tariff basket (discussed below) — was also used in the second international model.

Consequently, as a result of data limitations, the price measures used by Boylaud and Nicoletti varied across sectors — 'actual' prices for some sectors and 'listed' tariff baskets for others.

In keeping with earlier OECD telecommunications publications (OECD 1999a), Boylaud and Nicoletti converted all of their telecommunications prices from units of local currency to US dollars using the purchasing power parities (PPP) produced by the OECD.[16] Unlike the more conventionally used exchange rates, PPP take account of differences in general price levels between economies and are not subject to the same short-term, often significant, fluctuations as are nominal exchange rates.

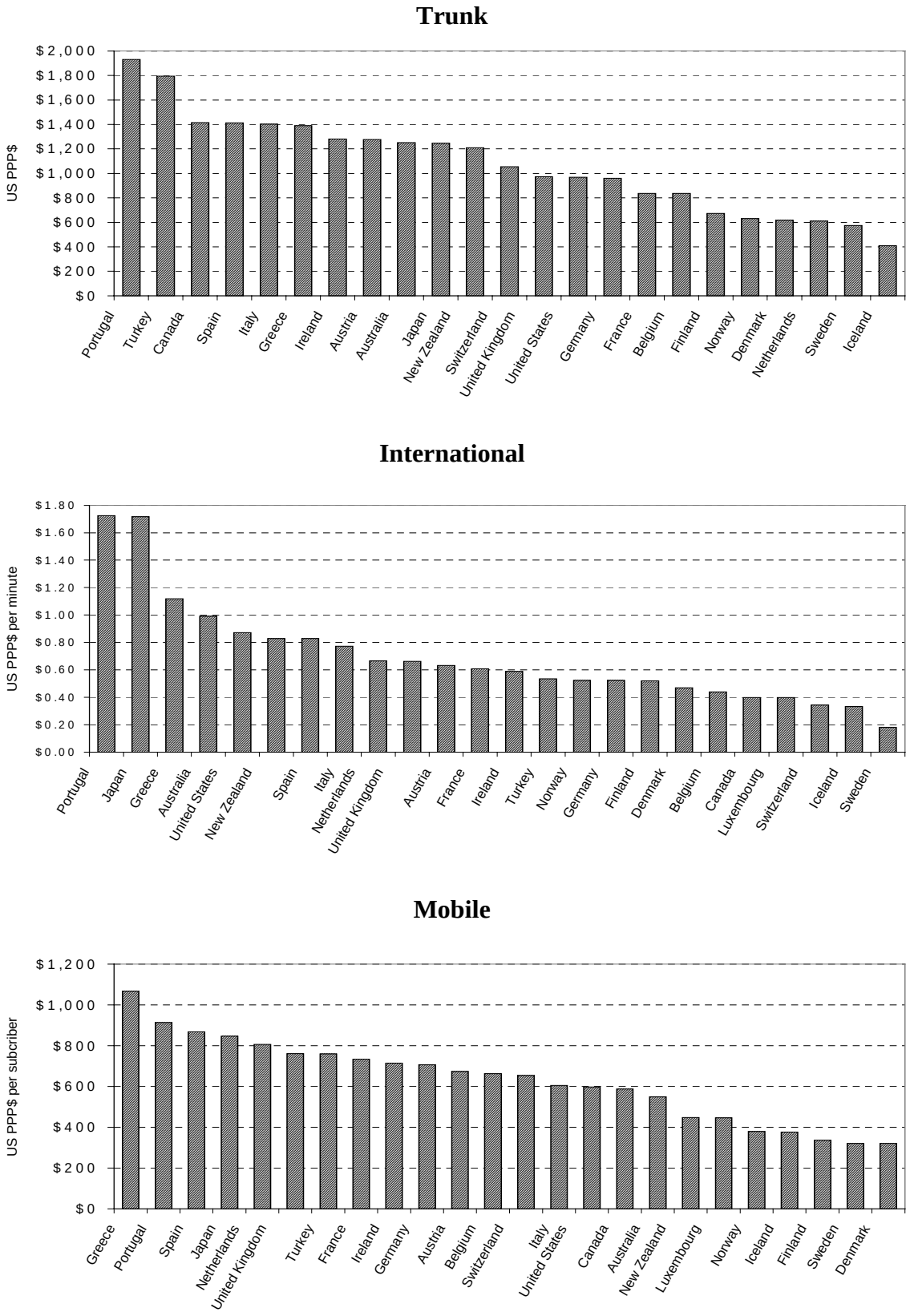
The resulting telecommunication prices expressed in US dollars vary substantially between economies (figure 3.2). The relatively affluent Scandinavian economies — Finland, Sweden, Iceland, Denmark and Norway — have among the lowest telecommunications prices in the OECD. The smaller economies of north-western continental Europe — Luxembourg, Belgium and sometimes the Netherlands — also tend to have low trunk and international prices. At the other end of the spectrum, telecommunication prices in Portugal, Spain, Japan and Greece tend to be the highest, or among the highest, in the OECD. Australia generally ranks in the middle third of OECD economies, with relatively low mobile prices and high international prices in 1997. The prices in the major English speaking economies, such as the United States, the United Kingdom, Canada, Ireland and New Zealand, are generally comparable to those in Australia.

The extent of this price dispersion may be partially the result of using PPPs. Nevertheless, it appears broadly consistent with, although slightly higher than, that indicated in a recent international price benchmarking study (PC 1999) covering seven of the OECD economies included in the dataset at a similar point in time.

The price data for the 24 OECD economies included in this chapter are sourced from the dataset used by Boylaud and Nicoletti (2000).

[16] The PPP used in this chapter for the five additional OECD economies are sourced from the dataset of Boylaud and Nicoletti. The PPP used for all non-OECD economies, except Taiwan, are estimated from World Bank data showing the relationship between PPP and nominal exchange rates for each economy (World Bank 2000) and data from the International Monetary Fund (IMF) indicating the average nominal exchange rate for 1997 (IMF 2000). In the absence of PPP estimates for Taiwan, the nominal exchange rate was used in its place (ITU 2000).

Figure 3.2 **OECD telecommunications prices, 1997**



Data source: Nicoletti, G., OECD, Paris, pers. comm., 2 February 2001.

Wherever possible, the original data sources used in compiling the OECD dataset are also used for the non-OECD economies. However, where the original data sources do not provide the required data for non-OECD economies, alternative information sources are used. As a result, the price data for some sectors in some non-OECD economies may not be strictly comparable to those for OECD economies. While not being strictly comparable, such price measures are included, in the absence of superior price measures, to provide an indicative effect of regulation in these economies. The prices used for non-OECD economies are discussed below.

- Mobile sector — ITU data on mobile phone revenue and subscribers (ITU 2000) are used to calculate annual mobile revenue per cellular subscriber (the same measure as used for the OECD data) for most non-OECD economies. For those economies for which the ITU does not publish mobile revenue, mobile revenue was estimated from total industry revenue using revenue shares derived from economies with a comparable level of mobile phone penetration — the number of mobile subscribers as a share of total population.[17]
- International sector — Boylaud and Nicoletti estimated two international price equations, one using an OECD international tariff basket as the dependent variable, and the other using international revenue per minute of outgoing international calls. As the OECD tariff basket is difficult to calculate and draws on detailed tariff data that are not readily available, it was not possible to derive comparable price measures for the non-OECD economies. Instead, Boylaud and Nicoletti's international revenue per outgoing minute model is used for the international sector, as the price data are easier to obtain. The international prices for the non-OECD economies are calculated from the total telecommunications revenue — assuming that the international sector accounts for a constant share of total revenue across broadly comparable OECD economies (defined on the basis of average number of international outgoing minutes per person for groups of comparable economies)[18] — and the number of minutes of outgoing international calls (both sourced from ITU 2000).

[17] The share of total revenue accounted for by the mobile sector for Uruguay is based on Argentina. The share for Colombia is based on the average of Brazil, Chile and Peru. The share for Poland is based on Turkey. The share for the Philippines is based on Thailand. The shares for India, Indonesia and Vietnam are based on the average of China, Mexico, Turkey and Russia.

[18] Broad groupings of economies were used as some economies, on average, earn proportionately more (less) revenue from international telephone calls and have a considerably higher (lower) number of minutes per capita than other economies. The average international revenue share for the highly internationalised non-OECD economies of Singapore and Hong Kong (18.2 per cent) were based on the average international revenue share in OECD economies with more than 55 minutes of outgoing international calls per person (Ireland, Mexico and the Czech Republic). The shares for the intermediate economies of Taiwan, Malaysia and Uruguay (9.5 per cent) were based on the average international revenue share in OECD economies with between 20 and 55

- Trunk services sector — as the OECD tariff basket is difficult to replicate for the non-OECD economies, an implied price is imputed for these economies from the random effects model corresponding to equation (3.1), given the regulatory and non-regulatory environmental variables existing in each economy. The results for the fixed effects model suggest that an economy-specific intercept term may not be needed, and in any event, observations on it are not available for non-OECD economies.
- Leasing sector — as it was not possible to obtain a comparable price measure for the non-OECD economies, Boylaud and Nicoletti's leasing model was not applied to the additional economies.

3.3 The impact of regulation on telecommunication prices

The relationships between price and *individual* regulations estimated by Boylaud and Nicoletti (2000) are used here to calculate an overall measure of the impact of *all* of the regulations included in their study. The resulting impact measure does not include the effect of any other regulations applying to the telecommunications industry other than the five regulations that were explicitly modelled. The econometric results for the models used here are reported in table 3.2 and are discussed at some length in Boylaud and Nicoletti (2000).

The price impacts estimated here for each economy measure the percentage increase in the price attributable to inappropriate regulation. Estimating these impact measures involves:

- identifying an appropriate benchmark against which to measure the impact of inappropriate regulation;
- establishing the effect of inappropriate regulation on price for each of the five individual regulations using Boylaud and Nicoletti's econometric results;
- aggregating the effects of individual regulations to calculate an overall effect for the regulatory regime employed in each sector;
- expressing this overall effect on price in each sector as a percentage of the (notional) price existing under the benchmark regime; and
- weighting these sectoral impacts to form an industry-wide average price impact.

minutes of outgoing international calls per person (the remaining 24 OECD economies). The share used for all other non-OECD economies (4.2 per cent) was the average international revenue share in OECD economies with less than 20 minutes of outgoing international calls per person (Japan, Sweden and Turkey).

Table 3.2 Models used to estimate the sectoral price impacts and the benchmark regulatory regimes for telecommunications

	Econometric results		*Benchmark regime*	
	Coefficient	*Z-statistic*	*Value*	*Economic interpretation*
Trunk (random effects model — OECD tariff basket)				
Constant	0.6168	1.1370		
Regulatory variables				
Internationalisation of domestic market	0.1083**	1.9240	0	No foreign telecom operators participating in joint ventures or other cooperation agreements with domestic operators in the domestic market
Index of government control	-0.5315***	-2.1090	1	PTO is fully government owned
Market share of new entrants	-0.0041	-1.0670	59	New entrants have a 59 per cent share of the trunk market
Time to liberalisation	-0.1155***	-4.7920	0	Liberalisation has occurred
Time to privatisation	0.0404*	1.5880	-7	No privatisation has occurred
Environmental variables				
Technology: capital intensity	0.0253	0.4280		
Economic structure: input costs	0.0266	1.2310		
Price rebalancing indicator	-0.0134***	-2.2220		
International (random effects model — international revenue per outgoing minute)				
Constant	-1.1205**	-1.9310		
Regulatory variables				
Internationalisation of domestic market	0.2056***	2.9170	0	No foreign telecom operators participating in joint ventures or other cooperation agreements with domestic operators in the domestic market
Index of government control	0.6228***	2.4030	0	PTO is fully privately owned
Market share of new entrants	-0.0095***	-2.4380	54.7	New entrants have a 54.7 per cent share of the international market
Time to liberalisation	-0.0651***	-2.5410	0	Liberalisation has occurred
Time to privatisation	-0.0224	-0.8250	0	Privatisation has occurred
Environmental variables				
Technology: capital intensity	-0.0006**	-1.6930		
Economic structure: input costs	0.0003***	2.6100		
Price rebalancing indicator	-0.0037	-0.5990		

(Continued on next page)

Table 3.2 **(continued)**

	Econometric results		*Benchmark regime*	
	Coefficient	*Z-statistic*	*Value*	*Economic interpretation*
Mobile (fixed effects model — mobile revenue per subscriber)[a]				
Constant	1.350***	2.110		
Regulatory variables				
Index of government control	0.500	1.120	0	PTO is fully privately owned
Market share of new entrants	-0.860***	-2.760	1	New entrants have a 100 per cent share of the international market
Time to liberalisation	0.090	0.520	0	Liberalisation has occurred
Time to privatisation	0.110*	1.330	-3	Privatisation to occur in 2000
Environmental variables				
Technology: capital intensity	-1.160***	-3.870		
Economic structure: income[b]	-0.030**	-1.860		
Leasing (fixed effects model — OECD tariff basket)[a]				
Constant	-0.48***	-2.11		
Regulatory variables				
Index of government control	0.11	0.06	0	PTO is fully privately owned
Market share of new entrants	0.00	0.22	0	There are no new entrants in the leasing market
Time to liberalisation	-0.08***	-3.23	0	Liberalisation has occurred
Time to privatisation	0.01	0.34	-3	Privatisation to occur in 2000
Environmental variables				
Technology: capital intensity	0.00***	3.78		
Economic structure: input costs	0.03**	1.72		

*** statistically significant at the 5 per cent level (critical value: 1.960). ** statistically significant at the 10 per cent level (critical value: 1.645). * statistically significant at the 20 per cent level (critical value: 1.282). **a** Model also includes an economy-specific intercept term. **b** For the mobile sector only, gross domestic product per person (expressed in US PPP$) replaced input costs as the measure of economic structure. Being a non-regulatory environmental variable, this variable played no part in the price impacts estimated in this chapter.

Source: Estimates based on Boylaud and Nicoletti (2000).

Identifying an appropriate benchmark regime

The most suitable benchmark to use will, in large part, depend on the economic rationale for regulation in the industry. In network industries such as telecommunications, this is largely influenced by whether or not the network possesses natural monopoly characteristics.

Reviews of the literature find little consensus among empirical studies as to whether the telecommunications network possess natural monopoly characteristics (eg Albon, Hardin and Dee 1997, PC 1999).[19] Previously, economists considered that the industry possessed natural monopoly characteristics, and hence monopoly pricing was likely to occur in the absence of regulation. However, recent technological change has caused many economists to rethink this view. Fibre-optic cables, and microwave and satellite transmitters, for example, are now effective alternatives to the traditional coaxial cables used for long distance transmission. And new transmission methods have greatly increased the carrying capacity of the 'twisted copper pair' in the customer access network, reducing its 'bottleneck' status. As a result, competition is now technically more feasible. On the other hand, new technologies have also increased the proportion of telecommunications costs that are fixed (though they have also provided more economies of scope). If natural monopoly characteristics remain in the network, they are still most likely to lie in the customer access network.

If some sections of the telecommunications network still possess natural monopoly characteristics, some form of regulation might be desirable to prevent PTOs from abusing any market power arising from their control of those sections of the network. However, identifying the 'best' regulatory regime is contentious, given the lack of consensus on the cost characteristics of the industry today.

For the above reasons, the price effects estimated here for each of the four sectors in the telecommunications industry are assessed relative to an alternative notional benchmark regime, one that *minimises* the prices implied by the econometric estimation of equation (3.1) for that sector. The value assigned to each regulatory variable under the benchmark regime is that which minimises the product of the estimated coefficient and the value that each regulatory variable can take on (reported in tables 3.2 and 3.1, respectively).

For example, given that the estimated coefficient on the *index of state control* variable is –0.5315, the standardised trunk price is minimised when the *index of*

[19] A related question is whether the industry possesses economies of scope — whether a single operator can provide all of the services provided by the industry more cheaply than multiple operators. Albon, Hardin and Dee (1997) and PC (1999, Appendix B) also discuss this issue.

state control variable takes on a value of 1, and not when it takes on any of the other possible values — 0, 0.2, 0.3, 0.5, 0.7 or 0.8.

Collectively, the values of the five regulatory variables — *internationalisation of domestic market*, *index of government control*, *market share of new entrants*, the *time to liberalisation* and the *time to privatisation* — that minimise prices are known as the benchmark regime (R^O). The benchmark regimes for each sector are listed and explained in table 3.2.

As a result of the mechanical way in which the benchmark regime is derived from the OECD's econometric results, the benchmark regime is not the same for each sector. In particular, the benchmark regime for the trunk sector is one involving public ownership, whereas for the other sectors it involves private ownership. This could be broadly consistent with the notion that there were natural monopoly characteristics in the local/trunk segment of the telecommunications network and, hence, public ownership of the natural monopoly segments was seen to be socially more desirable than private ownership.

The value that each variable takes on under the benchmark regime is constrained to be the maximum or minimum value in OECD economies, and not that which would theoretically minimise prices.[20]

The effect of individual inappropriate regulations on price

The regulations comprising the actual and benchmark regulatory regimes are assigned a score according to the criteria in table 3.1. The inappropriate component of each regulation is then calculated as the difference in the values of each regulatory variable under the actual and benchmark regime (R_i and R_i^O, respectively). Mathematically:

$$dR_i = R_i - R_i^O \qquad (3.3)$$

For example, if under the actual regulatory regime the PTO is 75 per cent publicly owned (25 per cent privately owned), then the *index of state control* variable takes on a score of 0.8, as public ownership lies between 50 and 100 per cent. If the econometrics implies that standardised prices are minimised when the PTO is 100 per cent publicly owned, then the *index of state control* variable takes a score of 1 under the benchmark regime. The extent of inappropriate regulation would be assessed as –0.2 (=0.8–1)

[20] For example, while the maximum possible market share for new entrants in the trunk sector is 100 per cent, no OECD economy has a share higher than 59 per cent. Hence, the market share of new entrants under the benchmark regime is set to 59 per cent (and not 100 per cent).

The effect of this inappropriate regulation on price can be assessed from equations (3.1) and (3.2). While expressing equation (3.1) in terms of standardised prices was useful for Boylaud and Nicoletti, it unnecessarily complicates matters here, as the most important consideration is the effect of each regulation on actual price. Rearranging equation (3.2) gives:

$$P = \overline{P} + \sigma Z \tag{3.4}$$

Substituting (3.1) into (3.4) and removing the matrix notation gives:

$$P = \overline{P} + \sigma\left(\alpha + \sum_{i=1}^{5}\beta_i R_i + \sum_{i=1}^{3}\gamma_i E_i\right) \tag{3.5}$$

$$P = \alpha' + \sum_{i=1}^{5}\sigma\beta_i R_i + \sum_{i=1}^{3}\sigma\gamma_i E_i \tag{3.6}$$

where:

$$\alpha' = \overline{P} + \sigma\alpha$$

Thus, the effect of a change in one unit of regulation i on price is the product of the actual standard deviation (σ) and the estimated coefficient of the corresponding regulation (β_i):

$$\frac{\partial P}{\partial R_i} = \sigma\beta_i \tag{3.7}$$

Thus the increase in price (dP) attributable to dR_i units of inappropriate regulation is:

$$dP = \frac{\partial P}{\partial R_i}dR_i = \sigma\beta_i\left(R_i - R_i^O\right) \tag{3.8}$$

Estimating the sectoral price impacts

Given that (3.6) is a linear equation, the change in price attributable to all inappropriate regulation for each sector is the sum of the price effects associated with each of the five individual regulations in that sector:

$$dP = \sum_{i=1}^{5}\sigma\beta_i\left(R_i - R_i^O\right) \tag{3.9}$$

If inappropriate regulation increases prices by dP, the notional price expected to exist under the benchmark regime (P^O) can be estimated as the actual price less the change in price attributable to inappropriate regulation, or:

$$P^O = P - dP = P - \sigma \sum_{i=1}^{5} \beta_i \left(R_i - R_i^O \right) \tag{3.10}$$

For each of the four telecommunications sectors, the price impact measures the percentage increase in price attributable to inappropriate regulation, expressed as a share of the notional price existing under the benchmark regime:

$$\textit{Sectoral price impact} = \frac{dP}{P^O} = \frac{\sigma \sum_{i=1}^{5} \beta_i \left(R_i - R_i^O \right)}{P - \sigma \sum_{i=1}^{5} \beta_i \left(R_i - R_i^O \right)} \tag{3.11}$$

The impact measures reported in this chapter are estimated using equation (3.11).

Estimating the industry-wide price impact

For each economy, the overall price impact for the telecommunications industry can be obtained by weighting each of the sectoral price impacts according to the relative size of each sector. For the 24 OECD economies, the industry-wide price impact covers all four sectors — trunk, international, mobile and leasing. Given the absence of comparable leasing price data for the leasing sector, the industry-wide average for the additional economies covers only three sectors — trunk, international and mobile.

$$\textit{Industry-wide price impact} = \sum_{s=1}^{3 or 4} w_s \times \textit{Sectoral price impact} \text{ for sector } s \tag{3.12}$$

where w_s is the share of industry-wide revenue accounted for by sector s; and

$$\sum_{s=1}^{3 or 4} w_s = 1.$$

For the 24 OECD economies, economy-specific revenue shares in the OECD database were used as weights. However, these data were not available for the additional economies included here. Consequently, the weights used for these economies are drawn from the average revenue shares from OECD economies (trunk 0.6297, international 0.1274, and mobile 0.2428).

3.4 Results

Using the methodology outlined above and the econometric results published by Boylaud and Nicoletti (2000), the overall impact of regulations on telecommunication prices is estimated for each sector in each economy for 1997 (table 3.6 and figures 3.3 to 3.7 at the end of this chapter). For the 24 OECD economies, the impact measures cover the trunk, international, mobile and leasing sectors, together with an industry-wide average of the four sectors. As mentioned previously, it was not possible to obtain a comparable price measure for the 23 non-OECD economies and, hence, the measures for these economies do not cover the leasing sector.

Assessment

The OECD data indicate that, for apparently similar services, there is a wide dispersion in telecommunications prices across economies.

There is a generally weak, albeit positive relationship between regulation and telecommunications prices. Economies with regulatory regimes substantially more stringent than the benchmark regime tend to have higher telecommunications prices. This appears to be true, especially for many non-OECD economies. Anecdotal evidence supports this, as telecommunication prices in many developing economies are considerably (orders of magnitude) higher than in most OECD economies.

Many of the impacts for particular economies are somewhat surprising. For example, the United States and the United Kingdom are generally regarded as having fairly liberal and competitive trunk sectors and, hence, would be expected to have relatively low price impacts. However, their price impacts are high, as their regulatory regimes differ in a number of important areas from what the econometrics suggests would minimise trunk prices. The econometrics indicates that trunk prices increase with the number of foreign participants operating in domestic joint ventures, and as the time to liberalisation increases.[21] Given that the United States and the United Kingdom have a high number of foreign joint ventures and have liberalised their markets before most other economies, the econometric results imply that they will have high price impacts.

[21] The *time to liberalisation* variable is measured as the negative of the number of years to liberalisation and increases — becomes less negative — as liberalisation approaches. A positive coefficient, therefore, implies that trunk prices increase as the *time to liberalisation* increases. Consequently, the econometric results imply that trunk prices are lowest when there is no prospect of liberalisation.

These results should be treated cautiously, as the signs of the estimated coefficients appear counter-intuitive. Liberalisation and foreign participation would be expected to promote competition in previously sheltered domestic markets and, hence, would be expected to reduce trunk prices, not increase them. This indeed was the case in Australia, with the entrance of the foreign-owned *Cable & Wireless Optus* in January 1992.

The results are often sensitive to small changes in the value of certain variables. For example, the inclusion of *internationalisation of the domestic market* variable shifts the United Kingdom from having the lowest average price impact for the international sector to having a moderately high price impact. Certain regulations can, and often do, have a significant effect on standardised prices and, more importantly, on the resulting price impact measures.[22]

As a group, the telecommunications industries in the more affluent Scandinavian economies appear different from those in most OECD economies. The data consistently indicate that they tend to have low telecommunications prices by world standards, despite appearing to operate quite restrictive and anti-competitive regulatory environments. If the OECD data are indeed representative of the industries in these economies, the OECD models may not do a particularly good job of explaining the determinants of their prices; there may be something special about these economies not included in the OECD model. It may also reflect the inappropriateness of some of the assumptions implicit in the approach taken here to measure the price impacts. In particular, the regulatory benchmark identified here may have been overtaken by recent technological advances in the industry.

The above methodology, which applies the results from OECD economies to estimate the effects of telecommunications regulation in non-OECD economies, appears reasonable for some higher income non-OECD economies (eg Hong Kong, Chile and Taiwan). However, it appears inappropriate for the less affluent economies of India, Vietnam, Russia, China and South Africa. As a result, many of these economies have been subsequently excluded, as the resulting price impacts appeared implausible.

Recognising the difficulties in undertaking applied quantitative assessments of the effects of regulation on prices and the practical compromises needed to do so, the estimates presented here should be treated with caution. Some of the econometric estimates, from which these price estimates are derived, appear counter-intuitive. Given the values that the regulatory variables can take on and the size of the estimated coefficients, some resulting price impacts seem implausible — both in

[22] The relative importance of any variable arises from the interaction of the sign and magnitude of the estimated coefficient and the range of values that the variables can take.

terms of the magnitude of the impact and the relative ranking across economies — especially given the limited range of regulations actually considered.

3.5 Conclusion

For what they are worth, the price impacts generally indicate that there is a weak, but positive relationship between regulation and telecommunications prices, holding other factors constant. Economies with regulatory regimes substantially different from the benchmark regime tend to have higher telecommunications prices. This is especially true for some non-OECD economies, if the various assumptions employed are indeed realistic.

Notwithstanding the implausibility of some of the estimates obtained here, the quantitative techniques used by Boylaud and Nicoletti, as opposed to the data used or the specification of their models, nevertheless appear useful for analysing the relationships between regulation and performance, especially within economies, and represent an important advance on earlier techniques.

Data and results annex

Table 3.3 **New entrants into telecommunications markets, 1997**

Economy	*No. of new entrants*			*Legal conditions of entry*	*No. foreign operators*[a]
	Trunk	*International*	*Mobile*		
Argentina	0	0	2	Limited by spectrum	5
Brazil	0	0	4	Limited by spectrum	na
Chile	5	5	6	Limited by spectrum	4
China	0	0	1	Limited by spectrum	1
Colombia	0	0	0	Duopoly	5
Hong Kong	0	0	0	Duopoly	4
India	0	0	0	Duopoly	11
Indonesia	0	0	0	Duopoly	4
Malaysia	1	1	3	Limited by spectrum	2
Peru	0	0	1	Limited by spectrum	1
Philippines	8	8	5	Limited by spectrum	3
Russia	0	0	Several	Duopoly	10
Singapore	0	0	1	Limited by spectrum	1
South Africa	0	0	2	Limited by spectrum	1
Taiwan	0	0	0	Duopoly	na
Thailand	0	0	2	Limited by spectrum	2
Uruguay	0	0	1	Limited by spectrum	1
Vietnam	0	0	1	Limited by spectrum	na

na: not applicable. [a] Number of foreign telecommunication operators participating in joint ventures or other cooperation agreements with domestic operators in the domestic market in 1995.

Source: Noam and Singhal (1996).

Table 3.4 **Liberalisation and privatisation in telecommunications, 1997**

Economy	*Year of liberalisation*			*Year of privatisation*	*Government ownership*[a]
	Trunk	*International*	*Mobile*		
					%
Argentina	1999	1999	Prior to 1997	1990	0
Brazil	2000	2000	Prior to 1997	1998	100
Chile	Prior to 1997	Prior to 1997	Prior to 1997	1987	0
China	Prior to 1997	No intention	Prior to 1997	No intention	100
Colombia	1998	1998	1999	No intention	100
Hong Kong	Prior to 1997	Prior to 1997	Prior to 1997	Prior to 1997	0
India	2000	No intention	Prior to 1997	1986	57
Indonesia	2000	Prior to 1997	Prior to 1997	1995	76
Malaysia	Prior to 1997	Prior to 1997	Prior to 1997	1990	67
Peru	Prior to 1997	Prior to 1997	Prior to 1997	1995	2
Philippines	Prior to 1997	Prior to 1997	Prior to 1997	1993	0
Russia	Prior to 1997	Prior to 1997	Prior to 1997	1997	75
Singapore	na	2000	Prior to 1997	1993	80
South Africa	2001	2001	Prior to 1997	1997	70
Taiwan	1999	1999	1998	1999	100
Thailand	2001	2001	Prior to 1997	1999	100
Uruguay	No intention	No intention	Prior to 1997	No intention	100
Vietnam	Prior to 1997	No intention	Prior to 1997	No intention	100

na: not applicable. [a] Share of PTO owned by the government.

Source: ITU (1998).

Table 3.5 **Environmental variables for telecommunications, 1997**

Economy	*No. of mainlines*	*Operating expenditure*	*Fixed expenditure*	*Price rebalancing term*[a]
	000	US PPP$ billion	US PPP$ billion	
Argentina	6,699	5.137	1.773	69.4
Brazil	17,039	27.507	9.493	69.4
Chile	2,354	4.474	1.544	69.4
China	70,310	36.907	12.737	69.4
Colombia	5,395	4.738	1.635	69.4
Hong Kong	3,647	4.934	1.702	69.4
India	17,802	6.968	2.405	69.4
Indonesia	4,983	11.153	3.849	69.4
Malaysia	4,223	6.342	2.188	69.4
Peru	1,646	3.398	1.172	69.4
Philippines	2,078	8.103	2.796	69.4
Russia	28,250	10.732	3.704	69.4
Singapore	1,685	1.910	0.659	69.4
South Africa	4,645	4.420	1.525	69.4
Taiwan	10,862	4.341	1.498	69.4
Thailand	4,827	3.320	1.146	69.4
Uruguay	761	0.461	0.159	69.4
Vietnam	1,587	1.183	0.408	69.4

a Trimmed average price rebalancing indicator for OECD economies.

Source: ITU (2000) and estimates based on ITU (2000), World Bank (2000), IMF (2000a) and Boylaud and Nicoletti (2000).

Table 3.6 **Price impact of regulation on telecommunications prices, 1997**

Per cent of notional price existing under benchmark regulatory regime

Economy	*Trunk*	*International*	*Mobile*	*Leasing*	*Industry-wide*
OECD					
Australia	21	33	23	4	19
Austria	10	51	17	11	20
Belgium	41	207	18	5	52
Canada	33	95	8	0	27
Denmark	63	12	16	3	39
Finland	5	34	50	17	22
France	41	95	16	9	34
Germany	40	176	17	8	38
Greece	37	35	10	19	27
Iceland	31	199	96	11	54
Ireland	17	56	16	10	22
Italy	32	41	10	3	21
Japan	39	34	14	5	23
Luxembourg	17	108	105	22	59
Netherlands	32	30	13	5	23
New Zealand	30	24	15	1	21
Norway	26	67	42	14	31
Portugal	22	15	8	6	15
Spain	28	30	7	4	18
Sweden	53	**b**	54	15	**b**
Switzerland	13	165	49	16	40
Turkey	35	**b**	17	24	**b**
United Kingdom	78	63	6	2	47
United States	61	32	8	1	38
Unweighted mean	*34*	*73*	*26*	*9*	*31*
Standard deviation	*17*	*61*	*27*	*7*	*13*

(Continued on next page)

Table 3.6 **(continued)**

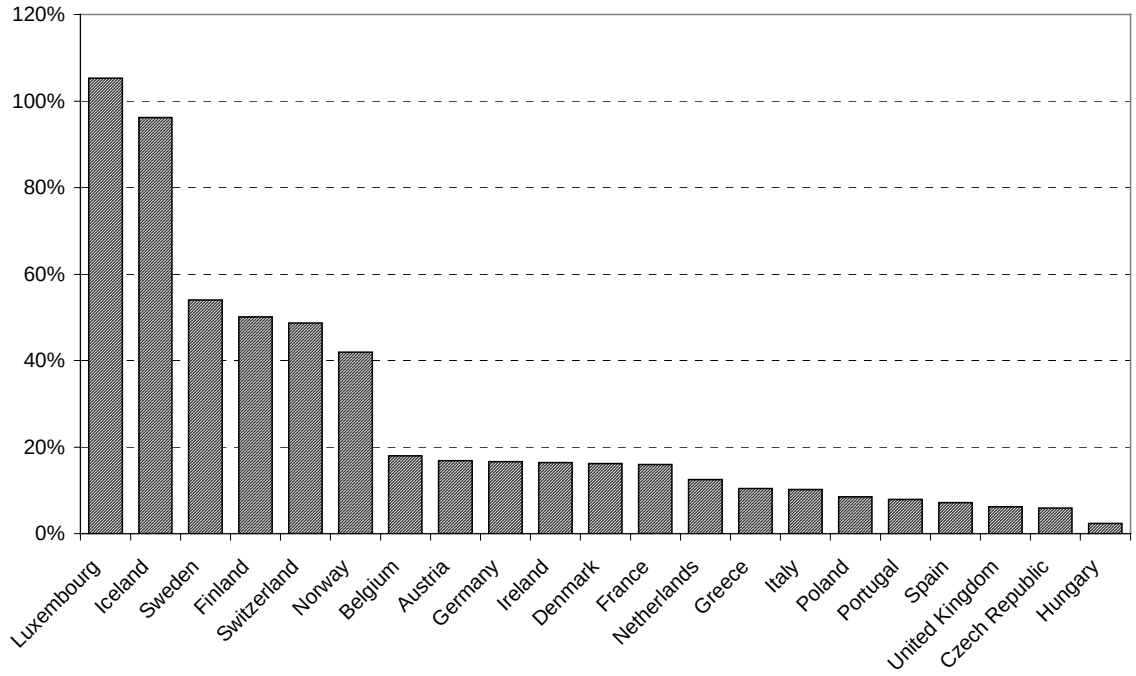
Economy	*Trunk*	*International*	*Mobile*	*Leasing*	*Industry-wide*
Additional OECD[a]					
Czech Republic	36	20	6	ne	22
Hungary	69	44	2	ne	38
Korea	18	16	9	ne	14
Mexico	54	16	7	ne	40
Poland	18	30	9	ne	17
Unweighted mean	*39*	*25*	*7*	*na*	*26*
Standard deviation	*23*	*12*	*3*	*na*	*12*
NON-OECD					
Argentina	64	21	6	ne	45
Brazil	27	15	16	ne	23
Chile	41	35	7	ne	32
China	**b**	**b**	**b**	ne	**b**
Colombia	28	22	20	ne	25
Hong Kong	49	47	24	ne	43
India	68	41	**b**	ne	**b**
Indonesia	41	52	56	ne	46
Malaysia	23	34	23	ne	24
Peru	32	12	7	ne	24
Philippines	30	23	8	ne	23
Russia	63	**b**	**b**	ne	**b**
Singapore	25	196	35	ne	44
South Africa	35	26	**b**	ne	**b**
Taiwan	25	54	40	ne	32
Thailand	41	111	18	ne	42
Uruguay	42	37	8	ne	33
Vietnam	**b**	**b**	**b**	ne	**b**
Unweighted mean	*40*	*48*	*21*	*na*	*34*
Standard deviation	*15*	*47*	*15*	*na*	*9*
All 47 economies					
Minimum	*5*	*12*	*2*	*0*	*14*
Maximum	*78*	*207*	*105*	*24*	*59*
Unweighted mean	*36*	*58*	*22*	*9*	*31*
Standard deviation	*17*	*54*	*22*	*7*	*12*

ne: not estimated. na: not applicable. **a** OECD economies not included in Boylaud and Nicoletti (2000). **b** Excluded.

Figure 3.3 **Industry-wide price impact of telecommunications regulation**

Per cent of benchmark telecommunications price, 1997

Europe



Africa, Asia, Oceania, North and South America

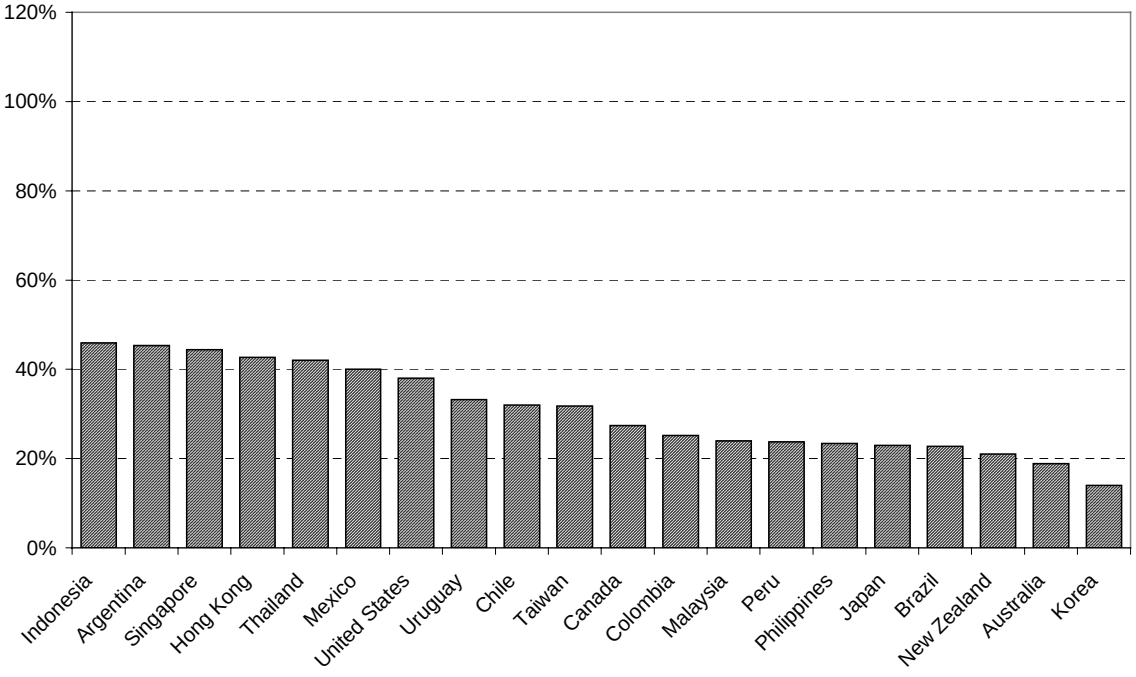
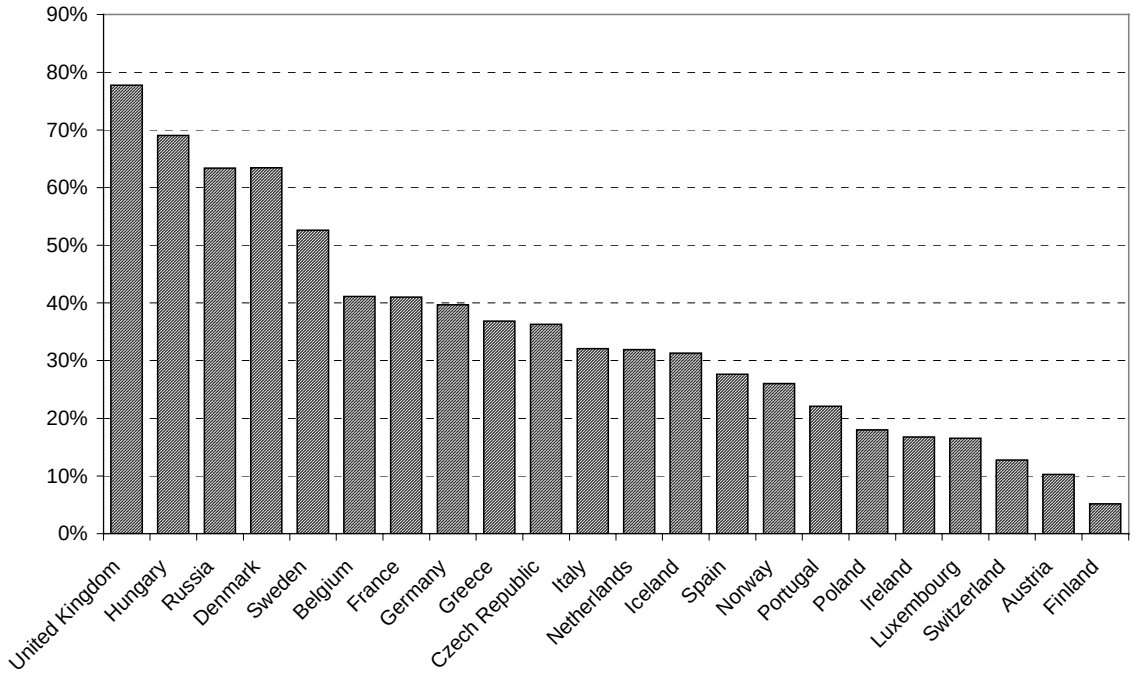


Figure 3.4 **Price impact of regulation in trunk telecommunications**

Per cent of benchmark telecommunications price, 1997

Europe



Africa, Asia, Oceania, North and South America

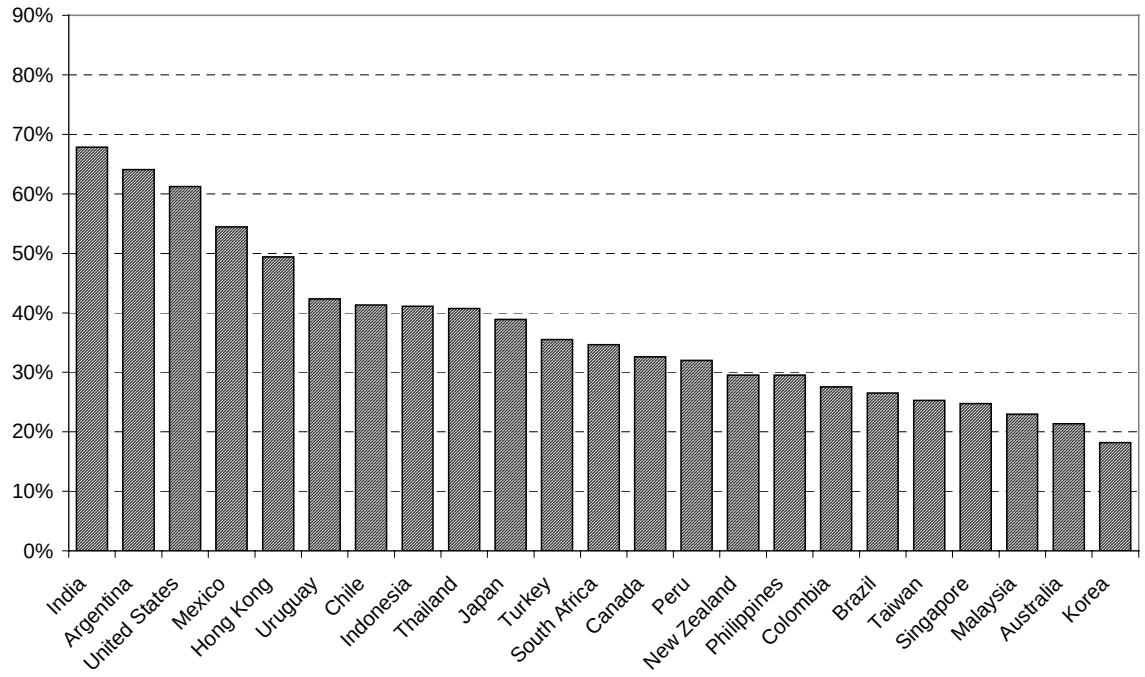
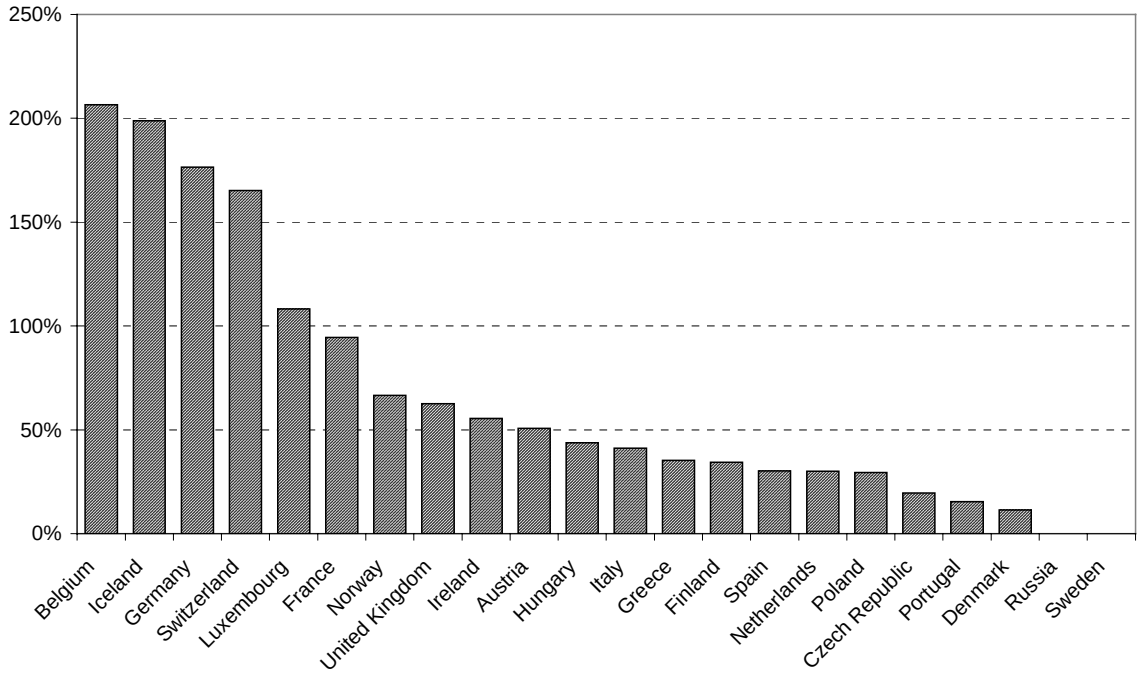


Figure 3.5 **Price impact of regulation in international telecommunications**
Per cent of benchmark telecommunications price, 1997

Europe



Africa, Asia, Oceania, North and South America

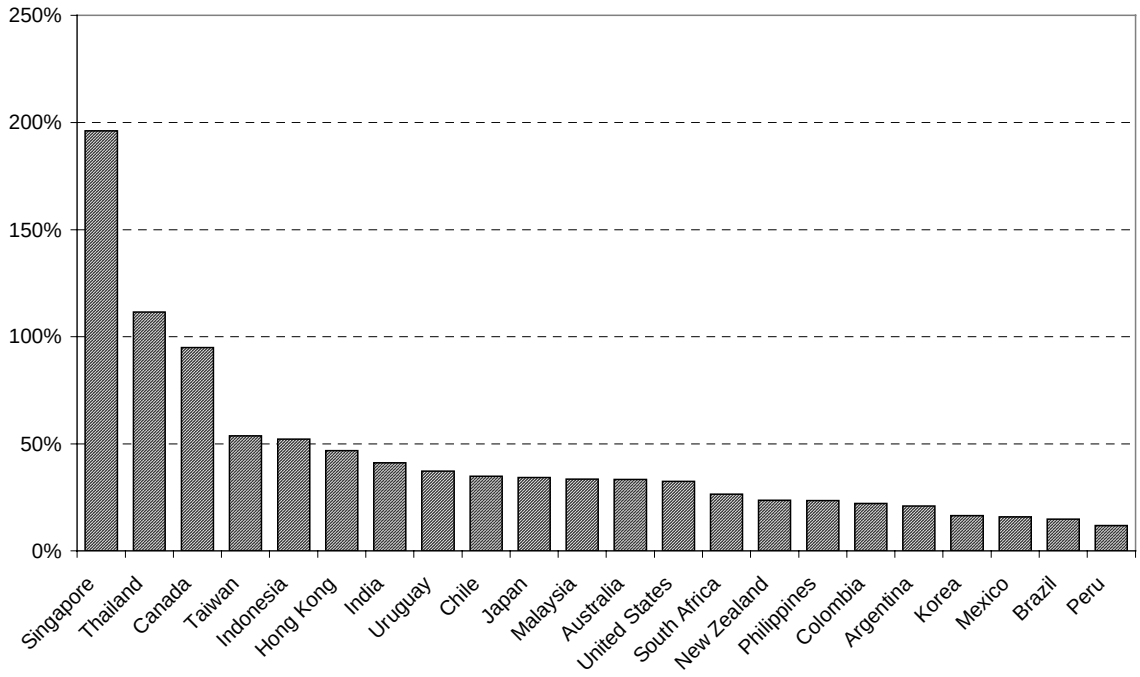
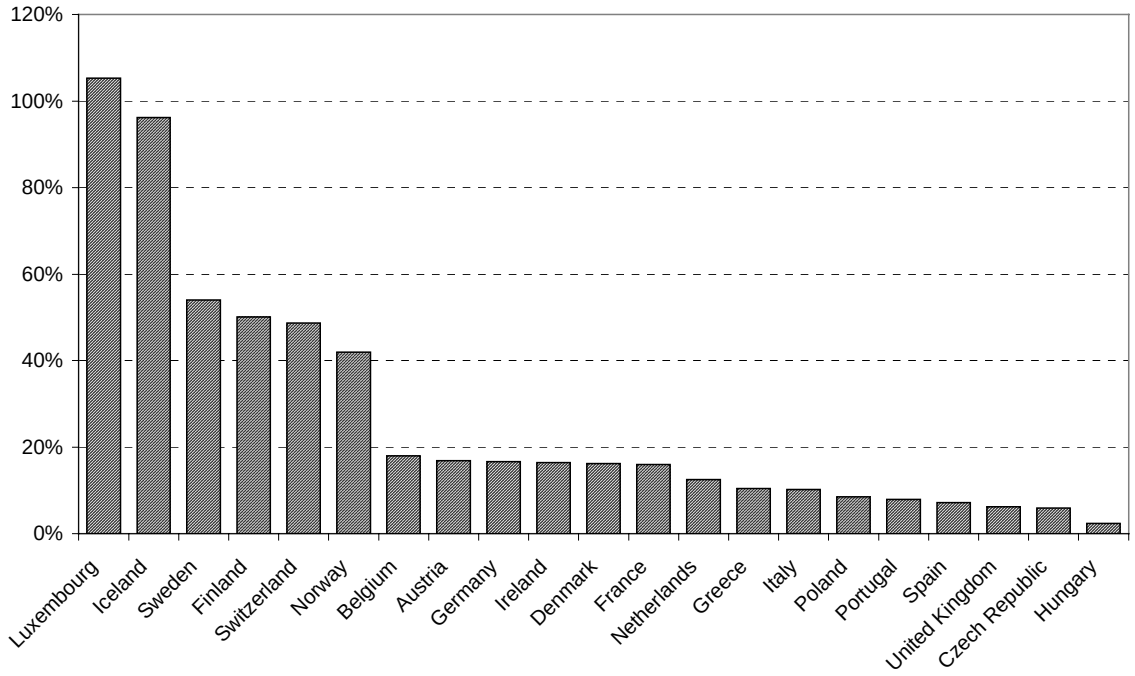


Figure 3.6 **Price impact of regulation in mobile telecommunications**

Per cent of benchmark telecommunications price, 1997

Europe



Africa, Asia, Oceania, North and South America

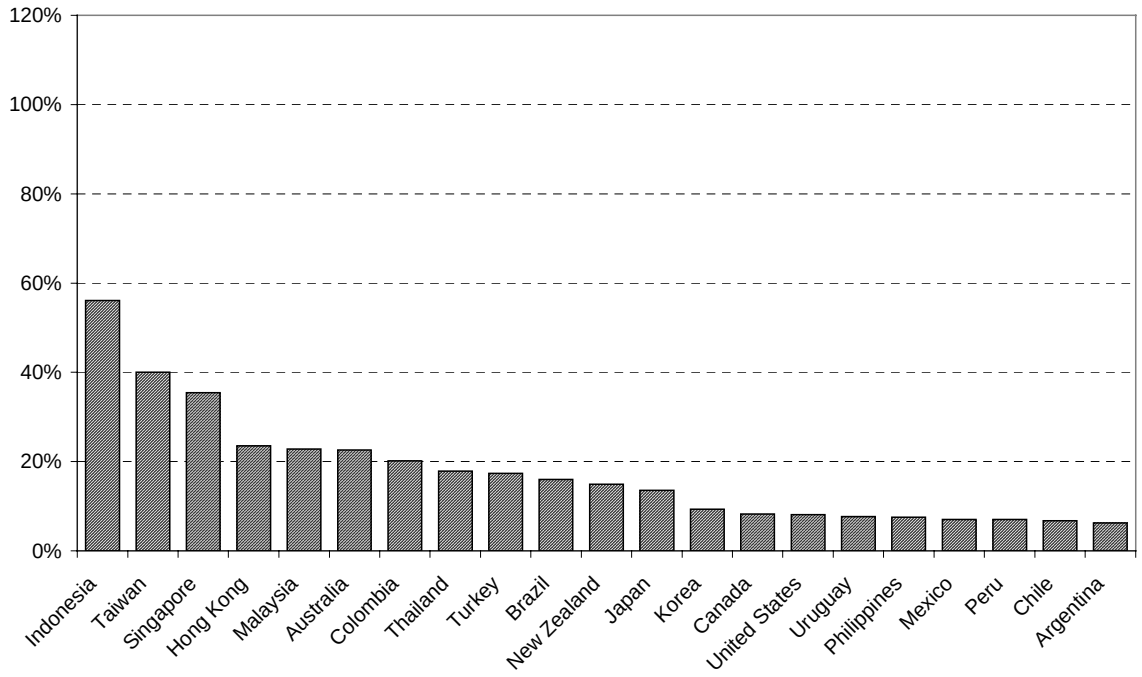
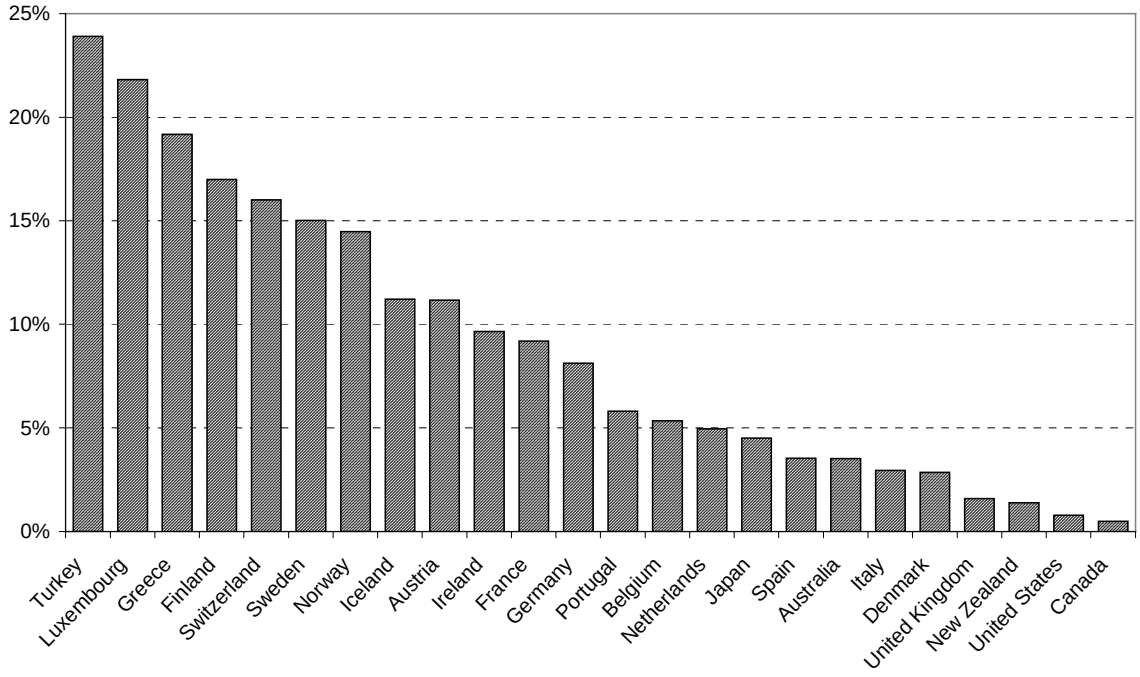


Figure 3.7 **Price impact of regulation for leased-line telecommunications**

Per cent of benchmark telecommunications price, 1997



4 Electricity supply

The electricity supply industry is an important service industry. Directly, it employs significant amounts of capital, labour and other resources, and is a major contributor to national output and income. In Australia, industry value added exceeded A$9.7 billion or just under 2 per cent of GDP in 1998-99. Indirectly, the energy produced by the industry impacts on most economic and social activity.

There is also a high level of government intervention in the industry. In part, this reflects historical concerns that, like telecommunications, the electricity supply industry possessed natural monopoly characteristics that meant that genuine competition was unlikely to occur in an unregulated market. Governments responded to these concerns by using regulation to prevent those in the industry from abusing any market power. Some governments, especially those in the Commonwealth and Western Europe, went significantly further by owning some, or all, of the industry.[1]

Over the last two decades, the notion that the *entire* industry possessed natural monopoly characteristics was increasingly challenged by a view that competition could occur in the generation and retail sectors. Recent technological advances have reinforced this view, by increasing the potential for competition to occur in generation.[2] The development of cogeneration,[3] for example, has changed the economics of generating electricity, thereby allowing large commercial operations to become small-scale power stations.

Many governments gradually accepted that competition was both possible and desirable in some segments of the industry, and responded by reforming the structure of the industry and the way it was regulated.

---

1 In comparison, governments in the United States and Japan, for example, regulated regional private sector monopolies (Joskow and Rose 1992).

2 These technological advances often have other advantages as well, such as reducing greenhouse gas emissions from the generation sector.

3 Cogeneration, the simultaneous production of electricity and usable heat, makes it more viable for large industrial firms to produce commercial quantities of electricity that can be sold into the electricity grid as a by-product of their existing manufacturing processes.

However, the nature and extent to which governments have embraced competition varies widely across economies. Some governments have gone further, in some cases considerably further, in the reform process than strictly needed to create a competitive generation sector. After implementing a pro-competition industry structure, the UK Government, for example, privatised *all* firms in the industry and introduced mandatory customer service targets in the retail sector. Consequently, the structure of the electricity industry and the accompanying regulatory arrangements vary widely among economies.

What effect have these regulatory reforms had?

Most of the existing research focuses on the effects of regulation in an economy or on individual firms (Joskow and Rose 1992). Indeed, in reviewing the pre-existing literature, the OECD concluded:

> It is difficult to draw general policy conclusions from existing empirical work that focuses on far-reaching reforms in a single market or other country-specific anecdotal discussion of regulatory changes because neither type of study separates the effects of regulatory reform from country-specific features. (Steiner 2000, p. 6)

In the third of the OECD working papers, Steiner (2000) explicitly examined the influence of *individual* regulations in the electricity generation sector on efficiency and price across a range of economies. The paper also assessed the impact of liberalisation and privatisation on performance. However, it did not examine the combined effect of *all* regulation.

This chapter draws out the implications of the OECD's econometric results to assess the combined impact on electricity prices of *all* of the regulations identified in Steiner (2000). In doing so, it estimates an overall price impact measure for each economy.[4]

The focus of this chapter is on the effect of regulation on industrial electricity prices.[5]

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4 The price impact measure used here is also known as a regulatory tax equivalent. No attempt is made to assess whether the regulations increase prices by increasing costs or by increasing profit (price-cost) margins, although the regulations covered in Steiner (2000) might reasonably be expected to increase costs by restricting competition in the industry and promoting x-inefficiency (eg allowing incumbents to employ more capital and labour than strictly necessary to produce a given level of output).

5 Steiner's other equations are also less well suited for international comparisons than her industrial price model. The measures of efficiency used are not particularly meaningful for economies reliant on hydroelectricity, and the degree of reserve generating capacity (reserve plant margin) and utilisation rates will vary across economies depending on economy-specific characteristics,

4.1 Regulatory reform in the electricity industry

To understand the approach taken in Steiner (2000) and, hence, its strengths and weaknesses, it is worthwhile considering the regulatory reform processes that have occurred worldwide in the electricity industry.

Prior to liberalisation, most economies had legislated monopolies that generated electricity and undertook transmission and/or distribution/retailing.[6] In many cases, a single vertically-integrated, regional or national monopoly (predominantly, but not exclusively, a publicly-owned one) undertook all of these functions. There was little or no choice for electricity customers.

Following the lead of England and Wales in 1990,[7] many OECD, and some non-OECD economies, began to reform their electricity industries and the way they were regulated. While the underlying motivations differed widely across economies, the reforms themselves were broadly similar — relaxing the tight regulatory controls preventing entry and, where possible, facilitating competition.

Liberalisation of the industry basically involved:

- structurally separating (unbundling) those activities that were considered to be competitive (generation and retailing) from those that were thought to be natural monopoly activities (transmission[8]) (termed *vertical separation*);
- dividing existing generating capacity among a number of generation companies (termed *horizontal separation*);
- allowing new generators to enter the market;
- guaranteeing open and non-discriminatory access for all generators to the transmission grid (subject to available capacity) (termed *third party access*);

such as climatic factors and grid design (eg the degree of interconnection influences the extent to which capacity can be shared between regions or economies). Retail prices are also more likely than industrial prices to be directly influenced by regulatory factors that have not been incorporated into the OECD's models (eg price controls).

6 Distribution was nearly always combined with retailing.

7 The UK electricity market is divided into three distinct regions — England and Wales (the largest region), Scotland and Northern Ireland. The nature, timing and extent of liberalisation differed between regions. Steiner (2000) used the term United Kingdom to refer to the English and Welsh market. This practice has been adopted here.

8 Although distribution is generally considered to be a natural monopoly activity, few economies have structurally separated distribution from retailing, despite the potential for operators of the distribution networks to use their monopoly power to expropriate for themselves some or all of the social benefits that could arise from introducing competition into the retail sector.

- enabling large customers (retailers and sometimes large industrial users) to purchase electricity directly from the generator of their choice; and
- regulating the natural monopoly activities to prevent any abuse of market power.

Many economies also established a wholesale pool, or spot market, for electricity (either mandatory or optional) to overcome limitations associated with the use of direct (bilateral) contracts between generators and retailers.[9]

Some economies went further still by:

- introducing a regulator independent of industry players and day-to-day political influence;
- allowing choice for some or all retail customers;
- providing a full range of tradable financial instruments (eg futures contracts and options);
- undertaking partial or complete privatisation of publicly-owned assets;
- introducing cross-ownership restrictions (especially between competitive and natural monopoly activities);
- liberalising restrictions on foreign investment and ownership;
- mandating service quality standards (some with financial penalties if they were not met); and
- allowing retailers to introduce innovative services (eg the ability to switch retailers over the internet, providing electricity jointly with other services, such as telephony and gas).

The reform process is on-going and dynamic. Despite some testing, the suitability and sustainability of many of the current reforms are largely unproven. Reforms are refined, enhanced and sometimes even replaced to improve the way the industry operates.[10] Thus, in many economies, the reform process is evolving over time to reflect changing circumstances and the additional experience gained under a 'competitive' industry model.

---

9 Contracts can hinder the development of competition in the generation sector by making it difficult for new generators to enter the market and compete effectively with existing generators (ie contracts can be used to lock consumers in).

10 For example, the United Kingdom established a wholesale electricity market (the Pool) in March 1990, only to replace it with a system of bilateral contracts in March 2001.

Even with these reforms, the electricity industry remains highly regulated in *all* economies. While many of the remaining regulations address social and environmental objectives (eg pollution), substantial regulatory effort is still directed towards economic goals, especially at preventing the abuse of market power in transmission and distribution. Governments directly or indirectly, through the remnants of the pre-liberalised monopolies, are generally highly influential players in augmenting the transmission grid and in cross-border trade in electricity (between economies and sometimes between regions in economies).

In essence, regulatory reform has gone hand-in-hand with structural reform of the industry and the way in which it operates. Thus, it is virtually impossible to separate the effects of regulatory reform from those arising from changes in market structure and, consequently, the OECD used the term regulation to include characteristics that are typically thought of as pertaining to market structure (as this chapter does).

4.2 OECD modelling of the impact of regulations

The OECD working paper assessed the effect of individual regulations on:

- industrial electricity prices;
- the ratio of industrial to residential electricity prices;
- utilisation rates (an efficiency measure for generation); and
- reserve plant margins (an alternative efficiency measure for generation).

Separate models were estimated for each of these performance measures on the assumption that the relationships being estimated were independent of each other. The rationale underlying the choice of each model, the methodology used, the choice of variables and the data used are discussed at some length in Steiner (2000).

These models were estimated by pooling regulatory, non-regulatory environmental and price data for 19 OECD economies — Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States.[11] The estimated models cover the period from 1986 to 1996.

[11] Unless otherwise stated, the term OECD is used here to refer to the 19 economies included in Steiner (2000). It does not include the 11 members of the OECD, many of which joined the OECD after 1986, not included in the paper — Austria, the Czech Republic, Hungary, Iceland, Korea, Luxembourg, Mexico, Poland, the Slovak Republic, Switzerland and Turkey.

Given this pooling of time-series data (the data for each economy from 1986 to 1996) and cross-sectional data (the 19 economies), panel estimation techniques — fixed and random effects models — were used to estimate these models. On the basis of various statistical tests, the OECD found that the random effects models were always preferred to those estimated using fixed effects and ordinary least squares (OLS). Consequently, only the results for the random effects model were published.

The OECD model of industrial electricity prices

Steiner (2000) econometrically estimated a linear relationship between industrial electricity prices (P) and the regulatory and non-regulatory environmental variables (denoted here by R and E, respectively). The reason for including the environmental variables is that they are also important determinants of price differences across economies and their omission would bias the resulting parameter estimates.

More precisely, the model estimated for industrial electricity prices was:

$$P = \alpha + \beta R + \gamma E + \varepsilon \qquad (4.1)$$

where α, β and γ were vectors of coefficients that were estimated econometrically and ε was the residual error term.

The estimated model consisted of six regulatory/market structure variables and three economy-specific, non-regulatory environmental variables. Table 4.1 details how each of the variables discussed below was measured.

The dependent variable: Industrial electricity prices

Not only do industrial electricity prices vary across economies, they also vary widely across customers within economies (Sayers and Shields 2001). Industrial electricity prices often vary with the type and size of business, the amount of electricity demanded, the time of day, the time of year, the conditions of supply and the available generating capacity. Many industrial customers also receive discounts on listed prices or other 'sweeteners' that effectively lower electricity prices.[12]

[12] For example, in 1984 the Victorian Government guaranteed and, through an additional agreement between the State Electricity Commission of Victoria (SECV) and the Victorian Treasury, agreed to fund for 30 years the supply of electricity to the Portland and Point Henry aluminium smelters in Australia. Under the contract, the price of electricity paid by Alcoa was

Given the wide variation in prices faced by industrial customers within an economy, some form of economy-wide average price is needed for international empirical work.

The OECD used annual average electricity prices per kilowatt hour (kWh) actually faced by 'industrial' customers, as determined by the International Energy Agency (IEA), as their dependent variable. The prices used were net of taxes on electricity (including value-added taxes) and were sourced from the IEA. It was implicitly assumed that these prices were sustainable in the long term. This proposition is largely untested, given that most economies have only recently liberalised their generation sectors and, given the lengthy approval processes and the time taken for constructing some new power stations, investment in the sector may take some time to reflect changes in the regulatory environment.

Table 4.1 **OECD's preferred model of industrial electricity prices**

Variable	*How measured*
Dependent variable	
Industrial electricity price	Pre-tax industrial price (expressed in US PPP$ per kWh)
Independent regulatory variables	
Unbundling of generation from transmission	Dummy variable (1=accounting separation or separate companies; 0=otherwise)
Third party access	Dummy variable (1=regulated or negotiated third party access; 0=otherwise)
Wholesale pool	Dummy variable (1=presence of a wholesale electricity market; 0=otherwise)
Ownership	Discrete variable (4=private ownership; 3=mostly private ownership; 2=mixed; 1=mostly public; 0=public)
Time to liberalisation	Negative of the number of years to liberalisation [Ranges from –11 to 0]
Time to privatisation	Negative of the number of years to privatisation [Ranges from –11 to 0]
Independent non-regulatory environmental variables	
Hydro share	Share of electricity generated from hydro sources
Nuclear share	Share of electricity generated from nuclear sources
GDP	Gross domestic product (expressed in US PPP$ billion)

Source: Steiner (2000).

tied to movements in aluminium prices. Given the movements in aluminium prices that occurred between 1984-85 and 1997-98, this translated into a A$1.45 billion reduction in the cost of electricity used by the aluminium smelters (Victorian Auditor-General's Office 1999, s. 3.8.66).

To enable meaningful comparisons to be made across economies, the OECD converted all values from units of local currency to US dollars using the OECD's purchasing power parities (PPP), as nominal exchange rates do not accurately reflect differences in spending power across economies:

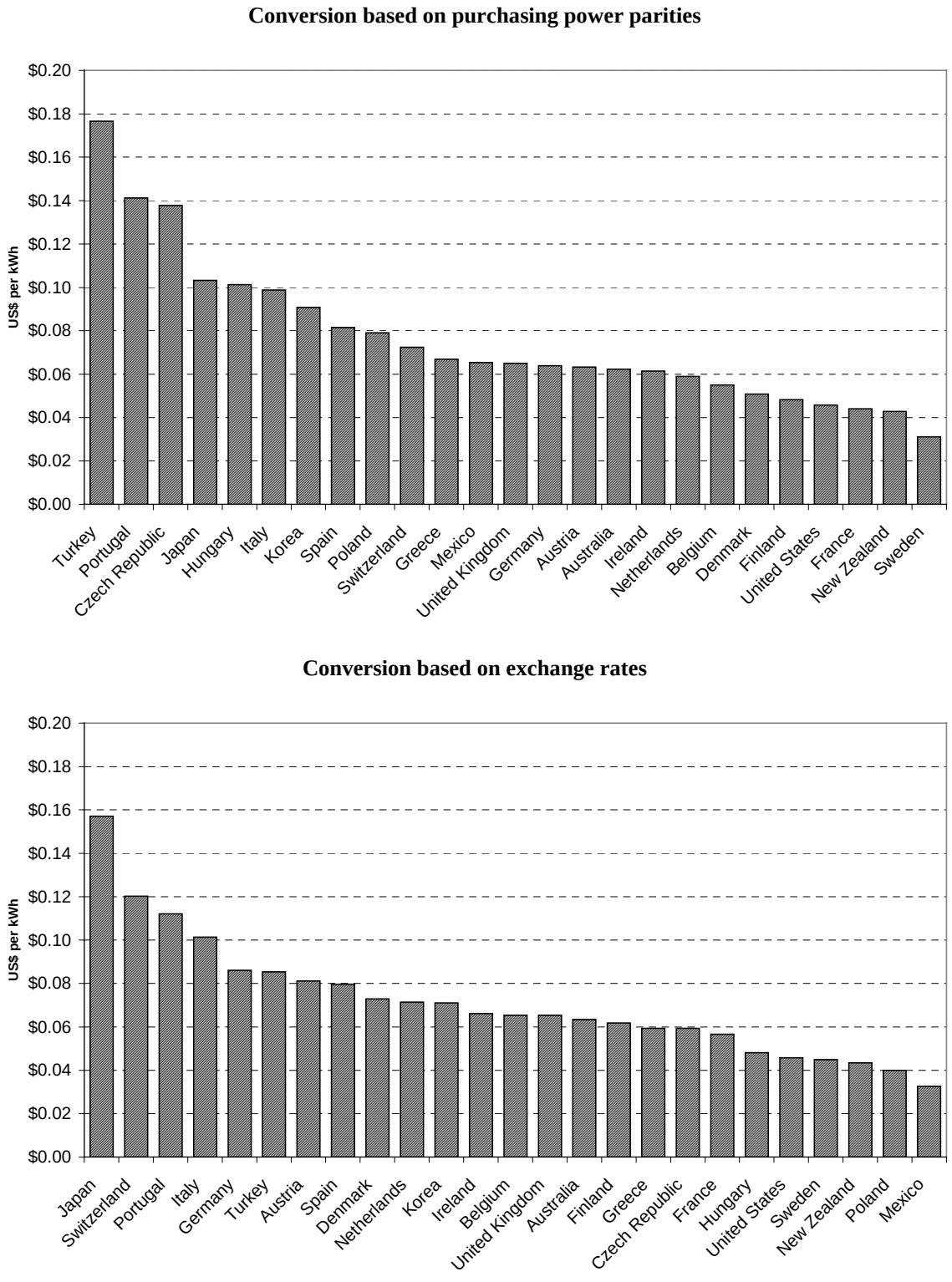
> Before PPPs became available, exchange rates had to be used to express GDPs of countries in a common currency for the purpose of international comparison. The assumption underlying this practice is that exchange rates reflect the relative prices of domestically-produced goods and services in the different countries. However, many goods and services, such as buildings and government services, are not traded between countries. Moreover, other factors, such as relative interest rates and capital flows between countries, also have a significant impact on exchange rates and their influence is such that exchange rates do not adequately reflect the relative purchasing power of currencies in their national markets. (OECD 1999b)

So, in essence, PPP exchange rates correct for differences in price levels and, hence, reflect differences in purchasing power across economies. Consequently, the ranking and magnitude of electricity prices obtained by the OECD differ from those based on market exchange rates (figure 4.1).

The IEA adjusts its electricity prices for the direct effect of taxes and subsidies, but not for many of the indirect factors that might cause electricity prices to vary across economies.[13] For example, electricity prices might vary across economies because governments require publicly-owned utilities to earn lower rates of return on their assets than their private sector counterparts. In light of this, comparisons of electricity prices alone may not provide an accurate assessment of the true impact of regulation on prices and the associated resource costs, especially when those economies that have fully privatised their electricity industry (eg the United Kingdom) are compared with economies with full public ownership (eg France).

[13] The IEA takes account of some indirect factors, for example, subsidies on locally sourced coal.

Figure 4.1 **Average OECD industrial electricity prices, 1996**[a]



a Tax-inclusive industrial electricity price.

Data source: IEA (2000, Tables 34 and 36, pp. I.63–I.64).

Regulatory variables

As the generation sector is the sector capable of delivering the biggest efficiency gains in the electricity industry, the regulatory variables used by the OECD focus on the key economic regulations needed to establish a competitive generation sector — structural separation of generation from transmission, whether third parties can access the transmission grid and whether a wholesale pool (electricity market) exists. The modelling did not look at other forms of regulation in the generation sector, nor at regulation in the transmission,[14] distribution or retail sectors, despite the potential for the transmission and distribution sectors to expropriate efficiency gains derived elsewhere in the system (King 2000) and the fact that some economies have delivered full or partial retail competition. The regulatory variables did not cover regulation addressing non-economic objectives, such as environmental or social policies.

Dummy variables were used to indicate the three key economic regulations needed to establish a competitive generation sector.

The *unbundling of generation from transmission* variable takes on a value of 1 if separate companies control the generation and transmission sectors, or if both sectors are controlled by a single entity keeping separate accounts for each sector (accounting separation); otherwise it takes on a value of 0. Having separate companies reduces the likelihood that any gains arising in the generation sector will be expropriated by the company controlling the transmission sector. Yet physical separation need not translate into economic separation, if it is accompanied by cross-ownership between the companies concerned or if one of the companies exercises any monopoly power. Accounting separation is a considerably weaker proposition than having separate companies, as it gives the single entity considerably more scope to engage in strategic behaviour and to maximise its joint profits to the detriment of society. Accounting separation is also weaker than the notion of 'ring-fencing' that is sometimes used in Australia and other economies, as the ring-fenced activities operate with greater autonomy from the rest of the organisation than do business units.

The *third party access* variable takes on a value of 1 if generators have a legal right to access the transmission grid on certain pre-specified terms and conditions (regulated third party access) or can negotiate the terms and conditions under which

[14] Some of the regulatory variables for the generation sector — *unbundling of generation from transmission* and *third party access* — carry implications about the structure and regulation of the transmission sector.

grid access can occur directly with the operator of the transmission grid (negotiated third party access); otherwise it takes on a value of 0. New generators need to be able to access the transmission grid on similar terms and conditions to existing generators to ensure effective and ongoing competition in the generation sector. However, the variable does not capture important differences in the way the third party access arrangements operate across economies.

The *wholesale pool* variable takes on a value of 1 if generators can voluntarily sell, or are obliged to sell, their electricity into a wholesale electricity market; otherwise it takes on a value of 0.[15] The pool is designed to overcome limitations associated with the use of long-term bilateral contracts that may stifle competition. However, the variable does not capture whether the pool is mandatory or optional and the rules governing how it operates. An optional wholesale pool that allows participants to voluntarily bypass the pool and negotiate their own bilateral contracts should lead to lower electricity prices than a mandatory pool in which *all* electricity must be sold, as bilateral contracts can be used to deliver mutually beneficial outcomes that would not be available under a mandatory pool.

Competitive electricity markets would generally be expected to lead to lower industrial electricity prices, so that the *unbundling of generation from transmission*, *third party access* and *wholesale pool* variables would be expected to be negatively related to industrial electricity prices.[16]

In addition to the three regulatory variables needed to establish a competitive generation sector, the OECD included three market structure variables in their model — *ownership*, the *time to liberalisation* and the *time to privatisation* — as they may also account for price differences across economies.

Ownership of the generation sector varies widely across economies, ranging from full public ownership all the way through to full private ownership. To

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15 The variable does not, however, differentiate between the different price setting arrangements that may occur in the absence of a wholesale pool (eg bilateral contracts and price controls).

16 Where insufficient competition exists, generators may be able to manipulate a wholesale pool by exercising their market power. The rules governing the operation of the market and the behaviour of the regulator will affect the extent to which this occurs. Insufficient competition can arise, for example, where the pre-reform generating capacity was divided into too few generators prior to establishing a wholesale market (insufficient horizontal separation) or where new generators find it excessively difficult to enter the market (eg if the third party access arrangements are too stringent). The recent UK decision to replace its wholesale pool with bilateral contracts was based on concerns about insufficient competition in the generation sector. However, it is not at all clear whether alternative price setting arrangements, such as the use of bilateral contracts, will necessarily deliver lower prices than a wholesale pool, as the underlying problem is the same under both regimes — the market power of the generators.

accommodate this, the *ownership* variable takes on different discrete values ranging from 0 to 4, depending on the mix of public and private ownership (table 4.1). Various hypotheses can be put forward as to why prices might vary with ownership. Private generators might be more likely than their public counterparts to earn higher profits by exploiting any residual market power that they may have. Conversely, they might be more efficient and, hence, able to charge lower prices. They may be also less likely to pursue non-economic objectives and this could be reflected in the prices charged.

The *time to liberalisation* and *time to privatisation* variables measure, respectively, the (negative) number of years to liberalisation and privatisation:

> Indicators of the time remaining to liberalisation and privatisation were included to proxy for the impact of expectations of liberalisation and privatisation on prices. (Steiner 2000, p. 23)

They are forward-looking indicators in that they assess the effect of regulation on prices *before* liberalisation or privatisation. They do not measure the price impact *after* liberalisation or privatisation. One rationale put forward by Steiner for including the time to privatisation variable was to test the following hypothesis:

> Furthermore, privatisation of historically public generators may still result in high prices in the short run. Governments may actually increase electricity prices in order to sell assets and generate revenue. (Steiner 2000, p. 23)

Similarly, incumbents may alter their behaviour *before* liberalisation in an attempt to shore up their existing customer base or increase market share to strengthen their competitive position, so that they are better placed to ward off potential competition from new generators.

Liberalisation is interpreted as being the year in which key legislative changes are enacted. In nearly all cases[17], liberalisation is accompanied by a change in one or more of the other regulatory variables included in the model.

Privatisation is deemed to occur in the year in which the first sale of a publicly-owned generator occurs. The definition does not take into account the *extent* of privatisation — it does not distinguish between whether 7 or 100 per cent of a firm or industry is privatised. Yet the economic effects are likely to be quite different.

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[17] Steiner (2000, p. 27) indicates that a Canadian electricity market was established in 1996 (the Alberta Pool). Despite this, liberalisation does not occur in the dataset for Canada in 1996 (or any other year).

The regulatory variables incorporated into the econometric modelling (table 4.1) are high-level indicators of the basic (regulated) structure of the industry in the 19 economies covered, as they do not pick-up many of the real-world complexities associated with these regulations that can also effect electricity prices.[18] As a result, these regulatory variables are, at best, broad indicators of the regulatory culture and operating environment that prevailed in each economy. The way these indicators are constructed arises in large part from the difficulty in precisely classifying and measuring regulations on a consistent basis across economies and limitations in the available data.

Non-regulatory environmental variables

The industrial price model also included three non-regulatory environmental variables — the share of electricity generated from hydro, the share of electricity generated from nuclear and gross domestic product (GDP).

The two share variables reflect differences in generating technologies across economies, which affect the marginal cost, and hence price, of generating electricity. In particular, the marginal cost of hydroelectricity tends to be considerably lower than for electricity generated from coal, oil or gas. The treatment of these technology variables as exogenous implicitly assumes that the technology employed in each economy is not influenced by economic regulation. This is not an entirely inappropriate assumption because, although economic regulations may have some affect at the margin, the choice of technology is primarily driven by commercial considerations (eg market opportunity, access to finance, the fixed and marginal costs associated with each technology that determine the efficient scale of operations and breakeven points), resource availability (an important consideration for hydroelectricity) and non-economic regulation (eg environmental and social regulation).

The inclusion of GDP adjusts for differences in the size of economies and is also an overall measure of national income. It implicitly incorporates two components — a genuine scale effect arising from differences in size or population across economies, and an affluence effect arising from differences in per capita incomes.

[18] For example, by only measuring whether particular policies exist, the regulatory variables considered here do not measure how restrictive these polices actually are or the extent to which they are binding.

4.3 Extending the economy coverage

Steiner (2000) focused on the more affluent OECD Member economies in Western Europe and North America. The study included few economies from the Asia-Pacific region and no economies from South America, Eastern Europe or Africa.

In the absence of alternative estimates of the effects of regulations on electricity prices in non-OECD economies, Steiner's findings for OECD economies are applied here to non-OECD economies. This assumes that the relationship between the regulatory and non-regulatory environmental variables and price (the estimated coefficients) is the same in non-OECD economies. But the structure of the electricity supply industry differs in many non-OECD economies — they are less likely to have third party access arrangements, a wholesale pool, or use nuclear energy than OECD economies, and they typically have lower GDP. Thus, it is unclear whether Steiner's findings on the effects of regulations on industrial electricity prices in OECD economies are representative of effects elsewhere.

The additional economies included here cover:

- OECD economies not included in the original OECD study;
- Asia Pacific Economic Cooperation (APEC) Member economies; and
- other economies (mainly South American).

In all, this chapter estimates price impacts for 50 economies (table 4.2). These economies provide a wide coverage of the more developed economies throughout the world, a coverage conducive to future general equilibrium modelling work. Africa remains under-represented in the extended coverage, as does the Eastern Europe, Central America, the Caribbean, the Middle East and the Pacific. Nevertheless, the 50 economies accounted for 90 per cent of global income and electricity production in 1998 (World Bank 2000, IEA 2000).

Steiner's initial coverage was based on those Members of the OECD for which the necessary data were available from 1986 to 1996.[19] Given the difficulty in collecting the corresponding regulatory and environmental data for the full time period, 1996 — the last year of the OECD study — was chosen as the year in which to assess the impact of regulation on prices for *all* economies. Thus, regulatory and environmental data were collected for each of the additional economies for 1996

[19] Despite this, selected data are missing from the dataset used (Steiner, F., pers. comm. 31 January 2001).

and combined with data from the OECD study.[20] The data for non-OECD economies are presented in tables 4.5 and 4.6 at the end of this chapter.[21]

Table 4.2 **Extended economy coverage for electricity**

Grouping	*Economies (listed alphabetically)*
Included in OECD study (19 economies)	Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States
Additional OECD Members (11 economies)	Austria, the Czech Republic, Hungary, Iceland, Korea, Luxembourg, Mexico, Poland, the Slovak Republic, Switzerland and Turkey
APEC Members (Non-OECD) (12 economies)	Chile, China, Hong Kong[a], Indonesia, Malaysia, Peru, Philippines, Russia, Singapore, Taiwan, Thailand and Vietnam
Other economies (8 economies)	Argentina, Bolivia, Brazil, Colombia, India, South Africa, Uruguay and Venezuela
No. of economies covered:	**50**
No. of economies by region:	Africa: 1; Asia: 13; Eastern Europe: 5; North America: 3; Oceania: 2; South America: 8; Western Europe: 18

a Hong Kong is included as a separate economy as its electricity system differs from that of China.

4.4 Calculating the price impact of electricity regulation

Steiner's econometric results indicated the impact of *each* economic regulation on price. From these individual effects it is possible to gauge the overall impact of all economic regulations — the regulatory regime — on price. As her study only included a subset of economic regulations affecting the generation sector, the impact measures calculated here are unlikely to measure the full extent to which economic regulations impact on industrial electricity prices.

The methodology here is similar to that used in chapter 3 to derive the price impacts for the telecommunications industry. The main difference arises from the fact that

20 As with the original OECD study, some subjective assessments were needed in order to classify the regulatory arrangements existing in each economy.

21 The PPP used in this chapter for the eleven additional OECD economies are sourced from the OECD (2000b). The PPPs used for all non-OECD economies, except Taiwan, are estimated from World Bank data showing the relationship between PPP and nominal exchange rates for each economy (World Bank 2000) and US dollar GDP data sourced from the International Monetary Fund (IMF 2000). In the absence of PPP estimates for Taiwan, the nominal exchange rate was used in its place (IMF 2000).

Steiner used actual, as opposed to standardised, prices as the dependent variable in her econometrics.

The price impacts estimated here for each economy measure the percentage increase in price attributable to inappropriate regulation. Estimating these impacts involves:

- identifying an appropriate benchmark against which to measure the impact of inappropriate regulation;
- establishing the effect of inappropriate regulation on price for individual regulations using Steiner's econometric results;
- aggregating the effects of individual regulations to calculate an overall effect for the regulatory regime; and
- expressing this overall effect on price as a percentage of the (notional) price existing under the benchmark regime.

Identifying an appropriate benchmark regime

An appropriate benchmark is needed against which to measure the effect of regulatory regimes. The most suitable benchmark will, in large part, depend on the rationale for regulation in the industry. In network industries such as electricity, and for the regulations considered here, this is largely influenced by whether the industry possesses natural monopoly characteristics.

Given that the prevailing economic view is that some regulation of the electricity industry is needed, the price impact of inappropriate regulation should be assessed against some 'appropriate' regulatory regime.

Ideally, this 'appropriate' regulatory regime should correspond to the optimal level of regulation — the socially least cost way of achieving the desired objectives. Identifying this is difficult in practice, but one practical option is to use the combination of regulations in OECD Member economies that minimise the prices implied by equation (4.1). The details of this estimate of the 'appropriate' regulatory regime (R^O) are discussed further at the end of this section.

The effect of individual inappropriate regulations on price

The regulations comprising the actual and benchmark regulatory regimes are assigned a score according to the criteria in table 4.1. The inappropriate component of each regulation (dR_i) is then calculated as the difference in the values of each

regulatory variable under the actual and benchmark regimes (R_i and R_i^O, respectively). Mathematically:

$$dR_i = R_i - R_i^O \tag{4.2}$$

For example, if under the actual regulatory regime, the generation sector is not separated from the transmission sector, the *unbundling of generation from transmission* variable takes on a score of 0. If the econometrics implies that prices are minimised when the generation sector is separated from the transmission sector (as it does), then the *unbundling of generation from transmission* variable takes on a score of 1 under the benchmark regime. The extent of inappropriate regulation would be assessed as –1 (=0-1).

The estimated coefficient of regulation i (β_i) in equation (4.1) indicates the effect on price of a one unit change in regulation i:

$$\frac{\partial P}{\partial R_i} = \beta_i \tag{4.3}$$

By estimating a random effects model of equation (4.1), the OECD's results imply that the (absolute) effect of each regulation on price is the same across all economies.

For regulation i, the effect of inappropriate regulation on price (dP_i) is the extent of inappropriate regulation (dR_i) multiplied by the estimated coefficient corresponding to regulation i (β_i):

$$dP_i = \beta_i dR_i \tag{4.4}$$

The impact of the entire regulatory regime on price (dP) is obtained by adding up the individual effects of all n regulations, irrespective of whether the coefficients are statistically significant or not (table 4.3):

$$dP = \sum_{i=1}^{n} dP_i = \sum_{i=1}^{n} \beta_i dR_i \tag{4.5}$$

Estimating the price impact measures

For each economy, the preferred model (equation 4.1) implies that, given the actual regulatory regime (R), the industrial electricity price (P) in that economy is:

$$P = \alpha + \beta R + \gamma E \tag{4.6}$$

If inappropriate regulation increases prices by dP, the notional price expected to exist under the benchmark regime (P^O) can be estimated as the actual price less the change in price attributable to inappropriate regulation, or:

$$P^O = P - dP = P - \sum_{i=1}^{n} \beta_i dR_i \tag{4.7}$$

Expressing this change in price as a percentage of the implied price under the benchmark regime gives:

$$Price\ impact = \frac{dP}{P^O} = \frac{P - P^O}{P^O} = \frac{\sum_{i=1}^{n} \beta_i dR_i}{P - \sum_{i=1}^{n} \beta_i dR_i} \tag{4.8}$$

The resulting price impacts can be viewed as crude measures of the extent to which the regulations applying in each economy are excessive.

Table 4.3 **OECD's preferred model of industrial electricity prices[a]**
Random effects model

Variable	*Estimated Coefficient*	*Z-statistic*	*Value under the benchmark regime*[b]
Constant	0.0667***	7.104	0.0667
Regulatory and industry variables			
Unbundling of generation from transmission	-0.0011	-0.659	Separate
Private ownership	0.0029***	2.700	[c]
Third party access	-0.0027*	-1.357	Third party access
Wholesale pool	-0.0052***	-2.306	Yes
Time to liberalisation	0.0008***	2.814	[c]
Time to privatisation	0.0006*	1.510	[c]
Non-regulatory environmental variables			
Hydro share in generation	-0.0341***	-3.252	[d]
Nuclear share in generation	0.0023	0.132	[d]
Gross domestic product	0.0000	1.011	[d]

*** statistically significant at the 5 per cent level (critical value: 1.960). ** statistically significant at the 10 per cent level (critical value: 1.645). * statistically significant at the 20 per cent level (critical value: 1.282). [a] Rounded to four decimal places. [b] Under the benchmark regulatory regime, *Unbundling of generation from transmission*, *Third party access* and *Wholesale pool* all take a value of 1. [c] Not included in the calculation of the price impacts because sign of estimated coefficient was counter-intuitive. [d] Takes actual value in benchmark regime.

Source: Steiner (2000, p. 34).

Steiner's econometric results

The approach described above can be used for any number of regulations (n).

However, Steiner's econometric results suggest that it may be inappropriate to use all of the regulations included in the OECD study to calculate the price impact.

Three of the six regulatory coefficients have the expected sign. Separating generation from transmission, allowing third party access to the transmission grid and allowing a wholesale electricity market are all found to lead to lower prices.

The coefficients on the three remaining variables are less intuitive. These variables are:

- private ownership;
- time to liberalisation; and
- time to privatisation.

Private ownership

The econometrics indicates that electricity prices increase with the extent of private ownership in the generation sector (table 4.3). However, the effect of ownership is unlikely to be independent of market structure, as the econometrics implies. The positive relationship between price and private ownership is likely to be strongest when there is a monopoly provider — private sector monopolists might be more likely to pursue higher profits than government monopolists and, hence, to raise electricity prices by exploiting their market power. However, this finding is less plausible in competitive generating sectors. Experience from other sectors, such as telecommunications and aviation, indicates that *some* private sector involvement is needed to introduce new technology, innovative business practices and to challenge the vested interests that have developed in industries previously sheltered from competition. But, given the way that the benchmark regime is derived from the econometric model estimated, the *ownership* variable under the benchmark regime will not allow for the possibility of mixed ownership, nor for interaction between ownership and other market structure characteristics.

The structure and ownership of the electricity industry varied widely in the OECD between 1986 and 1996 (and still does). At one end of the spectrum, six economies had, or effectively had, vertically-integrated monopolies over the entire period (Belgium, France, Greece, Italy, Japan and the Netherlands). All of these monopolies were publicly owned, except for in Belgium and Japan, which had private sector monopolies. At the other end of the spectrum, a number of economies

had introduced competition into the generation sector by 1996, but the ownership mix varied considerably.[22] New Zealand and Norway were the only economies to introduce competition into the generation sector exclusively involving public sector companies. Since the creation of the highly competitive Nordic Power Pool (NordPool), publicly-owned Norwegian generators have competed with publicly and privately-owned generators from Sweden and Finland.[23] Apart from the United Kingdom, which introduced competition into the generation sector by breaking-up its existing monopoly generator into a number of companies before privatising them, few OECD economies have *competitive* markets dominated by private sector generators.

The indicator of private ownership used in the econometrics is a discrete variable ranging from 0 (complete public ownership) to 4 (complete private ownership), depending on the extent of private ownership. The construction of this variable implies a uniform linear relationship between changes in ownership and price, which need not necessarily be the case. In addition, it implies that complete public or private ownership will yield the lowest possible price, not some combination of both.[24] Given that one of the two economies with complete private ownership has regional private monopolies (Japan), and that another economy with substantial private sector ownership is dominated by a large vertically-integrated private firm (Belgium), private ownership is unlikely to deliver the lowest electricity prices *in* the sample, even if it were capable of doing so in a competitive market.

The relationship between ownership and market structure could have been explicitly tested by including an additional interaction term explicitly linking the *ownership* and *unbundling of generation from transmission* (market structure) variables.

Collectively, these limitations cast doubt on the policy relevance of the particular econometric results relating to the *ownership* variable in the OECD sample. As a result, the *ownership* variable has been excluded from the benchmark regime used to calculate the price impacts estimated here.

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22 The degree of *effective* competition will also depend on other factors, such as the extent of unbundling in the generation sector and prevailing access arrangements.

23 Denmark subsequently joined Nordic Power Pool in 1999 (Western Denmark) and 2000 (Eastern Denmark).

24 One way of overcoming this limitation would have been to include separate dummy variables for each different ownership category (except for, say, complete public ownership).

Time to liberalisation and privatisation

The *time to liberalisation* and *time to privatisation* variables also suffer from some limitations that bring the policy relevance of the econometric results into question.

The *time to liberalisation* and *time to privatisation* variables are forward-looking indicators of the effect on price *before* liberalisation or privatisation occurs. These effects may occur, if the government announced the policy changes prior to implementing them, or if incumbents suspected that a change in policy would occur and altered their behaviour in a pre-emptive manner.

Prices would be normally expected to decline as previously sheltered markets were opened up to the rigours of competition, but the econometric results indicate that approaching liberalisation and privatisation tend to increase electricity prices (table 4.3). This result is consistent with the rationale put forward by Steiner that governments may increase electricity prices prior to privatisation in order to increase the sale price of the assets being privatised. Similarly, incumbents may increase prices ahead of liberalisation to maximise remaining rents, and perhaps to signal the opportunity for collusive behaviour with potential entrants.

However, there is doubt about these findings for two main reasons. First, there is a lack of variation in the *time to liberalisation* and *time to privatisation* variables in the OECD dataset. Second, even if there were sufficient variation in the sample, the issue of causality is not satisfactorily addressed. Does approaching liberalisation or privatisation increase electricity prices (as the econometrics implies) or does the increase in electricity prices lead to liberalisation or privatisation? It could be that the 'observed' increase in prices is not caused by liberalisation or privatisation, but rather is the rationale for liberalisation or privatisation. Governments may view liberalisation of the generation sector, in particular, as a means of restraining the price increases that were already occurring in these markets.

Given these limitations, there is doubt about the robustness and policy relevance of the findings relating to these variables — the *ownership*, the *time to liberalisation* and the *time to privatisation* variables — and, hence, they have been excluded from the assessment here.[25]

The benchmark regulatory regime therefore consists of generation being separated from transmission, third parties being able to access the transmission grid through either regulated or negotiated third party access policies, and the existence of a wholesale electricity market.

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[25] Ideally, the model should be re-estimated with the variables specified in a different way or omitted, rather than by excluding these variables.

4.5 The impact of regulation on electricity prices

Using the methodology outlined above, price impacts were estimated for industrial electricity prices for each of the 50 economies listed in table 4.2, using the data contained in Steiner (2000) and that listed in tables 4.5 and 4.6.

The price impacts estimated range from 0 to 35 per cent, with a mean of 13 per cent and a standard deviation of 9 per cent (figure 4.2). The full set of estimates is reproduced in table 4.8 at the end of this chapter.

The economies fall into five basic groupings (table 4.4).

Not surprisingly, those economies that have gone furthest in reforming their electricity supply industries have the lowest overall price impacts. These include the United Kingdom, the economies that comprised the highly competitive Nordic Power Pool in 1996 (Norway, Finland, Sweden), Australia, New Zealand and the South American economies (Argentina, Chile and Colombia).

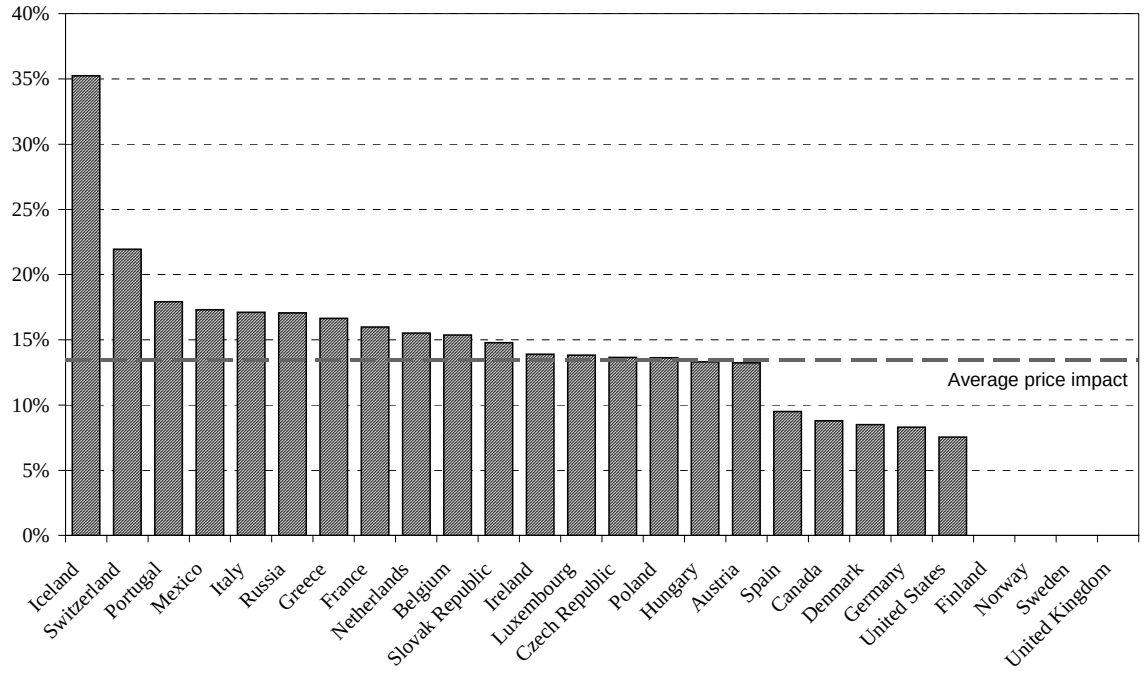
At the other end of the spectrum lie the smaller European economies of Iceland and Switzerland and the developing economies of Turkey, Uruguay, Venezuela and Vietnam. While these economies are heavily regulated, the functional form used also means that a given absolute price impact translates into a higher percentage price impact as electricity prices fall. As all of these economies are highly reliant on hydroelectricity with low marginal costs of generation (all in excess of 40 per cent and most in excess of 70 per cent), all of these economies have low prices under the benchmark regime.[26] Thus these economies are estimated to have high regulatory tax equivalents.

[26] IEA data (IEA 2000) suggest that the econometric model of industrial electricity prices substantially underestimates actual electricity prices in Switzerland and Turkey.

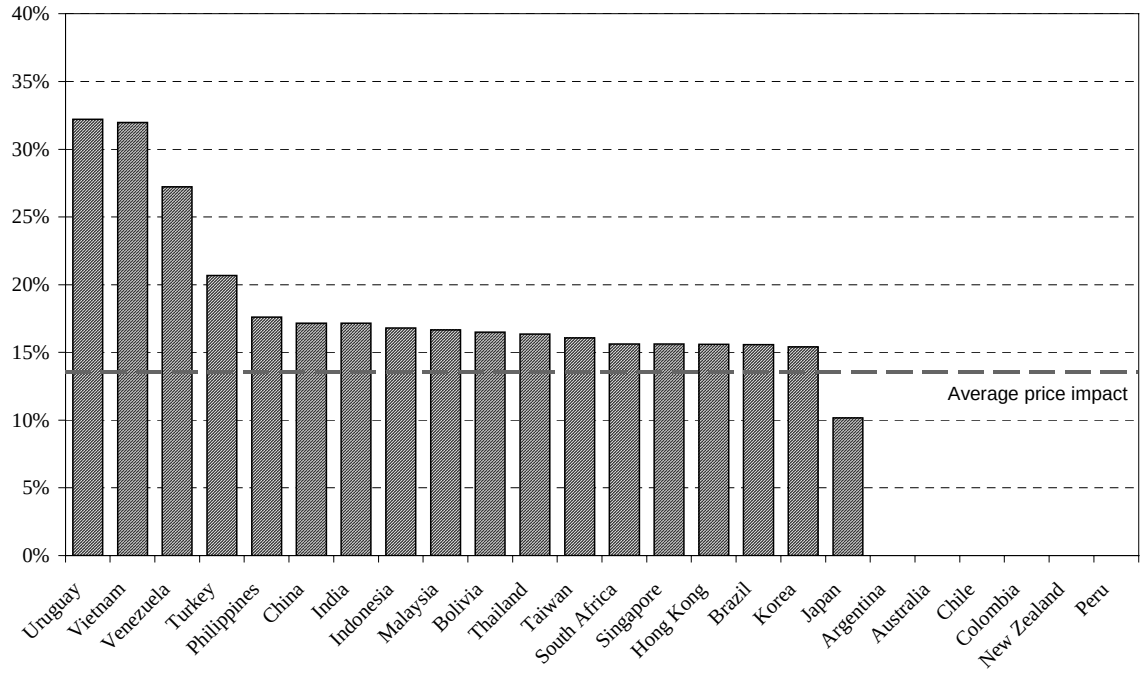
Figure 4.2 **Price impact of regulation in electricity supply, 1996**

Percentage increase on prices corresponding to benchmark regime

Europe and North America



Africa, Asia, Oceania and South America



4.6 Conclusion

The OECD electricity supply working paper identifies an important policy question — how does economic regulation in this important sector of the economy affect economic outcomes? The answer to this question has important implications for all economies, especially those yet to implement the structural reforms already implemented in the United Kingdom, Australia, New Zealand and in Scandinavia.

It is difficult to answer this question with any great precision, as the price impacts presented in this chapter are quite sensitive to the methodology and data used. The cumulative effect of the various limitations outlined above suggest that, at best, the price impacts may be indicative of the ordinal ranking of the effects of regulation across economies.

Table 4.4 **Economies grouped by price impacts for electricity, 1996**

	Range	*Economies (listed alphabetically)*
Highest	20% & over	Iceland, Switzerland, Turkey, Uruguay and Vietnam
	15 to 20%	Belgium, Bolivia, Brazil, China, France, Greece, Hong Kong, India, Indonesia, Italy, Korea, Malaysia, Mexico, the Netherlands, the Philippines, Portugal, Russia, Singapore, South Africa, Taiwan and Thailand
	10 to 15%	Austria, the Czech Republic, Hungary, Ireland, Luxembourg, Poland and the Slovak Republic
	5 to 10%	Canada, Denmark, Germany, Japan, Spain and the United States
Lowest	0 to 5%	Argentina, Australia, Chile, Colombia, Finland, New Zealand, Norway, Peru, Sweden and the United Kingdom

Data and results annex

Table 4.5 **Regulatory variables for additional economies, electricity, 1996**

Economy	*Unbundling* [a]	*Third party access* [b]	*Wholesale pool*
Argentina	Separate	Third party access	Yes
Austria	Separate	Third party access	No
Bolivia	Separate	Third party access	No
Brazil	Integrated	Third party access	No
Chile	Separate	Third party access	Yes
China	Integrated	None	No
Colombia	Separate	Third party access	Yes
Czech Republic	Separate	None	No
Hong Kong	Integrated	None	No
Hungary	Separate	None	No
Iceland	Integrated	None	No
India	Integrated	None	No
Indonesia	Integrated	None	No
Korea	Integrated	None	No
Luxembourg	Separate	Third party access	No
Malaysia	Integrated	None	No
Mexico	Integrated	None	No
Peru	Separate	Third party access	Yes
Philippines	Integrated	None	No
Poland	Separate	None	No
Russia	Integrated	None	No
Singapore	Separate	None	No
Slovak Republic	Integrated	None	No
South Africa	Integrated	None	No
Switzerland	Integrated	None	No
Taiwan	Integrated	None	No
Thailand	Integrated	None	No
Turkey	Integrated	None	No
Uruguay	Integrated	None	No
Venezuela	Integrated	None	No
Vietnam	Integrated	None	No

a Separate: accounting separation or separate companies; integrated otherwise. **b** Third party access: regulated or negotiated third party access; none otherwise.

Source: Assessment based on various sources (primarily US Energy Information Agency, International Energy Agency and national governments).

Table 4.6 **Environmental variables for additional economies, electricity, 1996**

Economy	*Hydro share*	*Nuclear share*	*GDP*
	Per cent	Per cent	US PPP$ billion
Argentina	39.3	9.6	272.2
Austria	65.0	0.0	226.1
Bolivia	56.5	0.0	7.4
Brazil	91.7	0.8	775.5
Chile	56.1	0.0	68.6
China	18.4	1.4	817.9
Colombia	79.6	0.0	97.1
Czech Republic	3.7	20.1	57.9
Hong Kong	0.0	0.0	154.1
Hungary	0.6	40.5	45.2
Iceland	94.1	0.0	7.3
India	16.6	1.8	376.4
Indonesia	13.9	0.0	226.9
Korea	2.3	32.6	520.2
Luxembourg	69.2	0.0	17.5
Malaysia	10.6	0.0	100.9
Mexico	19.3	4.9	334.2
Peru	79.8	0.0	61.0
Philippines	19.9	0.0	82.8
Poland	2.7	0.0	143.0
Russia	19.1	12.9	419.0
Singapore	18.2	45.6	18.8
Slovak Republic	0.0	0.0	91.3
South Africa	0.8	7.1	143.9
Switzerland	52.2	44.1	293.4
Taiwan	7.6	31.0	272.3
Thailand	8.8	0.0	181.8
Turkey	42.7	0.0	182.6
Uruguay	87.1	0.0	20.5
Venezuela	72.5	0.0	70.8
Vietnam	86.9	0.0	24.7

Source: IEA (1998), US Energy Information Agency, IMF (2000b) and World Bank (2000).

Table 4.7 **Price impact of regulation on industrial electricity prices, 1996[a]**

Economies in original study	*Per cent*	*Extended coverage*	*Per cent*
Australia	0.0	Argentina	0.0
Belgium	15.4	Austria	13.2
Canada	8.8	Bolivia	16.5
Denmark	8.5	Brazil	15.6
Finland	0.0	Chile	0.0
France	16.0	China	17.2
Germany	8.3	Colombia	0.0
Greece	16.6	Czech Republic	13.6
Ireland	13.9	Hong Kong	15.6
Italy	17.1	Hungary	13.3
Japan	10.2	Iceland	35.3
Netherlands	15.5	India	17.2
New Zealand	0.0	Indonesia	16.8
Norway	0.0	Korea	15.4
Portugal	17.9	Luxembourg	13.8
Spain	9.5	Malaysia	16.6
Sweden	0.0	Mexico	17.3
United Kingdom	0.0	Peru	0.0
United States	7.5	Philippines	17.6
		Poland	13.6
		Russia	17.1
		Slovak Republic	14.8
		Singapore	15.6
		South Africa	15.6
		Switzerland	21.9
		Taiwan	16.1
		Thailand	16.3
		Turkey	20.7
		Uruguay	32.2
		Venezuela	27.2
		Vietnam	32.0

a Percentage increase in pre-tax industrial electricity prices relative to the estimated price under the benchmark regulatory regime.

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