A Microstate with Scale Economies: The Case of Iceland

Tryggvi Thor Herbertsson and Gylfi Zoega

Centre for Small State Studies
Institute of International Affairs - University of Iceland

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Centre for Small State Studies
Institute for International Affairs
University of Iceland
Oddi, Sturlugata
101 Reykjavik
Iceland
Tel. +354 252 5262
Fax +354 552 6806
E-mail: smallst@hi.is
http://www.hi.is/~smallst/

A Microstate with Scale Economies: The Case of Iceland

by

Tryggvi Thor Herbertsson
Institute of Economic Studies
University of Iceland

and

Gylfi Zoega
Birkbeck College
University of London

Centre for Small State Studies
University of Iceland
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Preface

This paper was originally prepared for the conference "Iceland and the World Economy: Lessons for Small Countries in the Era of Globalisation," organised by the Center for International Development at Harvard University, October 2001. We would like to thank William Easterly and Aart Kraay for providing data on the world's microstates. Correspondence address Herbertsson: Institute of Economic Studies, University of Iceland, Aragotu 14, IS-101 Reykjavik, Iceland, tel.: +354 525 4535, fax: +354 525 4096, e-mail: tthh@hi.is, Zoega: Birkbeck College, Department of Economics. 7-15 Gresse Street, London W1P 2LL, United Kingdom, tel.: +44-207-631-6406, fax: +44-207-631-6416, e-mail: g.zoega@econ.bbk.ac.uk

Abstract

This paper looks at the importance of scale economies – defined in terms of the benefits from innovation – from both a theoretical and an empirical perspective. We argue that one can only gauge the degree of scale economies at the industry level by taking account of the degree of specialization – hence the reliance on international trade – as well as the size of an economy. We show that in Iceland specialization in fishing results in a sector which ranks 13th in the world, hence belying the small size of the population and the overall economy. Not surprisingly, the bulk of R&D in Iceland is focused on providing this industry with an ever-expanding range of inputs, resulting in a high rate of growth of GDP – as well as a high standard of living in the country as a whole – in comparison with other OECD economies.

JEL Classification System: Q2, Q3, O1
Keywords: Economies of scale, R&D, Icelandic economic history.

1. Introduction

Modern growth theory emphasizes the importance of Schumpetarian innovations in generating and fostering steady-state growth of output and consumption per capita. The incentive for such innovations is of paramount importance. One of the interesting implications of the recent work reviving the Schumpetarian view, such as Romer (1990) and Aghion and Howitt (1992), is the notion that large economies should offer greater incentives for innovation as these provide the potential innovator with a larger market. However, while Kremer (1993) finds some empirical support for this prediction using data on the world population, others have had less success using national data (e.g. Jones, 1995; Easterly and Kraay, 1999). In a cross section of countries, many small countries have both a high level of income per capita and enjoy high rates of growth.

It is the objective of this paper to assess this literature in light of the experience of the smallest OECD country. Iceland qualifies as a microstate with flying colors. The population is just above 280,000 and it has been geographically isolated through the centuries until quite recently. Yet it offers a high standard of living to its population (ranked number 6 in the OECD in 1998 in terms of purchasing power adjusted GDP per capita)[i] and has enjoyed high rates of growth of output per capita in past decades.

We will argue that despite its small size, Iceland has become a major player in a particular industry, namely the fishing industry, with all the benefits that scale economies can bring, including substantial incentives for innovation. In 1998 Iceland ranked 13th among the worlds fishing nations in terms of volume and 12th in terms of the value of exports.[ii] This microstate is a fishing superpower! Another example is Luxembourg, which is specialized in financial services.[iii] We will show that there are theoretical reasons why smaller economies should specialize in fewer industries – hence rely on international trade to a greater extent – and this seems to show up in the data.

2. Scale and Growth

Knowledge acquisition and the discovery of new ideas is the key to growth in many modern growth models, cf. Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992, 1998), and Peretto (1998). In these models the rate of growth of output per capita is directly related to the potential rewards from a successful innovation. A large population provides a large market for innovators which raises the incentive to invent (or adapt) new inputs and consumer goods. The Schumpeterian innovator has more to gain, the larger is the market for his produce – and hence the larger is the population of his country and the better is his access to foreign markets. Moreover, a large population will in all likelihood have a higher number of potential innovators and a larger supply of (nonrival) ideas.[iv]

These models find that the rate of steady-state growth of output per capita is a function of the size of the economy. However, this empirical prediction has run into difficulties. While Kremer (1993) finds supporting evidence at the global level, studies of the recent growth experience of individual countries have been less supportive (see e.g. Jones, 1995; Easterly and Kraay, 1999). The lack of empirical support is consistent with the common perception that small economies do not find themselves at a disadvantage in the modern economy.

Figure 1, adopted from Easterly and Kraay (1999), shows the average income per capita for different population quintiles in the period 1960-95 once geographical location, OECD membership (to pick up Iceland and Luxembourg), and oil abundance (to pick up Qatar and Bahrain) have been controlled for. The figure reveals the striking fact that microstates (defined as having an average population of less than one million in the period) are actually richer on average than larger countries, which contradicts the simple scale-effect hypothesis suggested by the new growth theories.

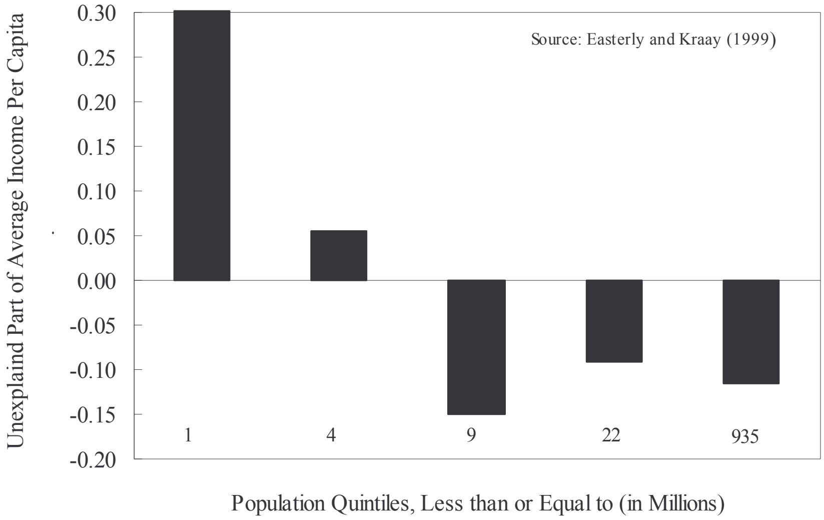


Figure 1. Unexplained Part of Average Income Per Capita

Figure 2 show that the results do not change when OECD membership is not controlled for.

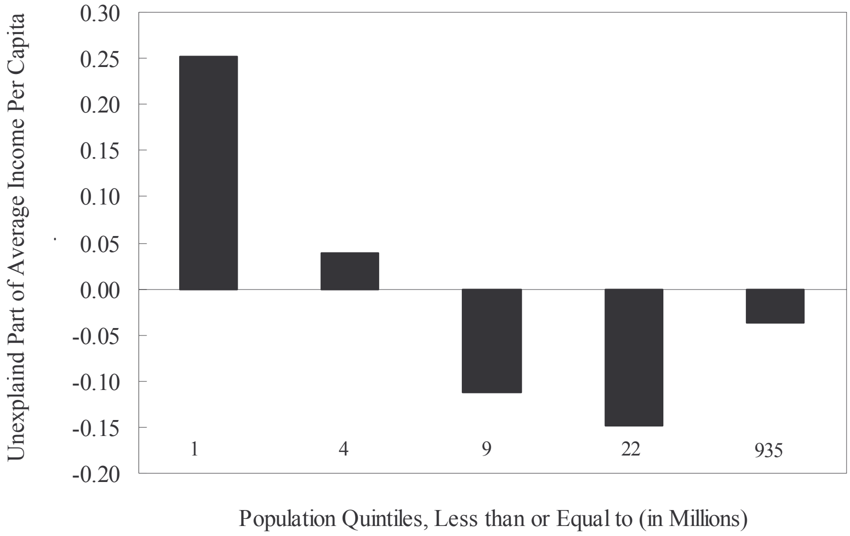


Figure 2. Unexplained Part of Average Income Per Capita when OECD Membership is not Controlled for

The general lack of empirical support has led to modifications of the growth models, aimed at elminating the scale effects. Jones (1998) introduces diminishing returns to the generation of new ideas – reflecting the difficulty of coming up with increasingly sophisticated innovations – which results in a different type of a scale effect: income, not growth rates, is now a (positive) function of scale. Also, increased research intensity raises the level of output but not its rate of growth. In addition, some recent papers have attempted to remove scale effects from the Romer/Aghion-Howitt models. Young (1998) and Perotti (1998) have extended the endogenous growth literature such that the scale effects are eliminated while changes in research intensity do affect long-run growth. In these models, an increase in the size of the population causes an increase in the number of sectors in the economy so that the size of the sector – and so the incentive for innovation – is independent of the scale of the economy.

3. International Trade as a Source of Scale Economies

But do these results prove unambiguously that the theoretical predictions about scale effects are not empirically relevant? Our starting point is the well-established fact that small countries trade more than large countries, cf. Gylfason (1999). Figure 2 plots openness, defined as exports plus imports as a ratio to GDP, against the log of the population in a sample of 103 counties for 1986.

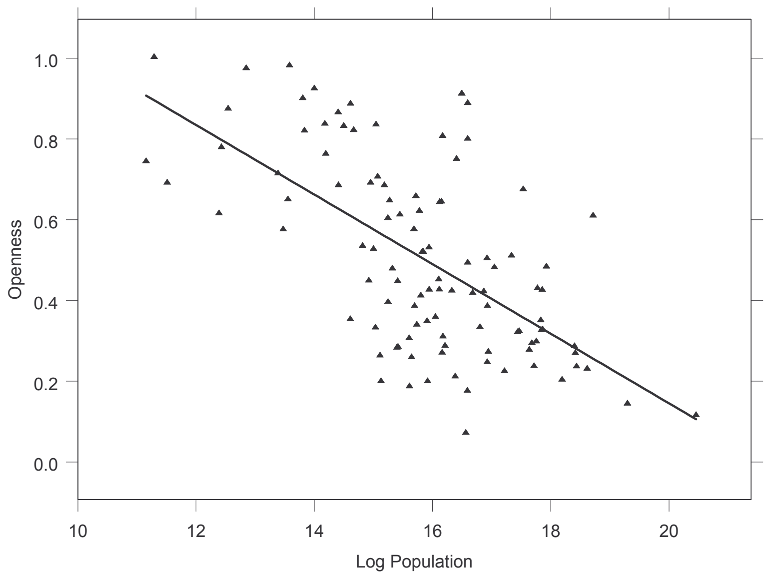
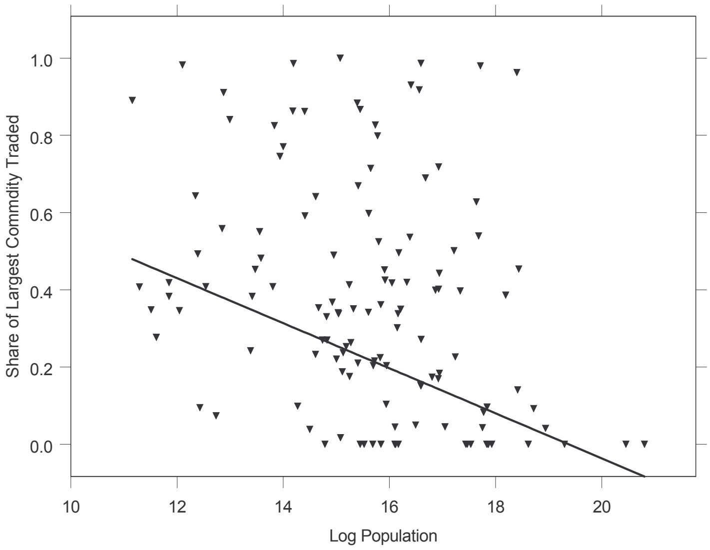


Figure 2. The Relationship Between Openness and Size in 103 countries in 1986

We can also take a look at the share of the largest single commodity in total exports in each country.[v] The large oil producers of the Middle East would then get a specialisation ranking of close to one while countries belonging to the G-7 group with well diversified exports would get a share closer to zero. Figure 3 plots the share of the largest single commodity traded in total exports in 128 countries in 1986 (or the closest year when data is available) against the population size in 1986 in the upper panel, and the maximum, minimum, and the median values of the export share corresponding to the population quintiles shown on the horizontal axes in the lower panel.[vi]

The relationship between the two variables in the upper panel is not tight. However, when we superimpose a regression line on the scatterplot it reveals a negative relationship between the two quantities as the hypothesis suggests.[vii] Note that, population size is not capable of capturing more than 10 per cent of the variance of the export share.[viii] The lower panel is somewhat more conclusive: the median share gets lower as population increases with the exception of the second largest quintile but many of the large oil producing countries belong in this category (Saudi Arabia, Iraq, Iran, Venezuela, Algeria). In conclusion, there seems to be some support for the hypothesis that small countries have more specialised exports.[ix]

The strong negative relationship between size and openness and the weaker relationship between size and export diversification suggests two reasons for believing in scale effects in spite of the apparent failure to detect them at the national level.



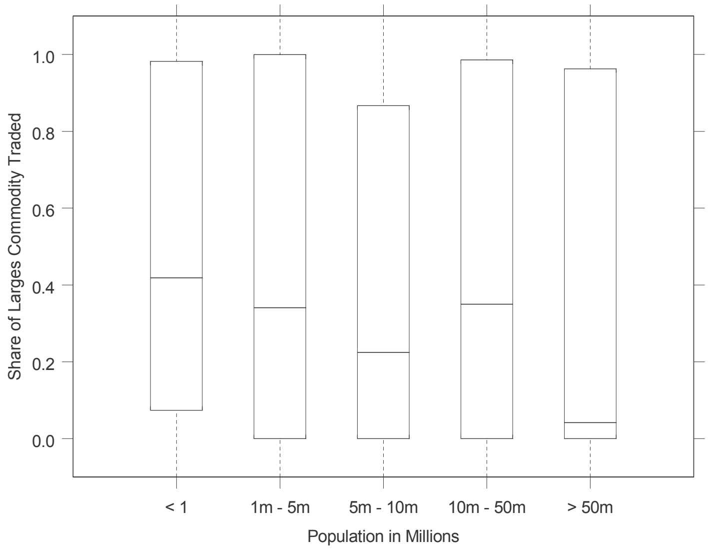


Figure 3. Share of the Largest Single Commodity Traded in Total Exports in 1986 in 128 Countries and Population Size

3.1 The International Flow of Ideas

As pointed out by Kremer (1993), the relevant entity may not be the size of the domestic population but the size of a population that shares ideas and innovations either in the form of a common market for inputs and consumer goods and/or in the form of the flow of knowledge. One test of this hypothesis is to see if small countries do better if we take into account the level of openness to international trade. Obviously, a small isolated country – take Albania during the Hoxa regime as one example – finds itself in a smaller world than another country of equal size but trading with its neighbours – take Luxembourg or Hong Kong as examples. The figure below corresponds to Figure 1 but adjusts for the openness of the economy to foreign trade.

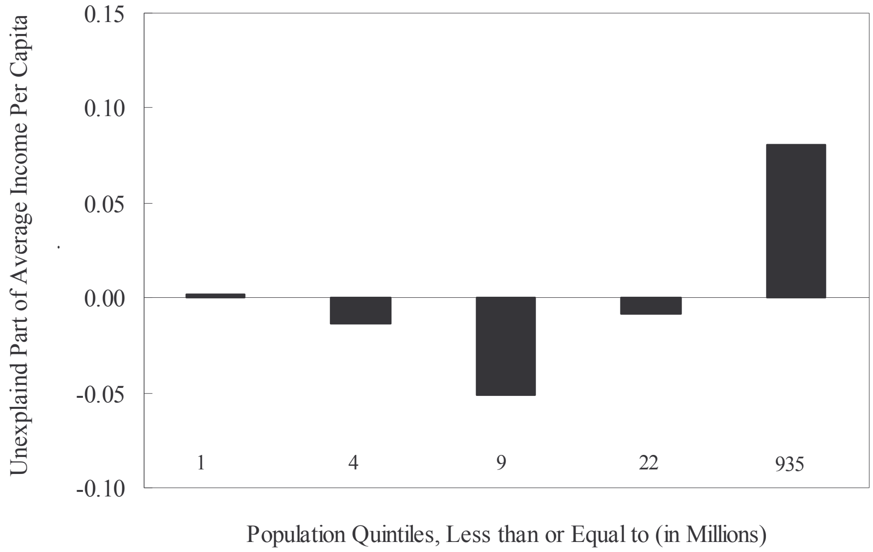


Figure 4. The Effect of Size on Average Income per Capita once Openness has been taken into Account

It is apparent from the figure that when openness (measured as the import + exports/GDP ratio) is controlled for little remains to be explained in terms of the average income per capita for the group of small countries. This brings us to our main thesis, which involves the interplay of size, specialization and scale economies.

3.2 Specialization and Scale Economies

Openness and international trade changes the equation by allowing small economies to reap the fruits of industry-level scale economies – internal as well as external – by specialising their production and using trade to acquire a larger set of goods. Internal scale economies make it advantageous for economies to specialize in the production of a limited set of goods and rely on trade with other nation to secure supplies of the remainder. This idea goes as far back as to Adam Smith and has been formalised by Helpman and Krugman (1985) amongst others. The resulting intra-industry trade simultaneously reduces the number of goods produced and increases the number of goods consumed.

External economies can then set in and further strengthen the pattern of specialization and trade as first described by Marshall (1890). First, the large output of a specialized industry creates a market for innovations in input production and the level of R&D is increased on that count. This is the relationship modelled by Romer (1990) and Aghion and Howitt (1992). Second, a larger market of skilled labour is created which can ensure a continuous supply of workers to individual firms. With a large number of firms workers are effectively shielded from firm-specific shocks: when one firm contracts its production and employment another must be expanding. Thus workers would want to move to areas where the concentration of firms in the industry is highest. By moving they gain insurance against income and employment shocks and may for that reason be willing to work for a wage which is lower than what they would demand from an isolated company. Finally, firms enjoy greater intra-industry spillover effects the larger is the industry. For all three reasons, firms operating in large industries would enjoy a benefit over and above those in smaller industries. They have an ample supply of new inputs and able workers and they benefit from discoveries made by other firms through formal and informal social contacts.

We start by assuming that technology is the same across countries and independent of country size and, to simplify the argument, also the same across industries. Since a new input can only be marketed within an industry – or a set of industries – and innovations similarly take place within industries, the existence of external economies of scale opens up the possibility that size and specialization may both yield scale economies as shown in Figure 5 below.

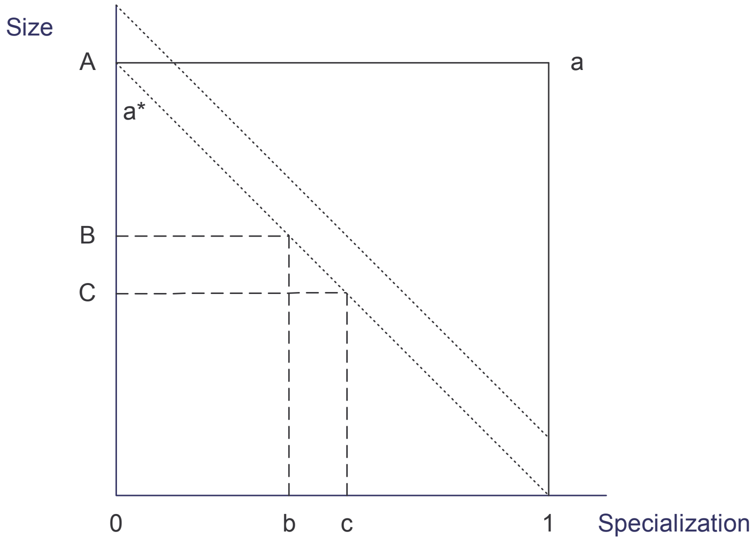


Figure 5. The Trade-off Between Size and Specialisation and the Iso-scale Curves

The figure shows two downward-sloping "iso-scale curves" that show the combinations of (country) size and the degree of specialisation that generates a given level of external scale economies, defined as the average level of external scale economies across all industries. Thus along an iso-scale curve, industry size is constant. When the degree of specialisation rises, the size of each industry goes up and there are greater rewards to a successful innovator and more potential innovators at the industry level. A country of size *A* can thus produce all goods and reap minimum scale economies at point *a** or specialise completely in one industry and reap maximum benefits at point *a* which is located on a higher iso-scale curve. It follows that two countries of different size can reap the same scale economies if the smaller one has a higher degree of specialisation. Thus countries of size *B* and *C* specializing at degrees *b* and *c*, respectively, enjoy the same level of scale economies since they are both on the same iso-scale curve. The level of scale economies – defined as the size of the market for new innovations and the number of potential innovators – is determined by a combination of size and specialization. We now sketch a simple model to show the possible interaction between trade and size in determining scale effects and growth at the industry level.

Figure 6 describes our intuition for the representative industry. The bottom panel shows the relationship between specialization and the size of the representative domestic industry. The smaller the number of industries – that is the greater is the degree of specialization – the greater is the number of firms in each remaining industry for a given country size. This explains the negative slope of the schedule. However, the larger the size of the economy, the larger is each industry for a given level of specialization. So the relationship lies further to the right, the larger is the economy. This brings us to the issue of equilibrium specialization.

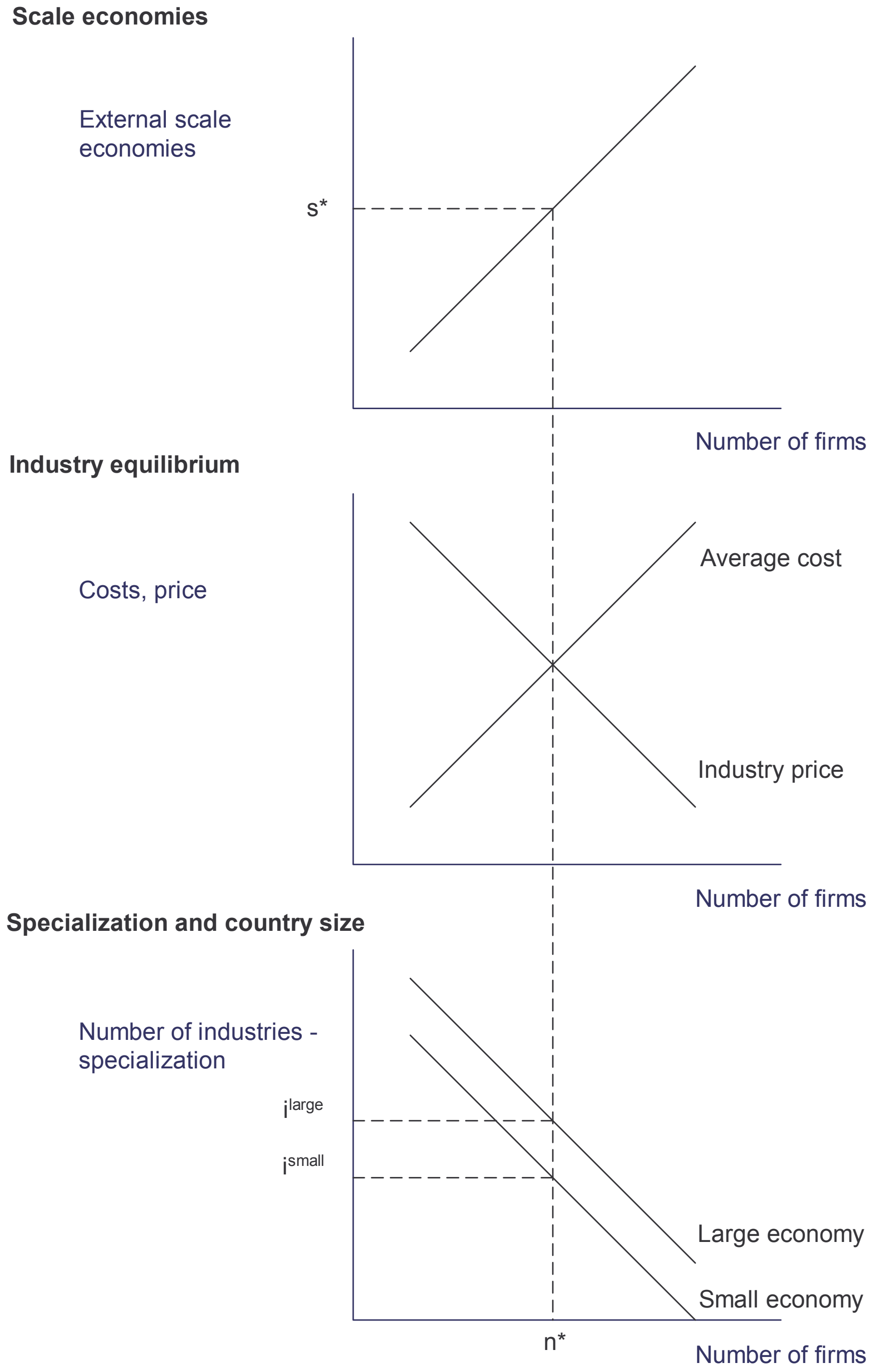


Figure 6. Optimal Specialization and Growth

In the middle panel we show the industry equilibrium under conditions of imperfect competition in the product market.[x] The industry price curve is downward sloping which reflects the effect of increased competition on equilibrium prices. The more firms there are in the industry, the greater is competition and the lower are equilibrium mark-ups. The upward-sloping average cost curve shows the relationship between the number of firms and average costs. The more firms there are in the industry, the lower is output per firm, and the higher is the level of average costs because of increasing (internal) rates of return. When $n > n^*$ average cost exceeds price so firms will drop out and n converge to n^*. Similarly, when $n < n^*$ average costs are lower than price and new firms will join the industry. Thus n^* is the equilibrium – or steady state – number of firms in the representative industry. For a given size of the economy L, the equilibrium at the industry level determines the degree of specialization as shown in the bottom panel of the figure. The relationship between the number of industries in equilibrium i^*, the number of firms in each industry n^* and the size of the economy is, of course, the identity $i^*n^* = L$.

The top part of the figure has the relationship between specialization and external scale economies. The greater is the degree of specialization, the larger is each industry and the greater is the potential benefit to a successful innovator. This implies a positive relationship between specialization and growth. The slope of this relationship depends on the sources and the nature of the external economies. If these stem from the incentive to come up with new types of inputs, *a la* Romer (1990), the slope is a decreasing function of the cost of such innovations. If the cost is low, an increase in industry size has a bigger effect on the incentive to innovate and economic growth. If they stem from the benefits of a common labour market the slope will depend on the risk aversion of workers which determines how much they value the employment insurance that a large industry can provide. Finally, the greater is the rate of within-industry learning, the greater is the flow of new ideas and the greater is the marginal benefit from increasing industry size. In summary, the following factors call for a steep external-scale economies curve:

- Low costs of inventing new inputs.
- A high degree of risk aversion among workers.

- A high rate of learning and knowledge spillovers at the industry level.

Note that the two economies – the large and the small – enjoy the same level of external scale effects. The difference in specialisation nullifies any effect of country size on the scale effect: both economies enjoy the same scale economies at the industry level. As long as the small economy is big enough to be able to sustain one industry in equilibrium, we get the result that the level of scale economies should be independent of size! Furthermore, we find that:

- An expansion of foreign markets reduces average costs – the average-cost curve shifts to the right in the middle panel – which causes new entry into the different domestic industries and increased specialization. From the top panel we find that this results in increased external economies and a boost to R&D and growth.
- An increase in the intensity of foreign competition reduces industry price – the price curve shifts to the left in the middle panel – which causes exit from the representative industry and a fall in the level of specialization. Growth is reduced.
- An increase in the price of inputs – such as oil or other raw materials – causes the average-cost curve to shift to the left which reduces the equilibrium number of firms in each industry and so also reduces the degree of specialization and the rate of growth.
- A fall in the cost of inventing new technology and an increase in the rate of learning-by-doing shift the scale-effect curve in the top panel to the left which shows up in a higher rate of growth for a given level of specialization.

We now want to draw on the experience of Iceland, which is one of the smallest microstates. In particular we would like to assess the extent of any scale economies in light of the discussion above and check for sectoral differences in the level of R&D and the rate of technical progress. We start with a brief historical account.

4. Iceland since 874 A.C.

Icelandic history can roughly be divided into four periods. First, there is the era of settlement (874-930) by Norwegian Vikings and their Irish slaves, which is followed by the Common Wealth (930-1262). We take this to be the earliest period as both the structure of society and its industries did not change much over this period. In 1262 social unrest and resource constraints forced the Icelanders under the King of Norway and the country remained under his control until 1397. In 1397 Iceland followed Norway into the so-called Kalmar Alliance formed by Denmark, Norway, and Sweden, and dominated by the first. This sets in a prolonged period of Danish influence. When that alliance was resolved in 1448, Iceland remained an integral part of Denmark until the establishment of home rule in 1904, autonomy in 1918, and full independence in 1944.

We now briefly describe the evolution of the population as well as changes in the structure of industry over this long period of time.

4.1 Population Developments

Population growth in Iceland was very much dependent on the forces of nature until the beginning of the 19th century. Earthquakes, volcanic eruptions, drift ice from the arctic, "glacier bursts", harsh weather as well as epidemics influenced population growth greatly. During the early settlements the climate was relatively warm and the cultivation of different crops easy. The climate became harsher when temperatures declined resulting in what is referred to as "the little ice-age" from the end of the 11th century until the beginning of the 19th century. As a consequence drift ice was more common which caused harsher weather because the presence of drift ice lowers both temperature and precipitation, changing the climate from cold-temperate oceanic to a more continental, arctic type.[xi] Figure 7 plots the population from the time of settlement to 2050.[xii]

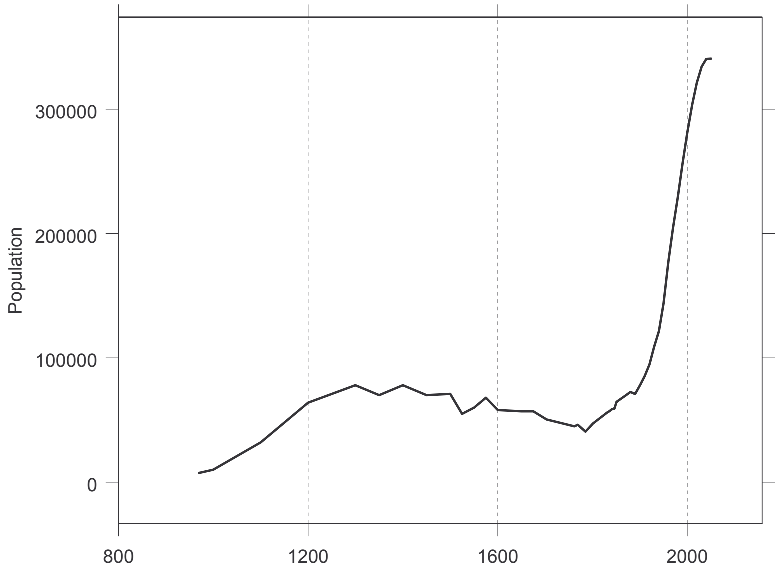


Figure 7. Population in Iceland, 970-2050

At the end of the settlement period (1100) it is estimated that there were approximately 32,000 inhabitants in Iceland, 78,000 in the early 13th century but, due to various reasons described below, the population fell to almost 40 thousand people at the end of the 17th century.[xiii] Below is an account of major events that caused the declining population.[xiv]

- The first recorded shock to the population was in 976. Bad weather and unfavourable general conditions caused widespread famine. It is possible that the settlers were not prepared for the very harsh winters that occasionally hit Iceland since they had no possibility of learning anything from natives who had adapted to their environment.
- Annals record that earthquakes, drift ice, and volcanic eruptions plagued the 1311-21 period, and that farmers lost a great part of their livestock.
- In 1362 the worst explosive eruption in Europe – since the eruption of Monte Somma in 79 A.C. destroyed Pompeii – destroyed a prosperous settlement in Litla Hérað by tephra-falls and floods. Consequently, the name of the area was changed to its current name Öræfi (“land of waste”).

- The Black Death epidemic hit Iceland in 1402 and in 1495 another epidemic hit the Icelandic population.
- Bad weather and unfavourable general conditions plagued the 1500-23 period and again the period 1578-98. The population was also hit by smallpox in the 1635-36 period.
- The years 1675-1700 had bad weather, volcanic eruptions, lumps, and small fish catches
- The period 1703-69 also had bad weather, earthquakes and, drift ice.
- In 1783-84 a volcanic eruption occurred in Mount Laki in Skaftafell county generating the greatest flow of lava on earth in historic times. Great earthquakes followed the eruption in August of the same year. Much of the vegetation, 50 per cent of all cattle, 75 per cent of horses, and 80 per cent of the sheep stock was wiped out leading to what is know as the "great famine". The population fell by as much as 20 per cent in the next 2 years. Annals report that volcanic ash covered the sky resulting in a "nuclear winter" in much of the Northern hemisphere. Crops failed in Europe leading to social unrest, Marie Antoinette's famous remark "Why don't they eat cake?", and possibly the French revolution.
- The inhabited area in Iceland has never comprised more than about one-fourth of the country due to a lack of vegetation. In 1875-1890 the population fell due to migration to America, mostly from the north and east coasts. The origins of the out-migration have been traced to an excess demand for land.

Since 1890 there have been no major shocks to the population although the Spanish influenza took many lives at the beginning of the 20th century.

4.2 Industrial Development

The settlers in Iceland brought with them animals from Norway. During the first few years of settlement they were occupied with raising the livestock, cultivating, and settling in.

An export industry did not appear until the 13th century with the advent of fishing on a larger scale. Fishing had mostly been for home consumption and domestic (barter) exchange. But during the 12th century the price of fish in Europe started to rise dramatically. The relative price of stockfish in terms of cattle increased by 25 per cent from 1200 to 1300, 42 per cent in 1350 -1400, and 119 per cent between 1420 and 1550.[xv] It has been postulated that an increasing demand for fish in Europe – due to rising population and the Catholic fasts – caused these price increases. Fishing was a major occupation on the island after 1400 although it was not the sole occupation of anyone. This was due both to the seasonality of fishing and laws that stated that all workers had to be continuously registered in service. These laws, abolished in 1893, heavily restricted labour mobility and entrepreneurship for many centuries. However, it is estimated that during the fishing season as much as half of the workforce was engaged in fishing and fish processing.

During the period 1602-1787 the Danish King, under the influence of mercantilist ideas, monopolised trade in the island. This is often thought to be the period of the greatest hardship in the history of Iceland. In addition to the monopoly and severe natural conditions that characterised this period, there were the above-mentioned restrictions on labour mobility and laws that severely restricted all commerce.

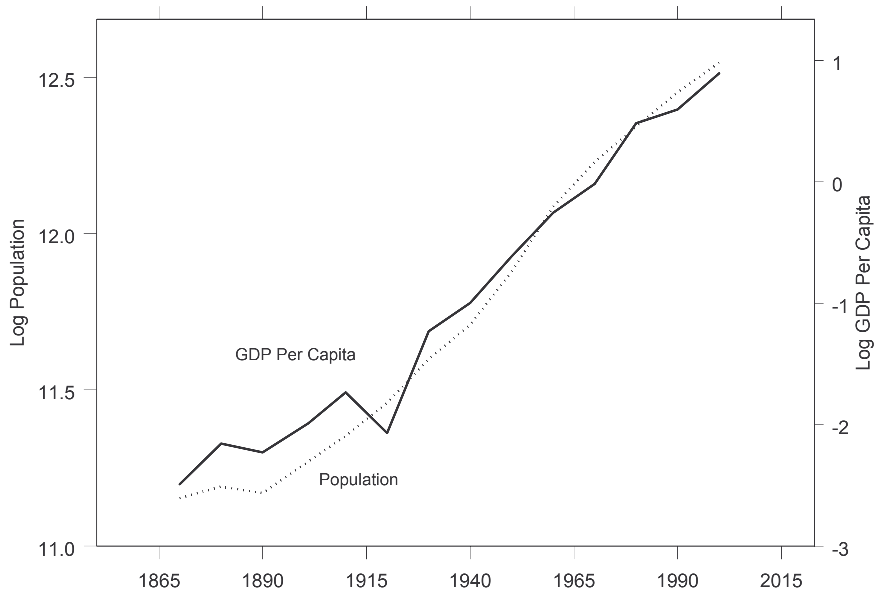


Figure 8. Population and GDP Per Capita in Iceland, 1870-2000

No data are available for GDP until 1870, but there is evidence that suggests that the standard of living was considerably higher at the end of the settlement era than at the beginning of the nineteenth century. In effect the "take-off" of the Icelandic economy did not occur until the middle of the 18th century.[xvi] Figure 6 plots the log of the total population in Iceland and GDP per capita, 1870-2000.[xvii]

The take-off of the Icelandic economy can be traced to the liberalization of trade at the beginning of 19th century, but also to the fact that warmer climate made agriculture easier in Iceland which freed up labour to start other industries and commerce. Better fishing technologies (such as sailing boats at the end of the 19th century and motor boats and trawlers at the beginning of the 20th) must also have contributed to increased growth. Figure 9 shows the distribution of employment across industries in Iceland 1870-2000.[xviii]

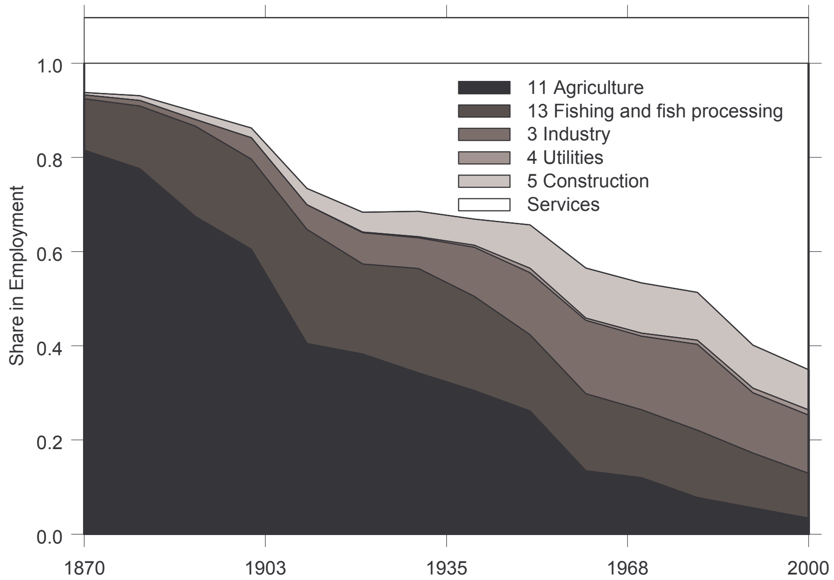


Figure 9. Distribution of Workers Between Industries in Iceland, 1870-2000

Catches from demersal fisheries have accounted for the largest part of the value added in the Icelandic fisheries, with cod, haddock and saithe being the most valuable species. Catches have more than tripled since 1918.

Rising fish catches and productivity in the sector have accounted for a very significant fraction of GDP growth. Today marine-product exports account for nearly 80 percent of commodity exports and 50 per cent of foreign exchange earnings. Efficient utilization of the resource is of paramount importance for the Icelanders.[xix] It is obvious that the fisheries have played a major role in the development of Iceland since the early 13th century.

Table 1 below ranks the fishing industries of different nations by size. The Icelandic fishing industry is ranked 13th in the world in 1998 despite a population of only around 280,000 people. Iceland being a population midget is by no means an economic midget in terms of the catching and processing of fish! The reliance on fishing makes the country more open but also, and more strongly, shows up in the large fraction of exports taken up by fish products.

Table 1. Nominal Catches by 15 Principal Producers in 1998, (1000 tonnes)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
China	6,165	6,654	7,372	8,323	9,351	10,867	12,563	14,182	15,722	17,230
Japan	10,389	9,550	8,498	7,684	7,248	6,617	5,967	5,936	5,916	5,259
USA	5,409	5,555	5,127	5,191	5,523	5,535	5,225	5,001	4,983	4,709
Russian Fed.	8,212	7,554	6,895	5,510	4,370	3,705	4,312	4,677	4,662	4,455
Peru	6,849	6,869	6,898	7,502	9,005	11,999	8,937	9,515	7,870	4,338
Indonesia	2,501	2,544	2,835	2,889	3,085	3,316	3,504	3,558	3,791	3,699
Chile	6,439	5,163	5,959	6,432	5,950	7,721	7,434	6,691	5,812	3,265
India	2,636	2,783	2,825	2,844	3,119	3,210	3,220	3,474	3,517	3,215
Thailand	2,444	2,498	2,619	2,875	2,928	3,012	3,013	3,005	2,878	2,900
Norway	1,795	1,603	2,012	2,431	2,415	2,366	2,524	2,639	2,856	2,850
Korea Rep.	2,436	2,467	2,172	2,321	2,257	2,358	2,320	2,414	2,204	2,027
Philippines	1,738	1,829	1,903	1,885	1,834	1,845	1,860	1,784	1,806	1,828
Iceland	1,501	1,505	1,047	1,575	1,716	1,557	1,613	2,060	2,206	1,682
Denmark	1,896	1,476	1,751	1,954	1,614	1,873	1,999	1,682	1,827	1,557
Mexico	1,447	1,361	1,373	1,158	1,103	1,192	1,329	1,464	1,489	1,181
World total	89,290	85,511	84,480	85,302	86,508	91,437	91,577	93,474	93,619	86,299

Source: FAO

We have shown that the fishing industry has taken on a prominent role in the economic development of the past one hundred years or so. The question is whether by specialising in the industry Iceland has managed to reap significant scale economies in terms of R&D spending and input innovations despite the country's small size.

5. Scale Economies and Technical Progress in Fishing

It is of great interest in light of the dominance of the fishing industry in Iceland whether we can find inter-industry differences in external scale effects. In other words, does the size of the fishing industry cause greater R&D spending in supporting industries and a greater flow of newly discovered inputs?

The total revenue of the seven largest "high-tech" suppliers of capital goods to the fishing- and fish processing industries (which account for over 80 per cent of the industry) was approximately 10 billion IKR in 1999. In comparison, total export revenues of the fishing industry in Iceland amount to approximately 100 billion IKR. The industry has been growing at very high rates over the last years. Revenue grew by 42 per cent between 1998 and 1999 and are expected to increase by 35 per cent between 1999 and 2000. Today 87 per cent of revenues come from exports.

The average spending on R&D in 1999 was 9 per cent of total turnover[xx] compared with 2.5 per cent in all manufacturing industries (ISCI 30-39) and 0.7 per cent for the economy as a whole.[xxi] (In 1991 direct trade between the fishing industry and the manufacturing industries (ISCI 32-39 excluding aluminium and ferrosilicate production) amounted to 22 per cent of total income of the manufacturing industries).[xxii]

The case of the largest company, Marel Inc., is interesting in this respect. The firm grew out of the University of Iceland producing "high-tech" products for the domestic fish-processing industry. The annual average revenue growth for the last 10 years has been around 38 per cent and today only 2-3 per cent of revenues stem from the domestic market. The importance of the domestic fishing industry has receded in the last eight years and today around half of revenue can be traced to sales of "high-tech" equipment to the chicken and red-meat industries, mostly in the United States.

The vibrant and innovative supply industry should have caused a high rate of productivity growth in the fishing – and fish-processing industries. This is confirmed in Table 2 below.

Table 2. The Rate of Growth of TFP, 1973-97

Fishing	2.1%
Fish processing	1.0%
All industries	0.8%

Source: IoES (1999)

Moreover, the sources of productivity growth in these industries are to a much larger extent due to domestic innovations than the adoption of new foreign inputs.

5. Conclusions

We have argued that the relationship between size and growth – or scale economies – is blurred by international trade. International trade enables countries to specialize and hence to reap benefits from scale economies at the industry level independent of population size. While a positive relationship between population and growth might exist in the data in the absence of international trade and specialization, the failure to detect such a relationship in today's integrated world of open economies does not constitute evidence against theoretical models predicting such effects. In particular, small economies can specialize and thus reap the same scale economies and high growth as larger economies.

The experience of Iceland appears to support our general thesis. A large and dominant fishing industry has fostered a vibrant and innovative industry that supplies intermediate goods to fishing and fish-processing companies. This industry now exports a large fraction of its output, which suggests high productivity and competitiveness.

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Appendix: Fisheries Management in Iceland

A fundamental problem for an economy based on a common property resource is that competitive private users fail to take into account external costs and benefits. Without a centralized management of the resource, this implies that firms have no costs in harvesting besides payment to capital and labor. Hence, there is a divergence between the private costs of the firm and social costs, which results in rent dissipation. This is referred to as the problem of the commons. Furthermore, production externalities in harvest activities can be present. The idea is that a small resource stock lowers productivity because the effort required to harvest a given output increases. This introduces a negative relationship between the size of production factors in harvesting and the resource stock. Thus, if one firm harvests an extra unit of the resource and decreases the resource stock, it increases the marginal costs of harvesting to other firms, an effect the firm itself does not take into account. Consequently, there is a tendency in such an economy to allocate too much physical capital to harvesting, which leads to rent dissipation and over-exploitation.

In the face of the market failure government actions may be called for in order to achieve equilibrium closer to the efficient outcome. The most direct instruments available are the establishment of property rights and Pigouvian tax schemes. By using one of these instruments, the first best solution can be obtained. On the other and, it seems plausible that the management of the latter policies will require a high level of information and therefore turn out to be costly, cf. Herbertsson and Sørensen (1998).

The current fisheries management system in Iceland was introduced in 1984.[xxiii] Up to 1984 everyone could enter the fisheries. The only restrictions were temporary closings and a limit on the number of days of fishing per boat. This caused overinvestment in the fisheries. In 1984, an individual-vessel-transferable-quota (ITQ) management system was introduced in the fisheries for major species and it was made more uniform in 1988.[xxiv] Each vessel is issued an annual catch quota. The size of the quota is simply a fraction of the total allowable catch for the year in question and the vessel's calculated share thereof. A particular vessel may hold quota shares for many different species. The Ministry of Fisheries determines the TAC on the basis of recommendations from the Marine Research Institute.

An important feature of the current system is that the Ministry of Fisheries has some autonomy in the annual allocation of quotas. This means that in allocating a quota the Ministry of Fisheries is not entirely bound by the rule described earlier. Thus, according to previous practice of the Ministry, proven seaworthiness and some minimal fishing activity of the vessel seems to be a prerequisite for receiving a quota. Quotas may be revoked at any time if the vessel in question is deemed to have violated the fishing regulations laid down by the Ministry of Fisheries.

TAC shares can be officially modified by a permanent transfer between vessels. The allocated vessel quotas are transferable subject to some restrictions. The quotas are also divisible so that any fraction of a given quota may be transferred. As quotas are only issued for a certain period of time transfers of future quotas, although by no means prohibited, are really only feasible on a contingency basis. The only way for an individual to enter the fisheries is by purchasing quotas from vessels already participating in the fisheries. This adds considerably to investment costs and therefore it has made entrance almost impossible in practice.

Although the system is economically efficient it has caused considerable political debate in Iceland with respect to fairness and equality and it is now being re-evaluated with an eye to potential changes. Its opponents argue that the resource rent only goes to the chosen few, who were lucky enough to have been already engaged in fisheries when the current system was imposed. Theoretically, a green-tax system would give results equivalent to the currently used system. The difference is that the resource rent would end up as government revenue instead of profits for private firms. Opponents of green taxes point at the weakness of the system due to the distortionary effect of taxes but ignore the double dividend nature of environmental taxes. The tax rightfully raises government revenue and distortions but it also decreases distortions from the common property problem in fisheries so the total effect is probably positive.

The principal benefits of property-rights-based ITQ systems are the small information requirements they involve. Taxing the harvesting sector optimally, on the other hand, requires costly information on each agent utilizing the resource, implying costs that might be greater than the actual benefits.

Endnotes

[i] Source: National Economic Institute.

[ii] Source: FAO (1998).

[iii] Approximately 14 per cent of workers in the service sector are employed in finance and insurance in Luxembourg compared with an unweighted average of 5 per cent in the OECD in 1998. Source: OECD (2000) and authors' calculations.

[iv] See Nelson and Phelps (1966) and Jones (1995).

[v] Of course a more appropriate variable to use would be the share of the largest industry in terms of foreign currency earnings. That way we would capture both specialisation in goods and services such as tourism, financial services, etc. because these data are not available, we use only goods exports.

[vi] Data on export shares are compiled from the *International Financial Statistics*: *Yearbook* 1987, data on population is from United Nations (1998).

[vii] The estimation is based on robust estimation to reduce the weight of outliers.

[viii] The raw correlation between the population size and the export share is -0.33 (t = 3.79).

[ix] We also investigated the relationship between the share of the largest good exported in GDP with similar results.

[x] Following Krugman and Obstfeld (2000), page 128.

[xi] Thorarinsson (1960).

[xii] Data on population 874-1702 comes from Steffansen (1975) and 1703-1995 from Statistics Iceland (1997). Data on population 1996-2050 are from United Nations Population Division's median variant population protections.

[xiii] Much of the population figures are estimates and guesswork since the first general census was taken in Iceland in 1703, the first census on modern lines covering a whole country, see Thorarinsson (1961).

[xiv] The account is mostly based on Finnson (1796).

[xv] Jón Þ. Þór (1997:42).

[xvi] This is based on the fact that conditions for farming deteriorated after 1300. These harsher conditions, among other thing, changed the population structure in Iceland indicating malnutrition and poverty. For example, the average height of males was 172 centimetres in 1104 but in the 17th and 18th centuries it had been reduced to 167 centimetres, Steffensen (1958). See Fogel (1994) for a discussion of the connection between economic development and nutrition.

[xvii] Jónsson (1999) and the National Economic Institute.

[xviii] Jónsson (1999) and the National Economic Institute.

[xix] We describe the system of transferable quotas used to manage the resource in Appendix.

[xx] The data were compiled by interviewing managers of the following firms: Marel, Hampiðjan, Sæplast, Formax, Skaginn, Vaki, and Póls-vogir.

[xxi] The figures apply to 1997. Source: the Icelandic Research Council, the National Economic Institute, and authors' calculations.

[xxii] Source: Ministry of Industry and Commerce (1995:33), the National Economic Institute, and authors' calculations.

[xxiii] With slight modifications made in 1988. This section is based on Arnason (1995).

[xxiv] The system is, however, not a true ITQ system. When the individual vessel quota system was introduced in the Icelandic fisheries the politicians left a loophole. A fisherman on a certain type of small boat is allowed to fish as much as he can as long as he uses hand- or longline. An overall catch quota is then placed on these boats and the fisherman who has the best boat and puts in the most effort will receive the highest catch and therefore the largest share of the overall catch quota. Such "Olympic fisheries" call for *capital stuffing*. The number of small boats fishing under this system increased from approximately 1150 in 1984 to approximately 2000 in 1991. Boats fishing under the system catch mainly cod which is the most valuable catch, excluding crustaceans. In 1984 the total cod catch of small boats was approximately 6 per cent of the overall cod catch and increased to approximately 14 percent in 1992.

Centre for Small State Studies
Institute of International Affairs - University of Iceland

Oddi, Sturlugata
101 Reykjavík
Iceland
Tel: +354-525-5262
Fax: + 354-552-6806
E-mail: smallst@hi.is
www.hi.is/~smallst