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Internal and External Migration in Iceland 1960-94: A Structural Model, Government Policies and Welfare Implications

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Abstract

Internal and External Migration in Iceland 1960-94:

A Structural Model, Government Policies and Welfare Implications

By Gylfi Magnússon

1997

This paper aims at analyzing migration patterns in Iceland. A model that explains individuals' migration decisions is constructed and then used to estimate the cost associated with relocating and how the shocks that drive migration are divided between common and idio-syncratic terms.

The model that explains individuals' migration decisions solves a lifetime utility maximization problem using dynamic programming. This turns out to be infeasible for the problem at hand using standard methods since there are an order of magnitude too many state variables. A method is developed to circumvent this by focusing on only a part of the state vector. The structural parameters of the model are estimated using the method of simulated moments.

The results are used to analyze the efficiency and welfare effects of government actions aimed at keeping marginal areas populated.

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1. Background

This part gives a brief overview of the development of the Icelandic economy through the centuries. The transition from a simple and stable agrarian society with no urban population to a modern society, increasingly centered in one city, is described with an emphasis on the resulting migration patterns. The role of the government in society is described as well, in particular policies that affect migration decisions.

1.1 The Icelandic Economy and Population

Iceland is a small island in the North Atlantic Ocean, located between Greenland and Norway. Its population of a little over a quarter of a million people enjoys a standard of living comparable to that of the Scandinavian countries.[1]

Iceland was mainly settled by Norwegians in the ninth and tenth centuries. It was a colony of first Norway and then Denmark for more than six centuries from 1262 to 1918 after an initial period of self-government. The legal system and social norms in Iceland are thus, not unexpectedly, fairly similar to those in these neighboring countries.[2] The country has been independent since 1918.

For most of Iceland's history agriculture was the main industry. It has been estimated that the country was capable of supporting approximately 50,000 people using traditional farming methods, sheep and cattle being the most important livestock.[3] The population

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[1] In 1994 GDP per capita was USD 23,285 or approximately 8% less than in the U.S. and 3% more than in Germany. When converted to purchasing power, the Icelandic GDP per capita was approximately 78% of that in the U.S. Source: Hagtölur mánaðarins [1996].

[2] See Stefán Ólafsson [1990].

[3] Sigurður Þórarinsson [1974] describes the struggle of man with the harsh elements of Iceland and analyzes changes in weather and major natural disasters. Þórarinsson notes that the history of Iceland can with some simplification be described as the fight of man with fire and ice (p. 29). He estimates that for most of Iceland's history the number of inhabitants did not exceed 50,000 although there were probably

was spread all along Iceland's coastline with the interior of the country being too barren to support farming. Towns and villages were slow to form and none had more than a couple of hundred inhabitants as late as the beginning of the 19th century. Until that century there was little specialization in production and thus little domestic trade but some foreign trade, with woolen goods and seafood being the main exports.

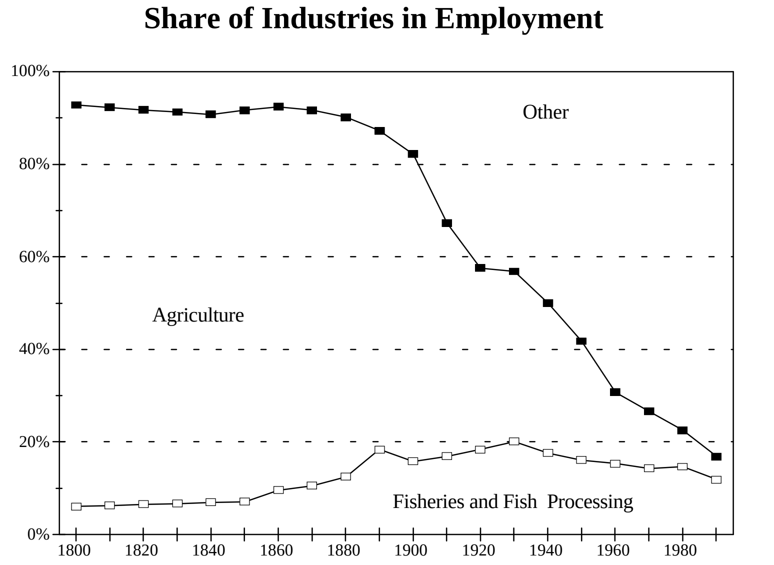

Fig. 1

The nineteenth century saw changes as the importance of agriculture diminished. This process accelerated dramatically during the first decades of this century. Fig. 1 shows in relative terms how employment in agriculture, fishing and fish processing and other industries has changed since 1800.[4] At the end of the last century, 66% of the population was still employed in agriculture, down from 87% one hundred years earlier. In 1994 only 4.4% of the population was employed in agriculture. Fishing and fish processing were the most important new sources of employment in the last century but the relative share of

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around 70,000 inhabitants in the late 11th century (pp. 93-94). The first Icelandic census was taken in 1703 and population figures are fairly reliable since that time. The population in 1703 was 50,358. Source: Landshagir 1995.

[4] Source: The Statistical Bureau of Iceland (Hagstofa Íslands), quoted in Sigurður Snævarr [1993], pp.113-115 and Sögulegt yfirlit hagtalna [1995].

these industries in employment reached its peak early this century and has slowly decreased since the 1930's. Several other industries, including manufacturing and various services have provided new sources of employment this century. Public sector employment has grown significantly.

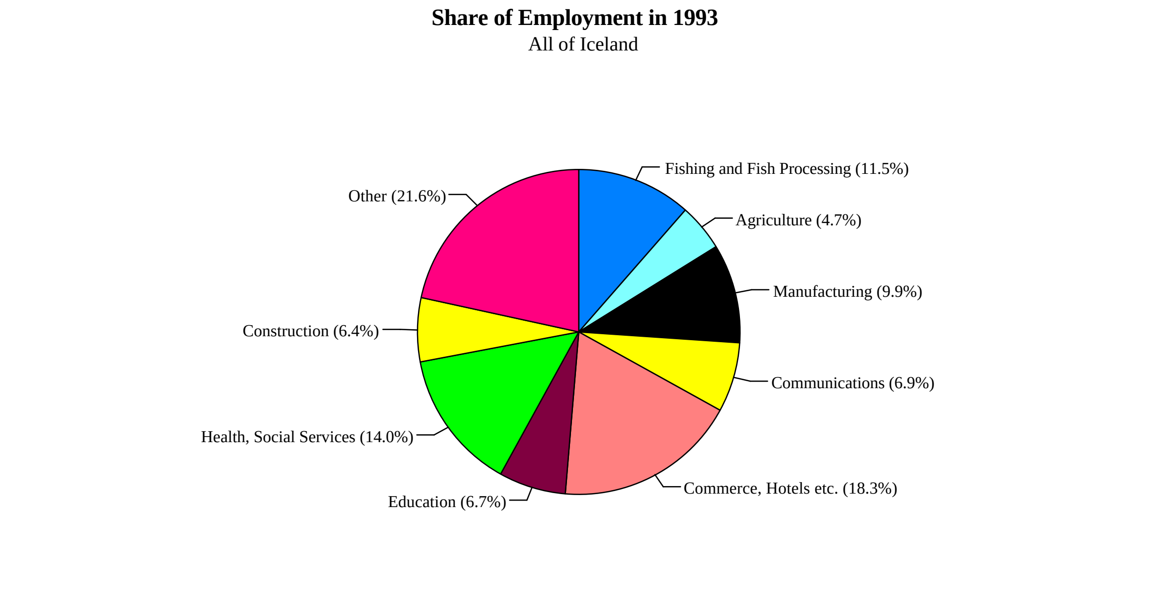

Fig. 2

The bulk of the traditional industries, fishing and fish processing and agriculture is located outside the capital region as can be seen in Figs. 2-4.[5]

The change from an economy that was based on agriculture to one that is much broader based has led to dramatic changes in Iceland's settlement pattern. In the 19th century the most marked change was the formation of many small villages, almost all of them in coastal areas that were suitable for the emerging fishing industry. Until the beginning of the 19th century Icelandic fishermen almost exclusively used open rowing-boats for fishing and as late as at the beginning of this century this kind of vessel was still responsible for two thirds of total landings. The very limited range and capacity of rowing-boats induced a settlement of fishermen that was spread all along the parts of the coastline where landing was easy and good fishing grounds nearby. Fishermen from other nations

[5] Source for Figs. 2-4: Landshagir 1993.

also fished in the waters around Iceland but they used bigger ships and in general more capital intensive methods.[6]

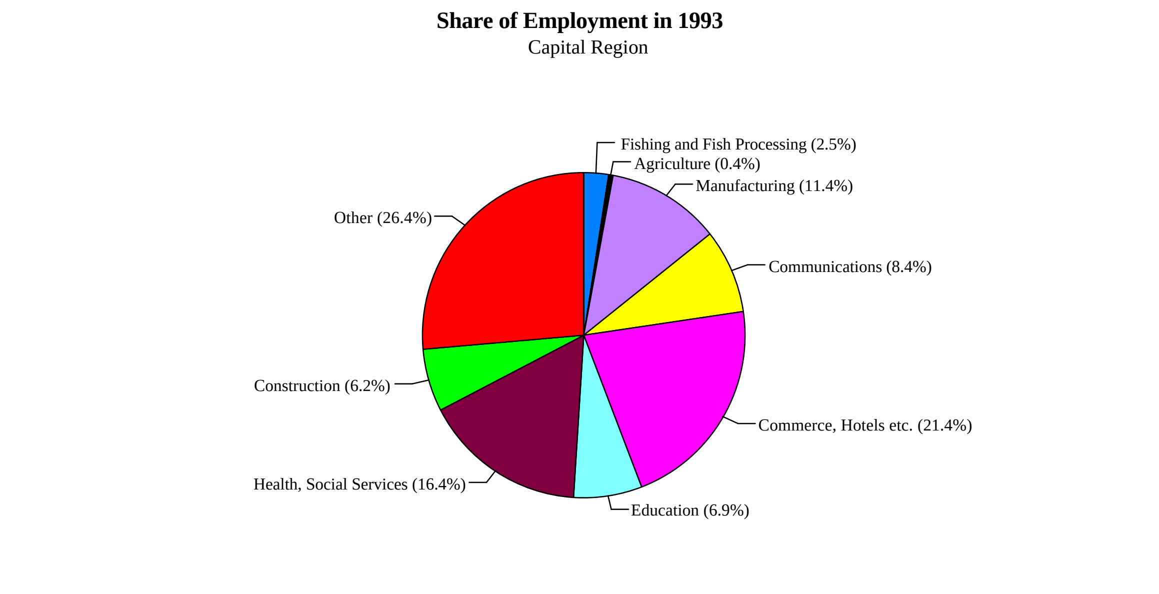

Fig. 3

It is something of a puzzle why Icelanders did not make better use of the fertile fishing grounds surrounding their country earlier. Several factors seem to be needed to explain this. Risk aversion probably played some role but shortage of capital undoubtedly played a large role. In the words of Gils Guðmundsson: *"Usable timber [for shipbuilding] was fairly limited and few if any carpenters that could take on such a task. Additionally, the financial means of most people were so limited that they did not allow for great and expensive endeavors. The wealthy were rich of land but rarely had many liquid assets."*[7] Lúðvík Kristjánsson describes the dearth of adequate timber for shipbuilding in Iceland, with driftwood being the only domestic source.[8]

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[6] There are several sources available that describe the Icelandic fisheries. The five book length studies that I have mainly consulted are Ragnar Árnason [1995], Sigfús Jónsson [1984], Lúðvík Kristjánsson [1980-86], Gils Guðmundsson [1977] and Gerhardsen [1961].

[7] Gils Guðmundsson [1977], pp. 22-23.

[8] Lúðvík Kristjánsson [1980-86, Vol. 2] , pp. 113-119.

After some turmoil in the first centuries of Iceland's history, society settled down in a very stable equilibrium until the nineteenth century. Rigid social norms aimed at preventing overpopulation or, in other words, running into the "Malthusian frontier", tied individuals to farms and hindered marriage of people who were not thought to be able to support a family. Migration from one region to another or even from one farm to another nearby was not an easily available option, neither for farm employees nor leaseholders. Domestic politics were dominated by landowners (freeholders) and farmers had considerable power over those required to live on their farms, both employees and family members. This system certainly did not aid in the development of new industries and may have had a significant effect in delaying the development of domestic fisheries. The old order of the farm-centered society gradually broke down in the 19th century.[9]

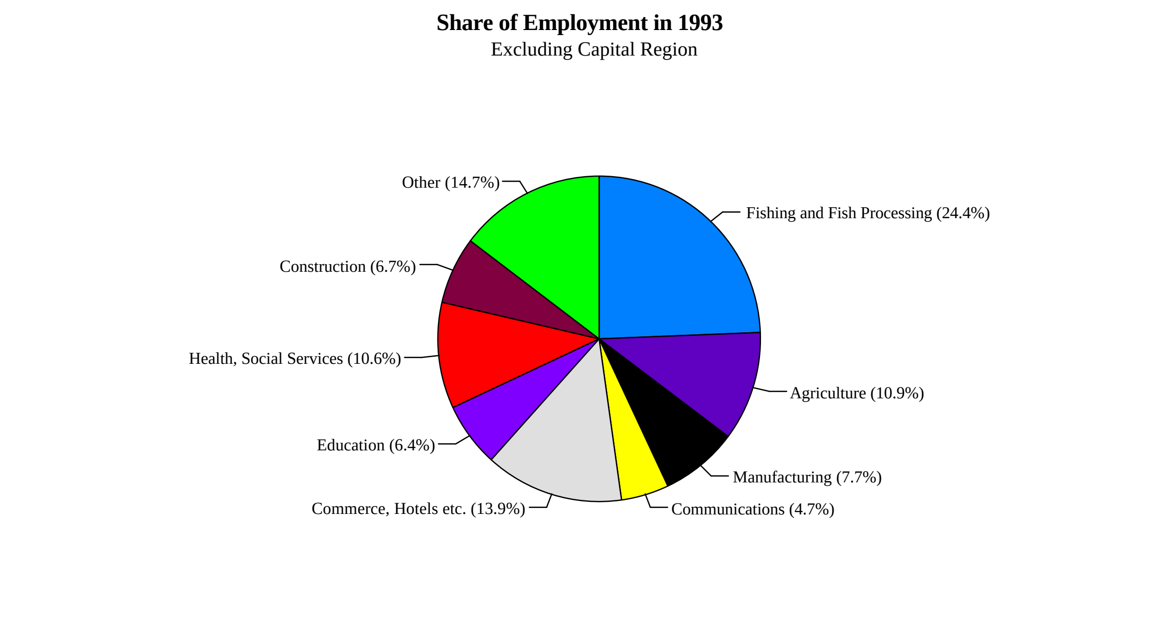

Fig. 4

During the 19th century Icelandic fishermen increasingly switched from open rowing-boats to larger vessels with a greater range and capacity. This called for larger villages

[9] Guðmundur Hálfdanarson [1993] describes the breakdown of the old social order and the political forces involved. He concludes that economic forces prevailed over the wishes of the very conservative political elite at the time. See also Jón Gunnar Grétarsson [1993].

with a reasonably flexible labor market and proper harbors that could service this kind of vessels. In the first decade of this century the first trawlers were bought by Icelanders and the pace of the movement towards more capital intensive fishing methods increased dramatically, rowing boats were motorized and far larger and more productive vessels taken into use.[10]

This century has seen a continuation of the migration from rural areas to neighboring fishing villages as the importance of agriculture has diminished. However, the flow has increasingly been to the capital area. The proportion of the population employed in fishing or fish processing peaked at the beginning of the depression in the thirties and has decreased slowly since.

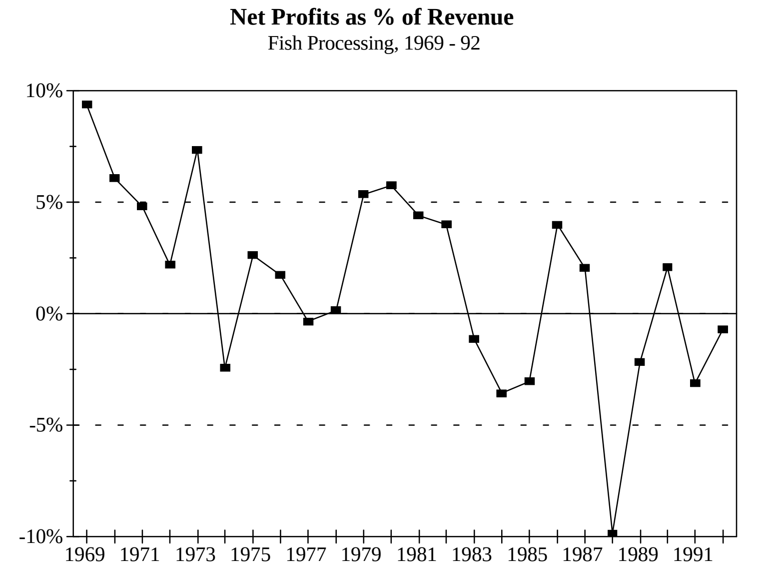

Fig. 5

Fishing and fish processing are however still the country's most important industries, contributing 52.4% of export revenues and 11.6% of employment in 1994.[11] The industries are an important employer in almost every village in the country and many of the villages would not be viable entities without their presence. They are especially

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[10] See Fig. 7 for the rate of investment in fishing vessels in the postwar period.

[11] Source: Hagtölur mánaðarins [1996] and Landshagir 1995.

important for people living outside the vicinity of the capital.[12] There is considerable variation in the environment facing fishing and fish processing firms in a given location over time. As a result, there is also considerable variability in the employment opportunities available in fishing villages. Figs. 5 and 6 show how variable the average profitability of firms in fishing and fish processing has been for the last two decades and that both are troubled industries, operating at a loss in most years.[13]

After decades of steady increase, the share of the population living in the capital area changed little during the 70's, hovered between 53 and 54%.[14] That decade saw substantial growth in the fishing and fish processing industries following the expansion of Iceland's exclusive fisheries zone from 50 to 200 nautical miles. Fig. 7 shows how the value of catches by Icelandic fishermen and the value of their fleet changed in 1945 to 1990.[15] The value of the fleet is based on the depreciated cost of construction. The figure shows that the value of the fleet grew substantially in the early 70's and that the value of catches followed with a few years lag. The share of fishing and fish processing as sources of employment increased in the 70's. After a slow decline since the depression, these industries provided 12.6% of all employment in 1968. The share increased between 1968 and 1983 to 14.0%. The share of these industries in employment has declined again since 1983.[16] See Fig. 1 for the long run trend.

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[12] In 1994 plants located in the capital area, where 58.7% of the population lived, processed 16.1% of the seafood processed in the country, by value. On average, the inhabitants of other areas processed 7.4 times as much. Source: Útvegur 1994 and population statistics. See also Figs. 2-4.

[13] Source for Figs. 5 and 6: Útvegur, Atvinnuvegaskýrslur, Útgerð og afkoma, various volumes.

[14] These population statistics and other used in writing this paper are based on published and un-published data from the Statistical Bureau of Iceland (Hagstofa Íslands), in particular one or more volumes of Landshagir and Tölfræðihandbók (Statistical Abstracts of Iceland), Manntal and Mannfjöldaskýrslur (Census), Hagtíðindi (Monthly Statistics) and Hagtölur á geisladiski (Statistics on a CD-ROM). I want to thank the staff at the Bureau for their assistance.

[15] Source for Fig. 7: Sjávarútvegur.

[16] Source: Þjóðhagsreikningar 1945 - 1992.

In the 80's and thus far in the 90's the proportion of the population living in the capital area has kept on increasing. See Fig. 8 for the proportion living in the capital area since 1800.

Most of the country's population growth this century has thus taken place in the capital, Reykjavík, or its neighboring communities while other parts of the country have experienced much slower growth or even a decline in their population. In 1994 156,513 individuals or 58.7% of the population lived in the capital area,[17] up from 65,555 or 45.5% in 1950 and 9,507 or 12.1% of the population in 1901. In the period 1901 to 1994 the number of people living in the capital area thus grew on average by 3.1% per year while in other areas the population grew from 66,445 to 110,270 inhabitants or 0.5% per year. The population of the north-west part of Iceland, the Western Fjords electoral district, decreased from 12,481 to 9,453 between 1901 and 1994.

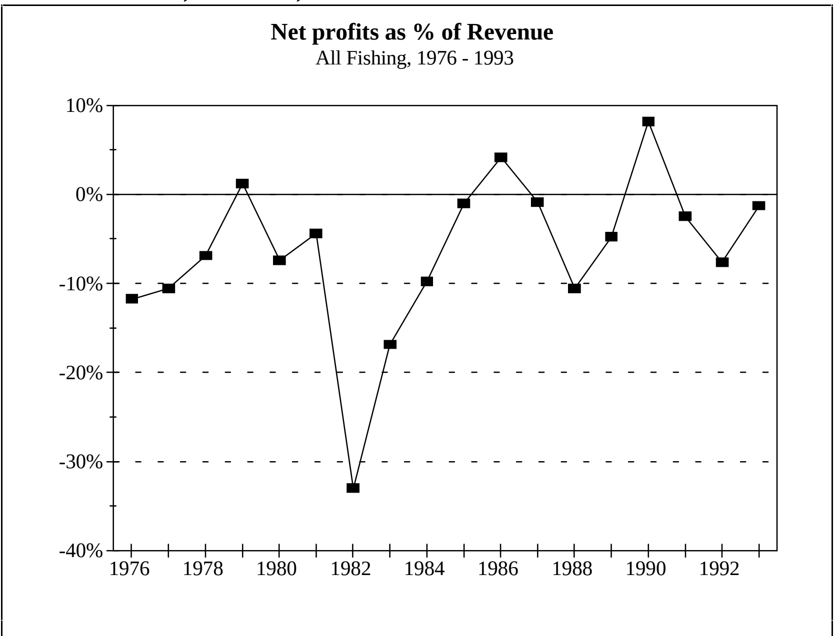

Fig. 6

Population growth in Iceland as a whole has been fairly rapid this century for a Western European country, 1.3% on average per year in the period 1901 to 1995, up from

[17] The capital region is defined as Reykjavík (the capital), Hafnarfjörður, Garðabær, Bessastaðahreppur, Kópavogur, Seltjarnarnes, Mosfellsbær, Kjalarneshreppur and Kjósarhreppur.

0.51% last century and a slight decline in the population in the 18th century. The population growth has slowed a little in recent years and was 1.1% on average in 1980-95.

The mass migration toward the capital area would not have been possible if jobs had not been created at a faster rate in that region than in other regions. It is however hard to point to unemployment in other areas as the driving force behind migration. In most years this century unemployment has been negligible in Iceland and was e.g. 0.95% on average in 1981-90 and 0.32% in 1971-80.[18] It has risen somewhat in recent years and was 5.3% on average in both 1994 and 1995.

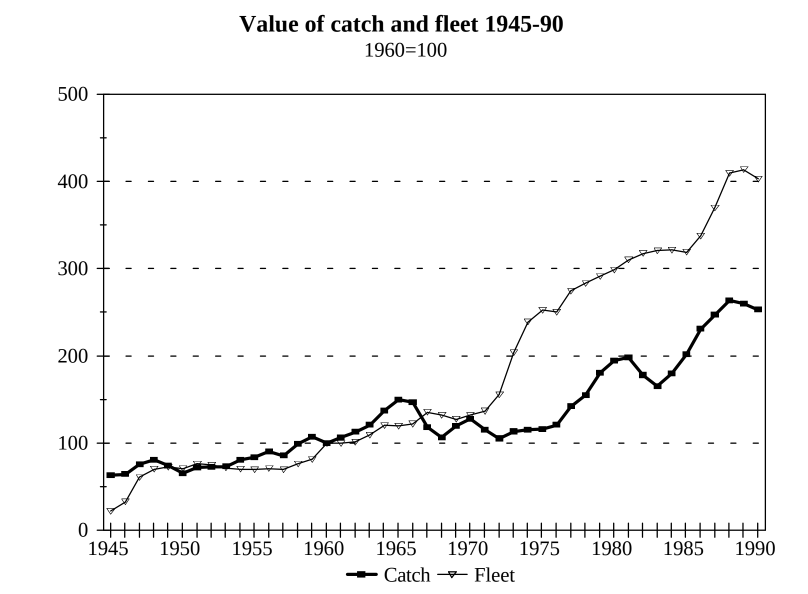

Fig. 7

The Western Fjords region has had the lowest unemployment rate in the country in almost every year since the mid seventies but a larger share of its population has left than in any other region. In the period 1980-95 unemployment has been slightly lower in most years in the capital region than in other regions on average. Since no region experienced substantial unemployment until the end of the period it seems impossible however to explain migration patterns by differences in unemployment levels.

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[18] Source for unemployment statistics: Landshagir, Tölfræðihandbók and Vinnumarkaður, various volumes.

It is hard to get a clear picture of wage differences across regions in Iceland. There is some data available on average income based on tax returns which seems to vary little across regions. In the period 1987 to 1994 wage income of people aged 20-65 living in Reykjavík was on average 98.2% of the national average. People living in the Western Fjords, the region that had the highest average, earned 107.1% of the national average.[19]

This is however not very informative because of differences in the composition of the labor force across regions. There is some data available that compares the average wages in a specific job category in the capital region on the one hand and the rest of the country on the other hand. This data covers several job categories that do not require a college degree.[20] Although some categories seem to pay better outside the capital region, the reverse holds for most categories.

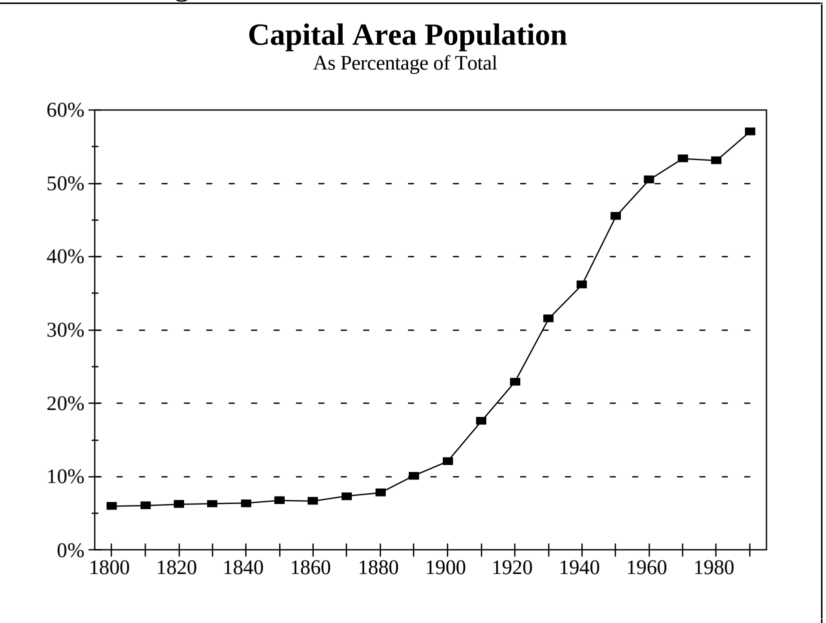

Fig. 8

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[19] Source: Landshagir 1995. The data is broken down by electoral districts so part of the capital region is counted with the South-West part of Iceland, the *Reykjanes* region. That region had income slightly above the national average.

[20] Source: Fréttabréf Kjararannsóknarnefndar 1991-96. The number of categories included in the bulletin varies a bit over time, the numbers quoted are based on samples of 26 to 36 categories.

In three selected time periods, the second quarters of 1990 and 1993 and the fourth quarter of 1995, 72% of the job categories paid better per hour in the capital area than in other areas. Ranking the categories by the ratio of wages in the capital area to wages outside the capital area, the median job category paid 6.8% more per hour in the capital area than in other areas. On average, wages were 10.0% higher in the capital area than outside it. The difference was smaller for unskilled blue collar workers than for skilled blue collar workers and white collar workers. The difference was similar for both genders and all three years in the sample.

These two data sets, the one on average wage income over all job categories and the other on average wages per hour in selected categories, thus point in different directions, at least for less educated workers. The former suggests similar wage levels in all regions with the capital slightly below average and the latter suggests that wages are somewhat higher in the capital region. The most plausible explanation is that differences in the composition of the labor force pull down average earnings in the capital region. In particular, the proportion of the population that are full or part-time students is higher in the capital region.[21]

Additionally, anecdotal evidence suggests that this difference between wage levels favoring inhabitants of the capital region may not exist or even be reversed for at least some categories of college educated workers. In particular, there is a near chronic shortage of trained individuals willing to accept government positions in certain rural areas in such fields as teaching and medicine. This has forced the government to bend its official rule on uniform wage scales for government employees irrespective of location and offer incentives to fill certain positions.

Nominal wages are however less interesting than purchasing power. Some data is available on relative price levels in the different regions of Iceland.

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[21] Source: Landshagir 1995.

In light of the migration patterns observed one would expect that housing prices are higher in the capital region than elsewhere. This is indeed the case and in most other regions houses sell for less than the cost of construction.[22] Apart from the cost of housing the cost of living seems though slightly lower in the capital region.[23] Small shops in isolated villages have to put up with higher transportation costs than shops in the capital area, have little chance of reaping any economies of scale and few if any local competitors to compete with for their customers. Additionally, many infrequently purchased goods and services are only available in selected areas, often only the capital area, and consumers in other regions thus have to put up with additional shipping and handling expenses when acquiring them or travel to purchase them in person. Consumers in the capital area have

[22] The State Bureau for Real Estate Evaluation (Fasteignamat ríkisins) publishes data on housing prices. In 1994 the price per square meter of a one bedroom apartment in seven locations outside the capital area ranged from 56% to 86% of the price in the capital area. Source: Markaðsfréttir Vol. 12. No. 1. The seven locations chosen were in the largest urban areas outside the capital area and prices are even lower in other areas. In 1992 the Bureau estimated that the market price of an apartment in some rural areas was only one fifth of that of a comparable apartment in the capital region. Source: Unpublished data from Fasteignamat. For a further description of the Icelandic housing market see Ingi Valur Jóhannsson and Jón Rúnar Sveinsson [1986] and Karl Sigurðsson [1988].

[23] The Statistical Bureau of Iceland (Hagstofa) estimated in 1976 the cost of the consumption bundle that the average family in Reykjavík consumes were this bundle instead purchased in one of four villages outside the capital area. The cost of living was higher in all the villages than Reykjavík but the difference was small, the cost of the bundle being 5.4% higher in the most expensive village than in Reykjavík and 3.4% more expensive in the least expensive village. Housing costs were lower in rural areas and excluding housing costs the bundle cost 6.0% more than in Reykjavík in the most expensive village. Most of the cost difference seemed to lie in higher energy cost and telephone charges outside the capital area. Price controls were in effect for many goods and services in 1976 and this may have reduced the difference in price levels between Reykjavík and other areas. Source: Athugun á framfærslukostnaði á fjórum stöðum utan Reykjavíkur (An Inquiry into the Cost of Living in Four Locations Outside Reykjavík) [1976]. It should also be kept in mind that it is well known that comparing the cost of a bundle of goods and services chosen in one location to the cost of the same bundle in other locations tends to exaggerate the cost of living in those other locations.

clearly benefited from economies of scale in the distribution of electricity and an abundance of geothermal energy in the vicinity of the city that has been harnessed to provide heating.[24]

The data on wages and price levels therefore suggests that moving to the capital region may slightly increase the purchasing power of wage earnings for the average employee. The fact that the difference is so small though suggests that the Icelandic labor market is efficient in equalizing the marginal product of labor in different regions. Low and fairly uniform unemployment across regions also point to the labor market being efficient in allocating labor.

Since the difference in real income seems to be so small and, as mentioned before, differences in unemployment rates are close to negligible, it is tempting to reason that other factors must also be important in driving migration to the capital area.[25] There is substantial evidence for this.

The capital area provides opportunities for a far greater variety of leisure activities than smaller villages with the bulk of the country's restaurants, cafés, cinemas, book stores, art galleries and post high school educational institutions, the only opera and

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[24] In 1990, the Statistical Bureau of Iceland (Hagstofa Íslands) surveyed families in Iceland and asked them about their expenditures. It turned out that there are noticeable differences depending on whether families live in the capital area or not. Housing expenditures were highest in the capital area but this was partially offset by lower energy related expenses, in particular for heating. On average families in the capital area only spent 40% as much on energy (excluding energy for vehicles) as families in other areas. Source: Neyslukönnun 1990 [1993]. Karl Sigurðsson [1988] reports that the cost of heating was 39% lower per square meter in 1988 for an apartment in the capital region than for an apartment in other areas (p. 40). For a detailed description of energy prices and subsidies in Iceland see: Orkuverð á Íslandi [1990].

[25] The State Auditing Bureau (Ríkisendurskoðun) states in its 1996 report on the Regional Institute (Byggðastofnun) that "...one cannot find a direct connection between wage income and unemployment on the one hand and population changes in the various regions on the other hand." (p. 14). Stjórnsýsluendurskoðun hjá Byggðastofnun [1996].

symphony orchestra, the national library, the two main professional theaters and several smaller ones etc.

There seems little reason to expect that an increase in the population of the capital area will in the foreseeable future lead to a significant increase in the cost of living due to a scarcity of some factor such as land. Reykjavík may be the largest city in Iceland but it is still tiny compared to the world largest metropolitan centers and not subject to the same problems of skyrocketing land prices, long commuting distances etc. Reykjavík and her satellite towns seem to be ready to grow considerably without the price of any important resource such as land, drinking water and geothermal energy rising considerably.[26] Neither are environmental problems such as the production of pollutants potentially a major problem since the population density of Iceland is so low, fossil fuels are not a significant source of energy except for automobiles, ships and airplanes and there is relatively little manufacturing industry. Iceland does suffer from some environmental problems, especially overfishing and soil erosion, but it is hard to see how migration to the capital area can adversely affect this.[27]

1.2 Government

The government in Iceland is democratic. Typically between four and six political parties are represented in the national parliament, *Alþingi*, with two or more of the parties forming a majority coalition government. The members of the parliament are elected from eight electoral districts. The number of members from each district varies to a degree with the population of the district but not proportionally so the largest districts are

[26]Ársæll Guðmundsson [1989] studied the effects of an increase in the population of the capital region on the cost of living and especially of providing government services in that area and concluded that costs would increase somewhat with increased population. He does not however allow for any cost reduction due to slower growth or a decline in the population of other areas.

[27] For a description of environmental problems and policies in Iceland and the effects of economic growth see Tryggvi Herbertsson and Sigríður Benediktsdóttir [1996].

underrepresented in the parliament and rural districts overrepresented. Fig. 9 shows Iceland's electoral districts.[28] The numbers by each region represent the population in 1994, the population growth rate in 1980-94 and the number of inhabitants per parliament representative after the 1995 elections.

Population in 1994, growth rates 1980-94 and inhabitants per parliament representative in 1995

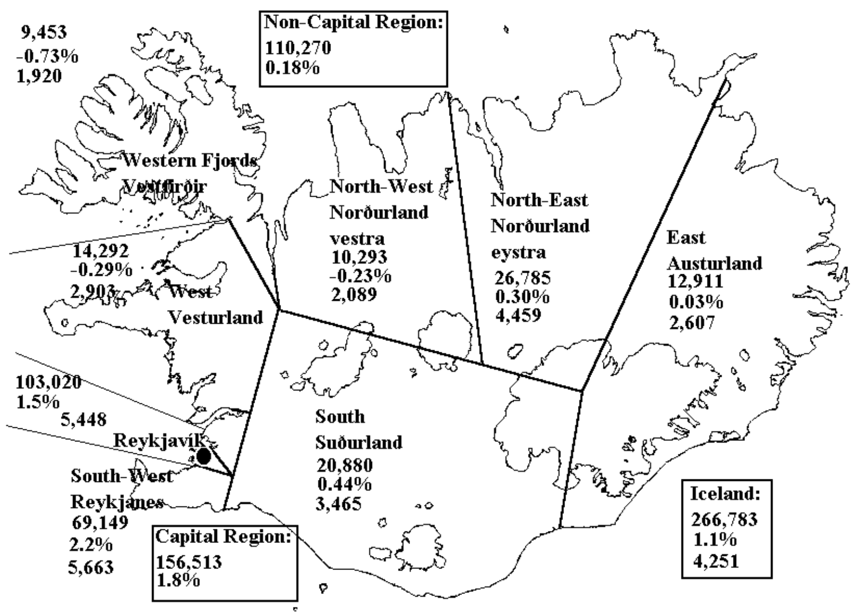

Fig. 9
Note: Part of the capital region votes with the South-West (Reykjanes) district

There are two levels of government, local and national. The national government plays a far larger role and was responsible for 79% of total government spending in 1995.[29] The country is divided into approximately 200 communities at the local government level. The majority of these are very small rural communities (*sveitahreppar*) but about a third consist of a fishing village and to a varying degree the rural population in its vicinity.[30]

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[28] Source: Landshagir 1995. The demarcation lines shown are a slight simplification of the actual ones.

[29] Source: Búskapur hins opinbera 1994-95.

[30] There were 197 communities in 1992. In some cases two or more neighboring villages fall under the jurisdiction of the same local government and they will in the paper be treated as one. The boundaries between communities have changed on several occasions, communities have merged and others have been

Government spending as a percentage of GDP grew slowly until 1982 when it hit 42% but has since been around 40%.[31] This share sustains a welfare state similar to that of the Scandinavian countries with free or heavily subsidized health care and education and various social services available to the citizens. Government expenditures are though a lower share of GDP in Iceland than in Scandinavia and close to the OECD average.[32] The main difference between the composition of Icelandic welfare spending and that of the Scandinavian countries is that Iceland has historically had much lower unemployment and thus needed less funds for unemployment benefits. Iceland has no military apart from a tiny fleet of coast guard vessels and thus negligible defense spending.

The Icelandic welfare state has a long history and its roots can be traced back to the first centuries of settlement.[33] Traditionally, local communities, *"hreppar"*, provided poor relief by relocating paupers to the farms of the better off in case the paupers' relatives were not able to provide for them. The hreppar also in some cases levied a tax on the well off and used the proceeds to attempt to prevent poor men from having to break up their households. Hreppar also formed a mutual insurance association against losses by fire and livestock diseases.[34] The existence of this fledgling welfare system meant that the better

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split up. Data on changes in the population of these districts is used later in the paper but the effects of changing boundaries have been filtered out as far as possible.

[31] Source: Búskapur hins opinbera 1994-95. Social security is counted with the numbers for the national government. Government spending as percentage of GDP was 18.7% in 1945. Source: Þjóðhagsreikningar 1945-92.

[32] Stefán Ólafsson [1993a] finds that the Icelandic welfare system differs from that of the Scandinavian countries in some respects, in particular in that the Icelandic tax system is less redistributive and that the share of GDP that is spent on welfare is somewhat lower. The differences are though for the most part minor. Ólafsson notes that this is interesting in light of the fact that Icelandic politics are not dominated by a large social democratic party as is the case in the other countries.

[33] For a description of the development of the Icelandic welfare state since the end of the last century, see Stefán Ólafsson [1993b].

[34] Source: Sigurður Nordal [1990], p. 92.

off had every incentive to fight population growth. This was probably the main reason for the development of the rigid social order described earlier, where the poor were not supposed to marry and thus not procreate, migration was curtailed and the growth of new and risky sources of employment stifled.

The breakdown of the old social order during the 19th century can arguably be classified as decreasing local government intervention in the economy, in particular in labor markets. The most important form of intervention in the economy by the national (colonial) government involved restrictions on trade, in particular the establishment and enforcement of trade monopolies, both for domestic and international trade. The trade restrictions were gradually lifted in the late 18th and early 19th centuries and the last remnants abolished in 1855.

The national government's role in the Icelandic economy increased significantly in the first 60 years of this century.[35] The government's control over the economy was in particular strengthened considerably at the time of the depression in the thirties. The collapse of Iceland's export markets due to the depression was met by subjecting imports to government licenses. This system and various controls on exchange rates and currency movements stayed in effect long after the end of the depression. The government has also at times directly controlled interest rates and attempted to control prices and wages.

The attempts at price controls were mainly intended to fight nationwide inflation but there was also some tendency to try to even out the difference in the cost of living between the capital region and other regions. One method was to mandate that resellers that operated nationwide had to charge the same price in all locations despite sometimes higher costs in rural areas, especially transport costs, and less competition. This is still the

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[35] Gunnar Helgi Kristinsson [1993] concludes that the history of the Icelandic power system from 1900 and until the formation of the so called 'Viðreisn' (Reconstruction) government in 1959 is a story of ever increasing government influence on society (p. 321).

case for oil companies.[36] Some state owned firms have followed similar policies, e.g. the country's only cement plant and the postal service.

The harsh climate calls for substantial use of energy for house heating and the inhabitants of the capital region have benefited substantially from their proximity to a cheap source of geothermal energy and economies of scale in distribution. There has been pressure on the national government to subsidize the cost of house heating in other regions and this has been done to a degree.[37]

Although the government sector's share of GDP kept growing, the period after 1960 saw a relaxation of government control over various economic variables and a move towards economic policies that are more in line with the rest of Western Europe. Iceland joined the European Free Trade Association in 1970 and now has close ties to and free trade agreements with the European Union and is a member of GATT/WTO. The regulation of interest and exchange rates has been abolished as have restrictions on currency movements and on the import of most goods except agricultural commodities.

Direct government controls such as quotas and price restrictions are now mainly in effect in the fishing and agricultural sectors but the government still plays an active role in some other sectors. Most importantly, two government owned banks control almost 60% of the banking sector[38] and various loan funds are directly or to a degree under government control. Privatization in recent years has somewhat reduced the number and influence of other government owned firms but several still remain, including electrical utilities, the telephone monopoly, a television station and a few manufacturing firms.

The breakdown of the farm-centered society was a great source of friction and political debate in the 19th century and well into this century. Changes in employment in

[36] See Samkeppnisráð: Álit nr. 11/1995 [1995].

[37] See e.g.: Orkuverð á Íslandi [1990].

[38] Source: Hagtölur mánaðarins [1996]. The share is even higher or about 80% if one counts as part of the government sector a group of non-profit savings banks that are to a degree under local government control.

agriculture now have almost negligible effects on the rest of the labor market but changes in settlement patterns continue to be a source of friction. Although banning migration or trying to stop urbanization by forced birth control or other such draconian measures has not been seriously considered for well over a century, governments have frequently implemented policies aimed at keeping marginal areas populated.

Given that the country is very sparsely populated, it is of significant economic importance how much is spent on providing infrastructure and services in remote areas or to provide other incentives for people to live in those areas. No attempt will be made here to quantify the amounts that have been spent to support settlement in marginal areas. It is hard to identify a well defined regional policy with clear-cut goals[39] but the regional effects of policies seem to affect political decision making in a variety of fields.[40]

A government institute, *Byggðastofnun* (Regional Institute), is supposed to provide both expert advise and data to the government on matters that affect marginal areas. It also oversees the distribution of government funds that have mainly been used to assist firms in trouble in marginal areas and to spur the development of new industries.[41]

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[39] At a conference on regional policy in Iceland in 1987 under the title 'Hefur byggðastefnan brugðizt?' (Has the Regional Policy Failed?), many participants claimed that it was impossible to answer this question because one could not identify any coherent regional policy. Hefur byggðastefnan brugðizt? [1987].

[40] Gunnar Á. Gunnarsson [1989] has analyzed industrial policy in Iceland in the period 1944-74 and concludes that the policy was heavily and increasingly influenced in this period by regional politics or by '... efforts by economic and political elites in the peripheries to counteract the rapid centralisation of power and wealth in the Reykjavik area and the South-West' (p. 315). See also Gunnar Helgi Kristinsson, Halldór Jónsson and Hulda Þóra Sveinsdóttir [1992].

[41] The State Auditing Bureau (Ríkisendurskoðun) estimates in a 1996 report on the Regional Institute (Byggðastofnun) that the cost of operating the Regional Institute in 1985-95 was 8.5 billion króna. This amounts to approximately 0.2% of GDP per year on average. This figure is however only part of the total spent on regional policy. Stjórnsýsluendurskoðun hjá Byggðastofnun [1996].

Various other loan funds and the state banks have also provided funds to firms in marginal areas at the request of political leaders. The question of who got access to capital was especially important when interest rates were regulated by the government. In the period 1945-90 inflation was rampant in Iceland or on average 19.2% per year measured by the Consumer Price Index. Inflation got constantly worse with time and was 37.3% per year on average in 1973-90. Interest rates were held artificially low and price indexation generally forbidden. This system collapsed in the 1980's as monetary savings dried up and the demand for price indexation in the financial system grew. Finally, interest rates were deregulated in the mid 80's and then controls on capital movements gradually lifted. Inflation in 1992-95 was much lower than previously or 2.7% on average.

Interest rates well below not only equilibrium rates but also well below the inflation rate made credit rationing necessary and access to funds was to a large degree decided by political forces. The boards of the state owned banks were and still are elected by the parliament, and their highest ranking officials appointed by the government. This system undoubtedly favored firms in rural constituencies that were overrepresented in the parliament. It however also meant that purchasing real estate in the capital area became one of few relatively secure investment opportunities and especially tempting for those who could borrow to finance part of the construction cost.[42]

As mentioned earlier, most of Iceland's providers of art and entertainment and higher education are based in the capital region. Many of these institutions are to a degree funded by the government, in particular those providing education and art. Their location in the

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[42] Approximately 5% of those living in rural areas in 1988 reported owning real estate in the capital region while only 3% of those living in the capital region reported owning real estate in rural areas. Source: Karl Sigurðsson [1988] (p. 14). Sigurðsson also reports that in 1988 a significantly higher proportion of those living in the capital region and not owning their abode planned on investing in real estate than of those living in other regions. Furthermore, those living in rural areas and planning to invest in real estate were far more likely to plan to buy real estate in the capital region than those living in the capital region to buy real estate in rural areas (pp. 15-16).

capital area is therefore not solely decided by market forces but rather a result of political decision making. Since the existence of such institutions does not only provide employment to their workers but also affects the standard of living for their neighbors, political decisions on funding for arts and entertainment can have substantial regional effects. Given that the political process in Iceland, which gives disproportionate influence to rural areas, has resulted in the provision of only one symphony, one opera, one main university etc., all in the capital area, it is tempting to reason that economies of scale or indivisibilities must make a different arrangement too costly to be practical. Since Iceland is one of the world's smallest countries it is to be expected that economies of scale make it expensive to try to provide all of the amenities that other affluent western societies have to offer. Allocating the provision of some goods to several locations would exacerbate the problems of scale.

Lately there has been discussion of moving selected government bureaus from the capital area to provide employment in rural areas. It is too early to tell whether this policy of moving parts of the central government to rural areas will have a significant effect on settlement patterns if implemented. Neither is it clear whether there is much political will to try to implement this policy since the employees of the bureaus that have been mentioned as candidates seem to strongly object to it. There has also been some movement to set up new government institutions away from the capital, most notably the establishment of a small college in 1987 in Akureyri, the largest village outside the capital region.

The aim of this paper is to analyze the effects of government policies that try to stop or at least reduce the migration from rural areas to the capital area. To achieve that goal a model is constructed that describes individual's decision making on migration. This is then used to estimate both the costs, pecuniary and non-pecuniary, that are associated with moving and how the shocks that drive migration can be attributed to on the one hand idio-syncratic and on the other common elements. This information is then used to simulate the response to government policies aimed at affecting migration and evaluate their effectiveness and welfare consequences.

2. Model

This part introduces the model used to explain individuals' migration decisions. The basic premise is that individuals make their migration decisions so as to maximize their lifetime utility. Migration is costly and thus individuals will only migrate if there is a sufficiently large gap between their annual utility if they continue to live in the current location and the utility they expect to enjoy in a new location.

The model used explains how individuals[43] react to shocks to their income[44] in the community where they live and their potential income in other communities. The basic premise is that individuals try to maximize their expected lifetime earnings in present value by choosing where to settle. In particular, once a year, every year that an individual is in the labor market, he chooses whether to stay in his present location or relocate to one of the other locations available.

For the purposes of the paper, the country is divided into 60 locations as follows: The capital region, a region of all the areas outside the capital where there is negligible or no fishing or fish processing and 58 villages that depend to a large, but varying, degree on fishing and/or fish processing for employment.[45] The rest of the world makes up the 61st community. For brevity all possible locations, including the capital and the rest of the world, will hereafter be referred to as villages.

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[43] The paper ignores the fact that most individuals are part of a family that makes joint decisions on migration. This is a simplification.

[44] The term income is used here in a loose sense and covers both pecuniary and non-pecuniary benefits, i.e. utility.

[45] The boundaries between villages chosen are in most cases based on current boundaries between local governments. The few exceptions are where the data made it more practical to use boundaries based on now defunct administrative divisions. The capital region consists of nine local government districts in two electoral districts (see footnote 17).

Data on migration in Iceland shows that the rate of migration is greatest among people in their early 20's and then slowly declines until people reach their mid-sixties, after that there is a slight increase.[46] Fig. 10 shows gross migration rates in Iceland for 1990-1992. The model focuses on individuals that are active in the labor market and no attempt is made to model the rate of migration for people under the age of 20 or above the age of 64.[47]

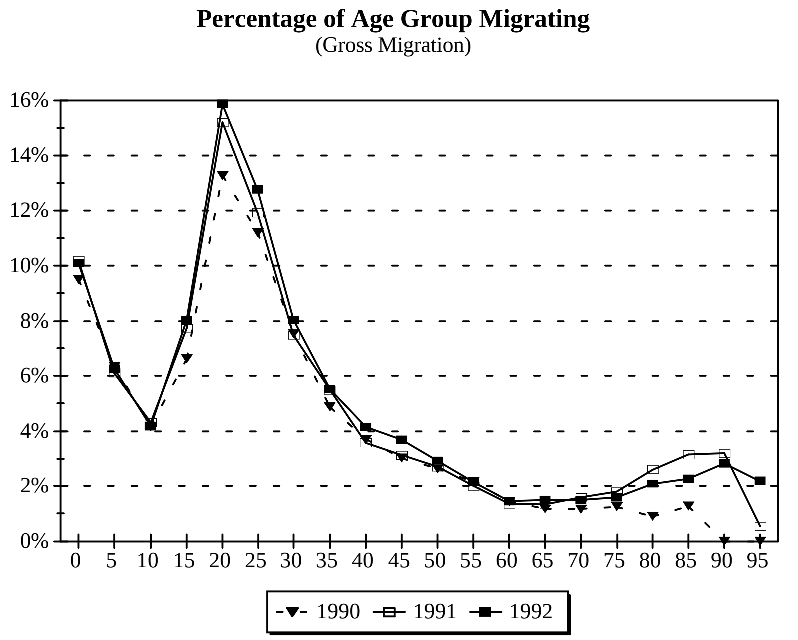

Fig. 10

The migration model is based on the following assumptions:

i) It is assumed that people enter the labor force between the ages of 20 and 29 with the rate of entry decreasing with age over that period and that they stay in until the age of 65. The parameter α describes how large a proportion of any given

[46] Source: Landshagir.

[47] It is assumed that the effect of people in these age groups moving on the population of the various villages is proportional to that of the people of working age who do move, scaled up or down for each age group as appropriate to take into account the number of people in the age group and how frequently people in the group migrate.

cohort enters when they are aged 20 through 24 with the remainder entering between the ages of 25 and 29.[48]

ii) Every time a person relocates she incurs a lump sum cost Δ.[49]

iii) All individuals have the same discount factor, β.

iv) Income in any given year is determined by two factors, π and Π, and an individual's location at the start of the year. π is idio-syncratic or individual specific. Π is the same for all members of a given cohort and highly correlated across cohorts. Both Π and π are vectors with 61 elements, one for every possible location. An individual, *i*, born in year *b* and living in village *N* in year *t* will in that year have the following income (utility):

(1)

$$u\left(\pi_{i,t}, \Pi_{b(i),t}, N\right) = \pi_{i,t}\left(N\right) + \Pi_{b(i),t}\left(N\right)$$

Each year every village experiences a shock that changes the element of each Π vector corresponding to that village. The shock is the same for all cohorts that have entered the labor force. The shocks are assumed uncorrelated across villages and uniformly[50] distributed on $[-\lambda,\lambda]$. In addition, each year every individual sees

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[48] Cohort is here used to refer to all individuals born in the same year.

[49] Assuming that all individuals have the same cost of relocation is of course a simplification. Setting up the model assuming that there is some distribution of this cost is straightforward but would unfortunately have made the estimation of the parameters of the model considerably more computer-time consuming. Since estimating the parameters is already very computer-time consuming this was not done. I did look into using data on the cost of housing in the various villages as a proxy for the cost of moving from a given village to another. The State Bureau for Real Estate Evaluation (Fasteignamat ríkisins) estimates housing prices and provided me with panel data. Unfortunately there were several problems with extending the model using this data so that was not done.

[50] The uniform distribution is used for several reasons. One is that it means that shocks are bounded in any given year and this simplifies integration. It also has the advantage that pseudo-random draws from a uniform distribution can be generated on a computer faster than for more complex distributions and in general calculations are faster based on the uniform distribution than e.g. the normal distribution. It is of

his (real and) potential individual specific income in each village change by a random factor. These shocks are also uncorrelated across villages and individuals and each shock uniformly distributed on [$-\lambda^*,\lambda^*$]. When the parameters of the model were estimated, λ^* was chosen to be normalized as equal to 1 and λ and Δ estimated relative to that.[51]

Thus, if the vector of common shocks is called ξ^1, we have:

(2)

$$\Pi_{b,t+1} = \Pi_{b,t} + \xi_t^1$$

And, if the idio-syncratic shock vector for individual *i* is called ξ^2, we have:

(3)

$$\pi_{i,t+1} = \pi_{i,t} + \xi_{i,t}^2$$

Note the nature of the transition of the π and Π vectors, the pdf of the annual change in each of them is independent of the level. In addition, the shocks to the separate elements of the vectors are independent of each other.

v) In the year that a cohort reaches age 20, the cohort specific payoff vector is assumed to be:

(4)

$$\Pi_{t-20,t} = \sum_{j=0}^{J} \xi_{t-j}^1$$

Where J is a non-negative number.[52] Likewise, when an individual reaches age 20, $b(i) = t - 20$:

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course reasonable to question the assumption that shocks in one 'tail' of the distribution are equally likely as shocks towards the center of the distribution. The uniform distribution has this characteristic for one draw. It is however more important for the model used that this does not hold for the sum of several draws. The sum of several draws from the uniform distribution has a bell shaped pdf.

[51] Hereafter we will ignore λ^* for the most part and, to save on notation, functions that depend on both λ and λ^* will be presented as if they only depended on λ.

[52] Although individuals do not live forever, villages can. This calls either for a more complicated shock process where the pdf of present shocks depends on previous shocks (or the levels of the payoff vectors) or

(5)

$$\pi_{i,t} = \sum_{j=0}^{J} \xi_{i,t-j}^{2}$$

An individual maximizing her expected lifetime earnings will implicitly maximize the following value function in any given year from the time she enters the labor force and until retirement:

(6)

$$U\left(t-b(i), N, \pi_{i,t}, \Pi_{b(i),t}, \beta, \lambda, \Delta\right) = \pi_{i,t}(N) + \Pi_{b(i),t}(N)$$
$$+ MAX_{X\in\chi}\left[E_t\beta \cdot U\left(t+1-b(i), X, \pi_{i,t+1}, \Pi_{b(i),t+1}, \beta, \lambda, \Delta\right) - \mathrm{I}(X \neq N)\Delta\right]$$

Where χ denotes the set of villages and $\mathrm{I}(\cdot)$ denotes an indicator function, in particular $\mathrm{I}(W) = 1$ if the condition W is true and $\mathrm{I}(W) = 0$ if it is false.

In the last year before retirement, the value function is:

(7)

$$U\left(\bar{\tau}, N, \pi_{i,t}, \Pi_{t-\bar{\tau},t}, \beta, \lambda, \Delta\right) = \pi_{i,t}(N) + \Pi_{t-\bar{\tau},t}(N)$$

As π and Π always enter the value function added together and the distribution of the sum of any pair of elements, one from each vector, in future time periods does not depend on anything except their sum today and λ, each individual only cares about the sum of π and Π, not the individual components. Mathematically:

Lemma 1

$$U\left(\tau, N, \pi - a, \Pi + a, \beta, \lambda, \Delta\right) = U\left(\tau, N, \pi, \Pi, \beta, \lambda, \Delta\right)$$

for any vector of constants, a. Proof: See Appendix A.

This result simplifies calculations when simulating the behavior of the model and allows us to write the value function hereafter as:

$$U\left(\tau, N, \tilde{\pi}, \beta, \lambda, \Delta\right)$$

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for some sort of discounting of the effects of past shocks on present utility as otherwise the distribution of village specific payoffs will as time passes become more and more extreme. I chose a cutoff point as this makes for the simplest calculations. J was estimated and not restricted to being an integer but to simplify the notation it is presented here as an integer.

where

(8)

$$\tilde{\pi} = \Pi + \pi$$

To find what drives migration in the model one has to find what values of π and Π and the structural parameters β, Δ and λ will induce an individual of a given age to move from her present location to one that has more promise. This kind of problem is easily solved in theory by backwards induction from the year of retirement.[53] In practice, this is however not feasible using brute force methods unless the stochastic state variables and time periods are far fewer than in this problem as otherwise the multiple numerical integrations needed will quickly overwhelm even the fastest of computers.

The first standard step in cutting down the dimensionality of this type of a problem is introducing dynamic programming, finding the value functions for one year at a time, starting with the year of retirement and moving towards the year in which an individual enters the system. Then, instead of integrating over all possible outcomes in every year from the present until retirement, one only has to integrate over all possible outcomes for one year's worth of shocks, calculating the value function in each step using the value function found in the previous step.

To find the decision rule for an individual of age τ contemplating a move from village *N* to village *F*, we note that he will compare the following:

a) The expected value function for the individual if he lives in *F* one year from now:

(9)

$$E_t U\left(\tau+1, F, \tilde{\pi}_{t+1}, \cdot\right) = \oint_{\xi_X \in [-2-2\lambda, 2+2\lambda], X \in \chi} U\left(\tau+1, F, \tilde{\pi}+\xi, \cdot\right) f\left(\xi\right) d\left(\xi\right)$$

[53] A lot of research has been done recently on models involving sunk costs and heterogeneous agents. See Dixit and Pindyck [1994] for an overview of the theory.

b) And, likewise for his current location, the expected value function in *N* one year from now:

(10)

$$E_t U\left(\tau+1, N, \tilde{\pi}_{t+1}, \cdot\right) = \oint_{\xi_X \in [-2-2\lambda, 2+2\lambda], X \in \chi} U\left(\tau+1, N, \tilde{\pi}+\xi, \cdot\right) f\left(\xi\right) d\left(\xi\right)$$

The decision rule is move iff $E_t \beta \cdot U\left(\tau+1, F, \tilde{\pi}, \cdot\right) - \Delta > E_t \beta \cdot U\left(\tau+1, N, \tilde{\pi}, \cdot\right)$. Unfortunately this does not sufficiently cut down the dimension of the problem. Since each shock vector has 61 independent elements, the integrals above are unsolvable in practice.

One step in circumventing the problem of dimensionality is to note that we are not primarily interested in the value function *per se* but rather in the decision rule that it implies since that is all that is needed to explain migration. In addition, note that there can never be a question of what village an individual moves to, *if* she moves. An individual will never move to another village than the one that has the highest combined individual and cohort specific payoff for that individual in the time period when she makes her decision.[54] This is of practical importance since it means that an individual only has to compare the expected value function next period in one location beside her current one when deciding whether to migrate and needs not estimate the value function in other villages. Furthermore, an individual will only move if the one period payoff in her best alternative village is sufficiently higher than the one period payoff in her current location, the problem is to quantify 'sufficient'.

How large a gap between $\tilde{\pi}_t\left(N\right)$ and $\tilde{\pi}_t\left(F\right)$ is needed to induce migration clearly depends on the individual's age and the structural parameters Δ and β. But λ and the other

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[54] Note that the best alternative to village *N* can be found by looking at the one term payoffs, it is not necessary to calculate the value functions:

$$\begin{aligned} &ARGMAX_{\ X \in \chi} E_t\ \beta \cdot U\left(t+1-b(i), X, \pi_{i,t+1}, \Pi_{b(i),t+1}, \beta, \lambda, \Delta\right) = \\ &ARGMAX_{\ X \in \chi} E_t\left[\ \pi_{i,t+1}(X) + \Pi_{b(i),t+1}(X)\ \right] = \\ &ARGMAX_{\ X \in \chi}\left[\ \pi_{i,t}(X) + \Pi_{b(i),t}(X)\ \right] \end{aligned}$$

elements of the two state vectors, π and Π (or just $\tilde{\pi}$), can also influence the decision. Noting that $E_t\tilde{\pi}_{t+j}(F)=\tilde{\pi}_t(F)\ \forall j\geq 0$ and $E_t\tilde{\pi}_{t+j}(N)=\tilde{\pi}_t(N)\ \forall j\geq 0$, a naive decision rule might be: Move iff $(\pi_t(F)-\pi_t(N))(\beta+\beta^2\ldots\beta^{T-t})>\Delta$ where T is the last year before retirement. This rule would be optimal if the individual did not have the option of migrating at a later date. But the rule is not optimal in general since in some cases it may be better not to move even if the above condition is met but rather wait and perhaps move at a later time period. By not moving, the individual settles for a lower expected payoff in the next period but can expect to gain instead an even better best alternative to *N* than *F*, and thus a higher payoff, in consecutive periods. Although the expected shock to the payoff to an individual in any given location, including of course the location that is the best alternative this period, is zero, the expected change in the one time payoff in her best alternative can be positive. The reason is that the best alternative next period may be other than the best alternative this period, thus:

Lemma 2

$$E_t MAX_{X\in\chi}\left[\pi^i_{t+1}(X)+\Pi_{t+1}(X)\right]\geq MAX_{X\in\chi}\left[\pi^i_t(X)+\Pi_t(X)\right]$$

Proof: This is a straightforward application of Jensens inequality.

In particular, the inequality will be strict unless no village can overtake the present best alternative in one time period, i.e. unless: $MAX_{X\in\chi,X\neq F}\left[\tilde{\pi}_t(X)\right]+1+\lambda<\tilde{\pi}_t(F)-1-\lambda$ where $F=ARGMAX_{X\in\chi}\left[\tilde{\pi}_t(X)\right]$.

This 'rising expectations' effect may mean that it is optimal for an individual to 'wait and see'.[55] The benefits from waiting depend on the expected increase over time in the one time payoff in the best alternative village for the individual. The rising expectations effect does not crop up if no village can overtake *F* in the time left until retirement, i.e. if

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[55] In addition, by waiting (not moving) the individual gains more information on the future path of $\tilde{\pi}$ (*N*) and $\tilde{\pi}$ (*F*) and this information is valuable, in particular it is more valuable if he has not moved. The effects of this also encourage the individual to 'wait and see'.

$\tilde{\pi}_t(S)+(T-t-1)(2+2\lambda)\leq\tilde{\pi}_t(F)$. The rising expectations effect is greater the more villages have payoffs close to $\tilde{\pi}_t(F)$ and the more years there are left until retirement.

A simple and, we hope, reasonable decision rule might therefore only take into account the payoffs at the current location, the best alternative and perhaps one or more of the runners up in addition to the age of the individual and the structural parameters. Such a decision rule would implicitly be based on an approximation to the real value function like the following, where we are assuming that an individual only takes into account the payoffs at her present location, her best alternative and first runner up but disregards all options that rank below second best:[56]

(11)

$$\begin{aligned}
&V(\tau,\tilde{\pi}_t(N),\tilde{\pi}_t(F),\tilde{\pi}_t(S),\beta,\lambda,\Delta)=\tilde{\pi}_t(N)+\\
&MAX\Big[E_t\beta\cdot V(\tau+1,\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\cdot),\\
&E_t\beta\cdot V(\tau+1,\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\tilde{\pi}_{t+1}(N),\cdot)-\Delta\Big]=\tilde{\pi}_t(N)+\\
&MAX\Bigg[\oint_{\xi_X\in[-1-\lambda,1+\lambda],X\in\{N,F,S\}}\beta\cdot V(\tau+1,\tilde{\pi}_t(N)+\xi_N,\tilde{\pi}_t(F)+\xi_N,\tilde{\pi}_t(S)+\xi_N,\cdot)f(\xi)d(\xi),\\
&\oint_{\xi_X\in[-1-\lambda,1+\lambda],X\in\{F,S,N\}}\beta\cdot V(\tau+1,\tilde{\pi}_t(F)+\xi_N,\tilde{\pi}_t(S)+\xi_N,\tilde{\pi}_t(N)+\xi_N,\cdot)f(\xi)d(\xi)-\Delta\Bigg]
\end{aligned}$$

With this simplification the dimension of the problem has been drastically reduced, instead of needing a 61-fold integral a triple integral is needed, over $\tilde{\pi}_{t+1}(N)$, $\tilde{\pi}_{t+1}(F)$ and $\tilde{\pi}_{t+1}(S)$. Furthermore, we can make use of the fact that individuals only care about the difference in payoffs, not levels, when deciding whether or not to migrate. Thus we can normalize by e.g. assuming that the payoff in the present location, village *N*, is always equal to zero. This involves rewriting the value function as follows:

Lemma 3

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[56] Strictly speaking, the maximum should be taken over three alternatives. The omitted alternative is only relevant when $\tilde{\pi}(N)\geq\tilde{\pi}(S)$. If that is the case then a person who moves to village *F* will expect to have going back to *N* as her best migration option instead of moving to village *S*.

$$V\left(\tau,\tilde{\pi}_t(N),\tilde{\pi}_t(F),\tilde{\pi}_t(S),\cdot\right)\equiv V\left(\tau,0,\tilde{\pi}_t(F)-\tilde{\pi}_t(N),\tilde{\pi}_t(S)-\tilde{\pi}_t(N),\cdot\right)+\tilde{\pi}_t(N)\cdot\frac{1-\beta^{\bar{\tau}-\tau+1}}{1-\beta}$$

Where $\bar{\tau}$ is the age of retirement. For proof of this proposition, see Appendix B.

This property means that a double instead of a treble integral is now needed to find the value function and thus the decision rule. In particular we use the fact that the expected shock to $\tilde{\pi}(N)$ is zero and integrate over $\left(\tilde{\pi}_{t+1}(F)-\tilde{\pi}_{t+1}(N)\right)$ and $\left(\tilde{\pi}_{t+1}(S)-\tilde{\pi}_{t+1}(N)\right)$ instead of integrating over $\tilde{\pi}_{t+1}(N)$, $\tilde{\pi}_{t+1}(F)$ and $\tilde{\pi}_{t+1}(S)$:

(12)

$$V\left(\tau,\tilde{\pi}_t(N),\tilde{\pi}_t(F),\tilde{\pi}_t(S),\beta,\lambda,\Delta\right)=\tilde{\pi}_t(N)+$$
$$MAX\left[E_t\beta\cdot V\left(\tau+1,\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\cdot\right),E_t\beta\cdot V\left(\tau+1,\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\tilde{\pi}_{t+1}(N),\cdot\right)-\Delta\right]$$
$$=MAX\left[\oint_{\xi_j\in[-2-2\lambda,2+2\lambda],j\in\{FN,SN\}}\beta\cdot V\left(\tau+1,0,\tilde{\pi}_t(F)-\tilde{\pi}_t(N)+\xi_{FN},\tilde{\pi}_t(S)-\tilde{\pi}_t(N)+\xi_{SN},\cdot\right)g(\xi)d(\xi),\right.$$
$$\left.\oint_{\xi_j\in[-2-2\lambda,2+2\lambda],j\in\{FN,SN\}}\beta\cdot V\left(\tau+1,\tilde{\pi}_t(F)-\tilde{\pi}_t(N)+\xi_{FN},\tilde{\pi}_t(S)-\tilde{\pi}_t(N)+\xi_{SN},0,\cdot\right)g(\xi)d(\xi)-\Delta\right]$$
$$+\tilde{\pi}_t(N)\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta}$$

The g functions represent the pdf's of the various shocks (they also depend on λ and λ^*). Their properties and the method used to evaluate them are discussed in Appendix C. An individual of age τ in village N at time t whose best alternative is village N and second best village S will evaluate the expected value function one year from now, if the individual moves, $E_tV\left(\tau+1,\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\tilde{\pi}_{t+1}(N),\cdot\right)$, and compare it to the expected value function if he does not move, $E_tV\left(\tau+1,\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\cdot\right)$. The decision rule is move iff

(13)

$$\beta\cdot E_tV\left(\tau+1,\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\tilde{\pi}_{t+1}(N),\cdot\right)\text{-}\Delta>\beta\cdot E_tV\left(\tau+1,\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\cdot\right)$$

Solving

(14)

$$\beta\cdot E_tV\left(\tau+1,\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\tilde{\pi}_{t+1}(N),\cdot\right)\text{-}\Delta=\beta\cdot E_tV\left(\tau+1,\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(F),\tilde{\pi}_{t+1}(S),\cdot\right)$$

allows us to find the cutoff points where the benefits of moving are equal to the costs as: $F^* = \Phi_2\left(\tilde{\pi}(N), \tilde{\pi}(S), \tau, \lambda, \beta, \Delta\right)$. The subscript on Φ denotes that it is based on looking at the two best alternatives. Note that adding a constant to both $\pi(N)$ and $\pi(S)$ will call for the same change in F^*:

(15)

$$F^* = \Phi_2\left(\tilde{\pi}(N), \tilde{\pi}(S), \tau, \lambda, \beta, \Delta\right) = \Phi_2\left(\tilde{\pi}(N) + k, \tilde{\pi}(S) + k, \tau, \lambda, \beta, \Delta\right) - k \;\forall\; k$$

Proof: This follows directly from Lemma 3 and the definition of Φ_2.

Since the *U* function can not be evaluated directly, it is not feasible to compare the decision rule implied by Φ_2 to the 'correct' decision rule Φ_{61}, i.e. one that is based on the *U* value function rather than the *V*, and use the comparison to test how reasonable the approximation is. It should be kept in mind though that, even if the decision rule implied by Φ_2 is strictly speaking incorrect, the estimation process described in Chapter 3 forces the decision rule found to produce results that mimic the data and, since the 'correct' decision rule by definition does the same, they will have to have similar characteristics. There is however a difference, given the same values of the of state variables and structural parameters, they will not always lead to the same decision for a given individual. Furthermore, if we could estimate structural parameters and the shocks that have hit the system based on Φ_{61}, they would differ from those estimated using Φ_2.

Since it is not feasible to find Φ_{61} it is not possible to figure out exactly how often the decision rule used errs but it is possible to get some indication of it. This was done by constructing an ever cruder decision rule, Φ_1, based only on the payoff in the current location and the best alternative (ignoring the second best alternative). Fig. 11 shows graphically how the two decision rules compared for an individual of a given age. Φ_2 recommends moving if the (simulated) state variables correspond to a point in either region I or II, Φ_1 recommends moving for a point in either region I or III. The results were quite encouraging, when simulations were run these two decision rules suggested the same action 98.5% of the time, i.e. the simulated state variables corresponded to a point in either region I or IV. Most of the time individuals were not even close to deciding to migrate using either rule so it would be surprising if the rules had not agreed in most cases but the percentage is still formidable. In the cases when the simpler decision rule gave a different result than the original one the results were almost equally divided between the simple one suggesting a move when the original rule did not and the other way around. This seems to suggest that taking into account alternatives beyond the first best alternative has little effect on the decision rule and by extension that ignoring all but the two best alternatives can still result in a decision rule that closely mimics the 'correct' one. For the sake of this comparison the same shock estimates were fed to Φ_1 and Φ_2 but scaled to take into account the different λ estimates.

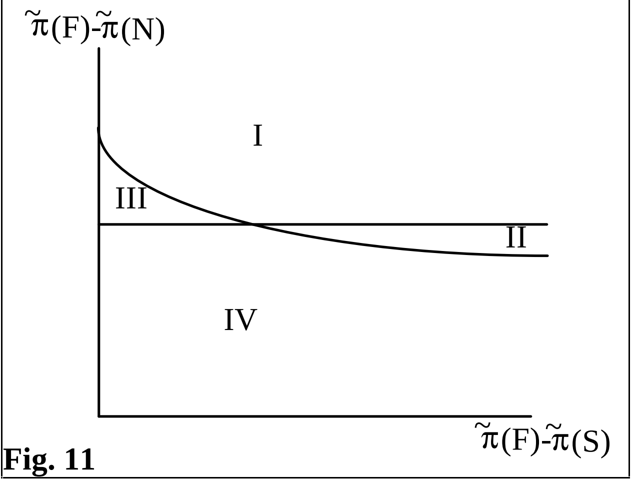

Fig. 11

Note that ignoring villages that are not among the best alternatives at present introduces a downward bias in the value function for any given structural parameters. (For details, see Appendix D.) This does however affect both the value function at the present location and at the current best alternative village. This reduces the likelihood of an individual using Φ_2 making the wrong decision due to the bias. It does though not eliminate the problem since the bias is likely to be lower for the value function in the best alternative village than in the present location. The reason is that individuals are less likely to move again if they have just moved to the village that has the highest one-term payoff for them and consequently it is of less importance to them what their outside options are.

Given the same structural parameters Φ_1 will suggest moving more frequently than Φ_2. If Φ_2 is used then at any given age the minimum gap needed between the payoff in the current location and the best alternative to induce migration will be higher the closer the second best alternative is to the first best alternative. Using Φ_1 instead is equivalent to assuming that the village that is now the second best alternative is so much worse than the first best alternative that it can not become the first best alternative in the time that is left until retirement. Fig. 12 shows this graphically. The two decision rules agree if the state variables correspond to a point in regions I or III but Φ_1 suggests migrating for a point in region II while Φ_2 does not. This is one reason why estimating the structural parameters should lead to somewhat different results depending on whether Φ_1 or Φ_2 is used. In particular, one would expect that the estimate for the cost of relocation, Δ, would be higher when Φ_1 is used than when Φ_2 is used. Graphically, increasing Δ shifts the horizontal line depicting the decision rule suggested by Φ_1 in Fig. 12 upwards. Since Φ_2 and Φ_1 have to result in a similar number of people migrating the horizontal line will have to be shifted upwards until the relationship between Φ_2 and Φ_1 looks like the one in Fig. 11.

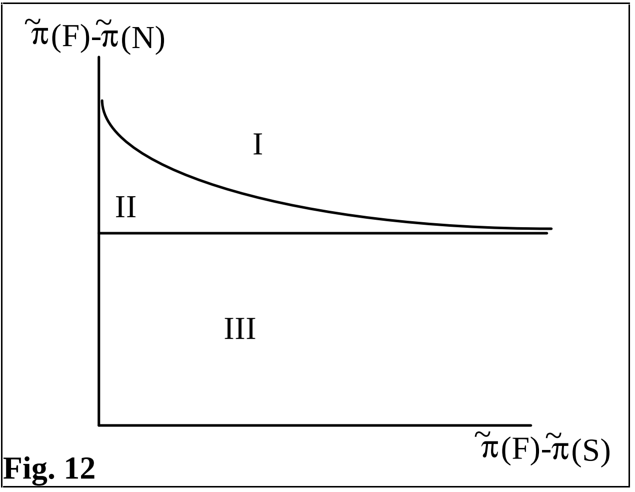

Fig. 12

The structural parameter estimates were quite similar for either kind of decision rule except that, as expected, the estimate for Δ was somewhat higher when Φ_1 was used. Since it does not seem to have a great effect to take the second best alternative into account in addition to the best alternative when estimating the decision rule it is tempting to reason that adding alternatives ranked lower than the second best will not have a great effect either.[57] This is of course a weak test of the validity of using *V* instead of *U* but does provide some support for the validity of ignoring the likelihood of moving in the future to a village that is not among the most promising alternatives at present.

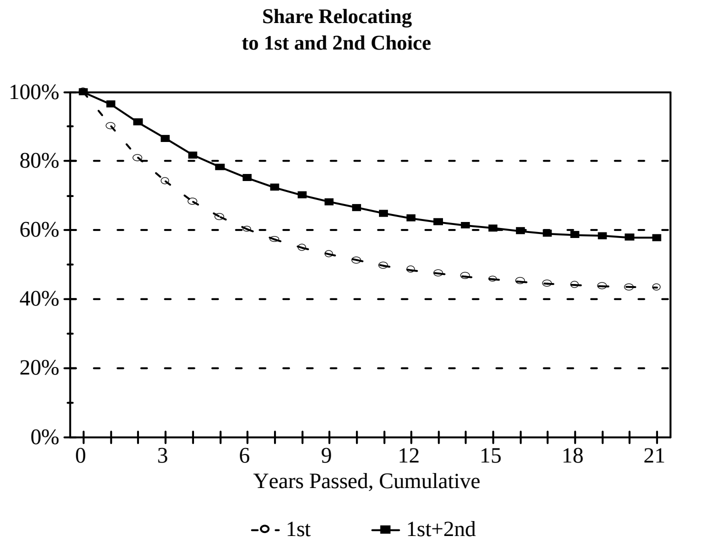

Fig. 13

In addition, it can be argued that, since it is not feasible to calculate *U* directly, it is natural to assume that the subjects of the study will base their decisions on simpler tools such as *V*. Even if it were possible to calculate Φ_{61}, given all relevant information, it can be argued that assuming that individuals have perfect information about expected payoffs in all potential locations is unreasonable, since gathering this information would be

[57] Note the similarity of this method to well known methods for determining e.g. how many periods' worth of lagged variables to use in an econometric estimation or what degree polynomial to use to approximate a particular function. More villages (degrees, lags) are added until the last addition has little effect.

prohibitively expensive. The model used here does not incorporate any search costs but if they are substantial one would expect that people only take into account the payoffs in a few locations when deciding whether to migrate.

The simulations did allow for checking how frequently the ranking of the best alternatives to the present location changed. If the ranking of the best alternatives changes relatively little that should provide support for not looking very closely if at all at those villages not ranked close to the top since it is unlikely that an individual will ever consider moving to them. In a few simulations run a count was made of how often an individual would move to a village that is his first or second best alternative in a given year and how this changed as more years passed from the time of the ranking. It turned out that an individual who did move would in 92% of the cases move to a village that had been ranked as either the first or second best alternative the year before. As expected this percentage fell as more years passed from the time of the ranking but still a high percentage of all relocations was to villages that had been ranked either first or second even if several years had passed since the ranking. In a ten year period, 68% of all relocations were to villages that had either been ranked first or second at the beginning of the period. Over a twenty year period, the share was 58%. Fig. 13 shows how large a share of the population that has moved since a ranking moved to a village that was ranked first or second and how this share changed as more time passed from the ranking.

3. Estimation

This part describes the methods used to estimate the parameters of the model. This turns out to be a computationally hard problem but the steps outlined in the previous chapter make it feasible in a reasonable amount of time. The most important innovation is to focus only on a specific subset of the alternatives open to an individual deciding whether or not to migrate.

There has been considerable research interest, both theoretical and empirical, in recent years in discrete decision models similar to the one presented here. Recent overviews of the empirical literature are provided in Pakes [1994] and Rust [1994]. The estimation method used here is based on the Method of Simulated Moments as described by McFadden [1989] and Pakes and Pollard [1989].

The first step towards estimating the parameters of the model was to write a computer program to find the Φ_2 function for a given combination of λ, Δ and β . This turned out to be feasible in a reasonable amount of computing time.[58]

A second program was then written to simulate the behavior of the model for any given combination of λ, Δ, β, J and α. This program was run iteratively for a given combination of the structural parameters until a common shock vector, ξ_t^1, was found for every year that resulted in the net changes in the population of the various villages observed in the data for that year. The data is annual for the time period 1970-1994 with one additional measurement in 1960. Since there were no measurements available between 1960 and 1970 it was impossible to estimate the shocks for individual years in that time

[58] The program, like most programs used for the calculations discussed in the paper, was written in Fortran. It took a little under an hour on a Pentium Pro 200 class computer to find Φ_2 for a given combination of λ, Δ and β. It took a few seconds to find Φ_1.

period so instead I found one vector of shocks that when applied every year from 1960-70 resulted in the net changes in population observed over the whole decade.[59]

Informally, ξ_t^1 was found by solving the following equation for all the villages at the same time, one time period at a time moving forward in time:

(16)

Number of people of working age in village *X* at time *t*, estimated from data

= Number of simulated people of working age in village *X* at time *t*

≡ Number of simulated people of working age or one year younger in village *X* at time *t-1* that do not move to another village and neither die nor retire in year *t*

+ Number of simulated people of working age or one year younger in other villages than *X* at time *t-1* that move to village *X* in year *t* and neither die nor retire in year *t*.

More formally, ξ_t^1 was found by solving:

(17)

$$P_t^S\left(\xi_t^1,\cdot\right) = P_t^O$$

Where *P* is a vector with 61 elements, each corresponding to the population of working age in a given village, *S* denotes simulation and *O* observation (data). Furthermore, for any village *X*:

(18)

$$\begin{aligned} P_{X,t}^S\left(\xi_t^1,\cdot\right) = & \sum_{i\in W_t(z)} I\left(\tilde{\pi}_{X,t}^i > \Phi_2\left(\tilde{\pi}_{N_i,t}^i, \tilde{\pi}_{S_i,t}^i, \cdot\right)\right)\cdot I\left(X = F_i\right) \\ & + \sum_{i\in W_t(z)} I\left(\tilde{\pi}_{F_i,t}^i \le \Phi_2\left(\tilde{\pi}_{X_i,t}^i, \tilde{\pi}_{S_i,t}^i, \cdot\right)\right)\cdot I\left(X = N_i\right) \end{aligned}$$

where W_t is the set of individuals of working age that are alive at time *t*, *z* denotes the pseudo-random number sequence (in practice, the seed of the pseudo-random[60] number

[59] There are of course more factors than migration that cause changes in net population, namely births and deaths. In the simulations run it was assumed that the number of births in a given village would in any year be equal to the number of births in the whole country in that year times the proportion of the population living in that village. The likelihood of any individual dying was based on data on the number of people alive born in a given year for several years between 1960 and 1992.

[60] The pseudo-random number generator used for the simulations reported is called the Park-Miller generator with a Bays-Durham shuffle as reported in Press et. al. [1992]. Using a more sophisticated

generator) used to generate the idio-syncratic shocks and to decide which simulated individuals die and when. N_i is the location of individual i at the end of the previous time period and F_i and S_i are his first and second best alternatives as before:

(19)

$$F_i = ARGMAX_{\ Y \in \chi}\left(\tilde{\pi}_t^i(Y)\right)$$

(20)

$$S_i = ARGMAX_{\ Y \in \chi, Y \neq F_i}\left(\tilde{\pi}_t^i(Y)\right)$$

Finally, $\tilde{\pi}_t^i$ denotes the sum of the individual and cohort specific payoffs for individual i as before:

(21)

$$\tilde{\pi}_t^i = \pi_t^i(z,\lambda) + \Pi_t^{b(i)}\left(\xi_t^1;\xi_{t-1}^1,\xi_{t-2}^1\ldots\xi_{1960}^1, J\right) = \pi_t^i(z,\lambda) + \xi_t^1 + \sum_{j=b(i)-J}^{t-1}\xi_j^1$$

where *b(i)* is the birthyear of individual *i*.

The solution to (17) was found using an iterative procedure, starting with a guess for ξ_t^1 and finding P_t^S based on that. This was then compared to the data and the elements of ξ_t^1 lowered that corresponded to villages that had more simulated than real inhabitants and the elements of ξ_t^1 that corresponded to other villages increased. The system was then simulated again based on the new ξ_t^1 and a new P_t^S found. This process was repeated until P_t^S was deemed sufficiently close to P_t^O.[61]

The resulting estimates are not unique, i.e. not the only ones that could have generated the data given the structural parameters and the particular pseudo-random number

---

pseudo-random number generator seemed to have a comparable effect on the simulations as that of changing the seed of this generator.

[61] In practice it took too long to make the simulations match the data exactly. Instead I settled for a total error of approximately 50 individuals, i.e. the sum over all villages of the absolute difference between the target population in a village and the population in that village in the simulation was not much above 50 in any given year. It was feasible to reduce this error to zero by increasing the number of iterations but not judged worthwhile since this involved minuscule changes in the shock estimates and took considerably longer.

sequence used for the idio-syncratic shocks, but this did not cause significant problems in practice. Discussion of the uniqueness of the estimates can be found in Appendix E.

A greater problem is that a common shock matrix that fits the data can be found for many different combinations of the structural parameters. The structural parameters are therefore not identified. More detailed data that was available for the years 1990-92 was used to identify them.[62] The criteria used for finding the structural parameter values was that simulations based on them would match as closely as possible, not only the net changes in population for all villages for all the years in the data as described before, but also two additional characteristics of the more detailed data for 1990-92:[63]

i) The number of people relocating in each of the three years in each of nine age groups (gross migration). Each age group was formed by grouping 5 cohorts together.
ii) The sum over all villages of the absolute change in the population in each age group in each village due to migration (net migration).

This resulted in the following target function:

(22)

$$\left|G_R\left(\omega_{2,R}\right)\right| = \sqrt{\sum_{y=1990}^{1992} \sum_{a=1}^{9} \sum_{c=g,n} \left[d_c^o\left(y,a\right) - d_c^s\left(y,a,\omega_{2,R}\right)/R\right]^2}$$

$\omega_{2,R}$ is the vector of structural parameters to be estimated, R is the ratio between the number of simulated individuals and the number of individuals that generated the data. $d_c^x\left(y,a,\cdot\right)$ is the number of people in age group a observed migrating in year y where $c=g$ indicates gross migration and $c=n$ net migration, $x=o$ indicates the observed data and $x=s$

[62] For this purpose I got data from Hagstofa Íslands (Statistical Bureau) that detailed how many people had migrated from any given village to any other given village and their age (grouped together 5 cohorts at a time). This data was available for the years 1990-92. The results were quite similar for all three years.

[63] Running the model for 1960-89 thus serves to solve the 'initial conditions' problem, i.e. it sets the system up in a reasonable state at the beginning of 1990. The common shock estimates that are the 'byproduct' of simulating the system prior to 1990 are also used later when simulating the effects of government policies.

indicates simulation. G is thus a vector of 3·9·2 or 54 elements. $|\cdot|$ denotes the Euclidean norm of a vector. The subscripted 2 denotes that the underlying decision rule is based on Φ_2 i.e. looking at only the two best alternatives. The estimation algorithm searched for $\hat{\omega}_{2,R} = ARGMIN_{\omega\in\Omega}\left|G_R(\omega)\right|$.

The algorithm used to minimize the target function was based on a crude grid search and then steepest descent search. The search was very computationally intensive since each function evaluation took several hours. This type of search does however scale well for parallel processing and was run on more than one computer. All the simulations run would have taken approximately three weeks on a single Pentium Pro 200 class computer. The criteria for stopping the iterations was that an approximately 1% perturbation in either direction of any of the five parameters would lead to an increase in the target function.

The number of simulated agents in each simulation run was the same as the population generating the data, so R was equal to 1. Since the rate at which gross movements integrate out and generate the net movements depends directly on the size of the population for small samples, it was not possible to pick a small R to speed up the simulations.[64] It would however have been possible to pick R>1, i.e. simulate a sample of this size several times using independent pseudo-random number sequences and take the average over the simulations. This would have reduced the standard errors of the

[64] The ratio at which the gross movements net out should converge to a specific number as the sample size goes to infinity. 150,000 may seem like a large sample but since it is distributed very unevenly over 61 villages and nine age groups there are only a few and sometimes no observations in some of the 'cells'. To make things even worse, only about 10% of the sample relocates in any given year. Under these circumstances, significantly reducing the sample size can be expected to have a clear impact on the ratio between net and gross movements. This was confirmed by attempts at basing the simulations on a substantially reduced sample. The ratio between net and gross movements was consistently higher for such a sample than for a simulation based on a sample the size of the population, other things being equal. This should be kept in mind when looking at the estimated standard errors of the structural parameters since the error estimates are based on the asymptotic behavior of the parameter estimates as the sample size goes to infinity.

parameter estimates but was not done since the calculations were already very time consuming and the estimated standard errors based on one run quite small.

To find out the statistical characteristics of the parameter estimates, $\hat{\omega}_{2,R}$, we use a result from Pakes and Pollard [1989]. For this purpose we introduce the following notation:

Let ω_2^0 denote the true parameters, i.e. the structural parameters that actually generated the data.[65] Let the vector valued function $G(\omega_2)$ denote the deviation of each target point ($d(\cdot\ )$ above) from the corresponding true $d^{true}(\cdot\ )$ when the system is governed by the structural parameters ω_2 and subjected to the same idio-syncratic shocks that generated the data. Note that $G(\omega_2^0) = 0$. Let $G_R(\omega_2)$ denote the random equivalent of $G(\omega_2)$ for fixed R.

Pakes and Pollard show that if the following conditions hold:

i) $\|G_R(\hat{\omega}_{2,R})\| \leq o_p(1) + \inf_{\omega_2 \in \Omega} \|G_R(\omega_2)\|$

ii) $G_R(\omega_2^0) = o_p(1)$

iii) $\sup_{\|\omega_2 - \omega_2^0\| > \delta} \|G_R(\omega_2)\|^{-1} = O_p(1)$ for each $\delta > 0$.

iv) $\|G_R(\hat{\omega}_{2,R})\| \leq o_p(h^{-1/2}) + \inf_{\omega_2 \in \Omega} \|G_R(\omega_2)\|$

v) $G(\cdot\ )$ is differentiable at ω_2^0 with derivative matrix Γ of full rank.

vi) For every sequence $\{\delta_h\}$ of positive numbers that converges to zero,
$$\sup_{\|\omega_2 - \omega_{2,R,h}\| < \delta_h} \frac{\|G_R(\omega_2) - G(\omega_2) - G_R(\omega_2^0)\|}{h^{-1/2} + \|G_R(\omega_2)\| + \|G(\omega_2)\|} = o_p(1)$$

vii) $\sqrt{h}\,G_R(\omega_2^0) \xrightarrow{d} N(0,V)$

viii) ω_2^0 is an interior point of Ω.

Then:
$$\sqrt{h}\left(\hat{\omega}_{2,R} - \omega_2^0\right) \xrightarrow{d} N\left(0, (\Gamma'\Gamma)^{-1}\Gamma' V \Gamma (\Gamma'\Gamma)^{-1}\right)$$

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[65] Note that we are here implicitly assuming that the model is correctly specified, in particular that individuals only take into account their two best alternatives.

$\xrightarrow{d}$ denotes convergence in distribution. The sequence a_h of random variables is $O_h(1)$ if for a given $\varepsilon>0$ there exists a δ such that Prob($|a_H|>\delta$) $< \varepsilon\ \forall\ H$. The sequence is $o_h(1)$ if it converges in probability to zero.

Conditions i)-iii) are sufficient for Pakes' and Pollard's Theorem 3.1 to hold, it shows that $\hat{\omega}_{2,R}$ converges in probability to ω_2^0. Adding conditions iv) through viii) allows them to derive their Theorem 3.3 which determines the asymptotic distribution of the simulation estimator.

A numerical estimate of the 54x5 matrix Γ was based on the results from the final perturbations used to check that the parameter estimates produce a minimum of the target function.

To find the 54x54 matrix V, it is useful to break $\sqrt{h}G_R\left(\omega_2^0\right)$ into two components as follows:

(23)

$$\sqrt{h}G_R\left(\omega_2^0\right) = \sqrt{h}\left[d^o\left(\omega_2^0\right) - d^{true}\left(\omega_2^0\right)\right] - \sqrt{h}\left[d^s\left(\omega_2^0\right) - d^{true}\left(\omega_2^0\right)\right]$$

The first term on the right hand side, V_d, represents the variability induced by the idio-syncratic shocks that generated the data. The second term on the right hand side, V_s/R, represents the variability induced by the simulated idio-syncratic shocks. The second term was estimated by repeated sampling using the previously estimated structural parameters and several different pseudo-random number sequences to generate the idio-syncratic shocks. The resulting $\hat{V}_s$ should indicate the variability of the target results due to the simulated idio-syncratic shocks. If the model is correctly specified, each simulation mimics the data generation process so $\hat{V}_s$ can also be used as an estimate of V_d. This led to the following estimate for V:

(24)

$$\hat{V} = \hat{V}_d + \hat{V}_s / R = \left(1 + 1/R\right)\hat{V}_s$$

The simulations showed that the interaction of the terms in ω_2 is quite complex but, as expected, β had the most direct effect on the age profile, Δ on gross migration and λ on the ratio between gross and net migration. The results were less sensitive to the choice of the remaining two parameters, J and α, as was reflected in relatively higher standard error estimates. The structural parameter estimates were as follow, with standard errors in parenthesis: β=0.95 (0.00078), Δ=8.4 (0.0066), λ=0.48 (0.00084), J=8.0 (0.069) and α=0.73 (0.0021). The standard errors are fairly small as is to be expected.[66] With a sample of approximately 150,000, the idio-syncratic errors are integrated out to a large degree and thus the elements of the estimated variance-covariance matrix $\hat{V}$ quite small.

The results for the common shock matrix are noted in Table I (at the back of paper). The numbers in Table I are averages based on 5 simulations, each using a different pseudo-random number sequence.

The standard errors reported in Table I for the shock estimates are based on a separate set of simulations. To calculate the standard errors, several vectors of random samples of structural parameters were generated with the mean of the population drawn from equal to our vector of structural parameter estimates. The sampling distribution was pseudo-normal and the standard errors used for the draws were based on our standard error estimates for the structural parameter estimates. Each set of structural parameters that had been selected at random was then used to calculate different shock estimates, using a different seed for the random number generator generating the idio-syncratic shocks every time. Finally, the differences between the resulting shock estimates were used to estimate the standard error of our previous shock estimates. Due to computer-time constraints only eight independent simulations were run for this calculation.

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[66] The standard errors estimates implicitly assume that the final perturbations to check that the search algorithm has converged are infinitesimal. This is however infeasible and the final perturbations used were quite coarse compared to the standard error estimates. This should be kept in mind when assessing the accuracy of the structural parameter estimates.

The extra step described above of drawing pseudo-random structural parameters was necessary since estimates of the standard errors of the shock estimates that are based only on the results of varying the seed for the random number generator will not take into account the effects of the expexcted error of the structural parameter estimates and thus be downwards biased. The estimated standard errors of the shock estimates vary somewhat between villages and tend as expected to be largest for the smallest villages.

Without further assumptions it is hard to say anything about the relationship between $\hat{\omega}_2$ and ω_{61}, the parameter vector that actually generated the data if one assumes that individuals take all alternatives into account when making their migration decisions. It is not feasible to find $\hat{\omega}_{61}$ but one can get some indication of how dependent $\hat{\omega}_\rho$ is on ρ by looking at how $\hat{\omega}_\rho$ changes with ρ for very small values of ρ. In particular it turned out to be straightforward but almost as computer-time consuming to find $\hat{\omega}_1$ as it was to find $\hat{\omega}_2$. It seems feasible to find $\hat{\omega}_3$ in a reasonable amount of time using the methods used for $\hat{\omega}_1$ and $\hat{\omega}_2$. The main hurdle is that it can be expected that finding Φ_3 will take at least an order of magnitude more computations than finding Φ_2.

Table II

Parameter	$\hat{\omega}_1$	**S.E.**	$\hat{\omega}_2$	**S.E**
β	0.94	0.0018	0.95	0.00078
Δ	9.2	0.021	8.4	0.0066
λ	0.46	0.0035	0.48	0.00084
J	8.2	0.030	8.0	0.069
α	0.75	0.0027	0.73	0.0021

Using the technique described above for $\hat{\omega}_2$ to find $\hat{\omega}_1$ gave the following result: β=0.94 (0.0018), Δ=9.2 (0.021), λ=0.46 (0.0035), *J*=8.2 (0.030) and α=0.75 (0.0027). As expected, all the parameter estimates except the one for Δ were quite similar to their counterparts in $\hat{\omega}_2$. The difference between $\hat{\omega}_1$ and $\hat{\omega}_2$ is however clearly statistically significant given the low standard error estimates. As mentioned before, the standard error estimates do not take into account the relatively crude stopping criteria for the search algorithm but taking those into account as well is not enough to explain the difference.

The estimate for λ indicates that most of the shocks that people experience are idio-syncratic (λ^*=1) as opposed to common (λ=0.48). It is not apparent how to convert Δ to pecuniary terms but it can be noted that its estimate is quite high compared to that of the shocks that people experience to their annual income. Relocating thus seems to call for substantial expenditure.

To get an indication of how costly it seems to be to move one can look at the expected shock in absolute terms each year to annual income for a person that does not move:

(25)

$$\text{Expected shock} = \int_{-1}^{1}\int_{-\lambda}^{\lambda}\left|\xi^1+\xi^2\right| pdf_1(\xi^1)\, pdf_2(\xi^2)\, d\xi^2 d\xi^1$$

It is straightforward to solve this integral for the pdf's used, the answer is $1/2+\lambda^2/6$. Plugging in the estimate for λ gives an expected shock of 0.54. When compared to the estimated cost of migrating, 8.4, it is apparent that the latter is quite substantial and the decision to migrate not taken lightly.

This result could be used to justify a government taking some steps towards reducing the variability in shocks in income over villages and in particular to channel funds to marginal areas. On the other hand, even if one assumes that a government can to a degree alleviate the common shocks, it is not clear how government policies can target the idio-syncratic shocks. Since the idio-syncratic shocks seem to be of considerably more importance than the common ones in driving gross migration, this reduces the potential benefits, if any, of government action.

4. Policy Simulations

This part describes how the model and the parameter estimates can be used to simulate the results of government policies aimed at affecting migration. Several examples are provided and the welfare implications of the policies described.

The model allows us to simulate the effects of government policies that aim to influence migration. The share of the population living in the capital area changed little in the 70's after having grown steadily for centuries but resumed growing around 1980 as mentioned in the first chapter. This and the fact that the data mainly covers the period 1970 to 1994 was most important in deciding to try to simulate the effects of potential government intervention aimed at influencing migration in 1980 to 1994. The hope is that this analyzis of the not so distant past can illuminate the effects of policies available at present.

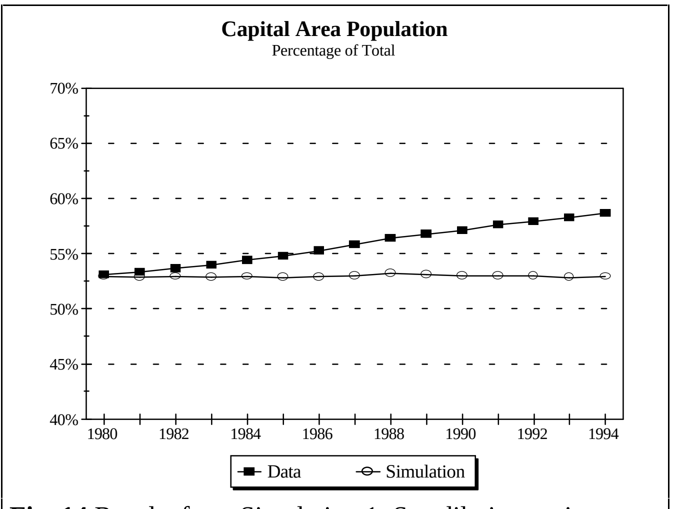

Fig. 14 Results from Simulation 1: Steadily increasing subsidies/taxes favoring rural areas. Maximum subsidy 0.095 per capita.

Several different subsidy schemes for this period were simulated and the effects on net migration to the capital and abroad, gross migration rates and total utility analyzed.[67]

[67] How to construct social-utility functions, in particular how to add up the utility of several individuals, is an age old problem in economics. We will not try to solve this problem here but simply report the results

Two different types of schemes were used, one that provided the same subsidy each year to each individual if he chose to live in a specific region, normally outside the capital area, and another one that provided a steadily increasing subsidy. To make the policy revenue neutral for the government, individuals living in regions that were not subsidized were subjected to a poll tax. In either case the simulated individuals assumed that the current subsidies and taxes would be in effect until they retired. In particular, individuals did not expect an ever increasing tax or subsidy.

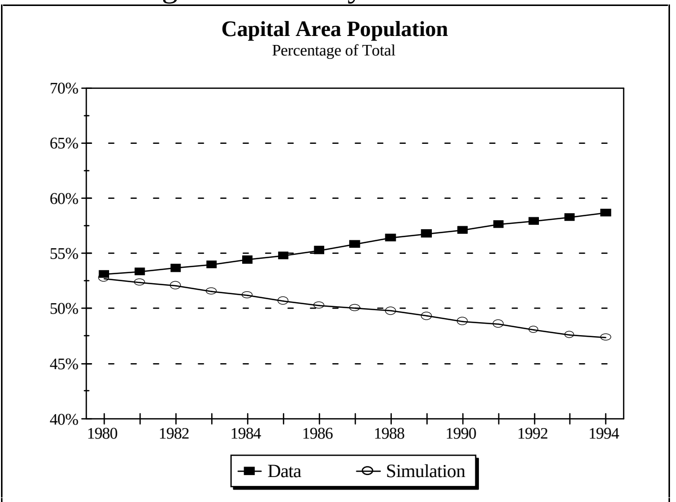

Fig. 15 Results from Simulation 2: Steadily increasing subsidies/taxes favoring rural areas. Maximum subsidy 0.19 per capita.

It turned out that the steadily increasing tax/subsidy schemes clearly dominated the fixed tax/subsidy schemes. The main reason is that the fixed schemes had the effect of inducing people to migrate from the capital in the early 80's and then migrate back towards the end of the period and this was quite costly. We will therefore focus on the results from the increasing tax/subsidy schemes.

Fig. 14 shows the results from the first simulation. Simulation 1 was set up so that the share of the population living in the capital was approximately the same at the end of the period, in 1994, as it was at the beginning, in 1980, or 53%. A subsidy scheme was

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from adding up the utility of all simulated individuals, thus implicitly assuming they all have the same individual utility function and the same weight in the social-utility function.

devised that achieved this goal. Under the scheme the subsidies grew linearly from 0 during the period 1980-94 and were equal to 0.095 per person at the end of the period, the unit of measure being the estimated cost of migration (Δ). The taxes grew similarly, adjusted for the different sizes of the groups receiving subsidies and paying taxes in each year, to neutralize the effects on the government's finances.

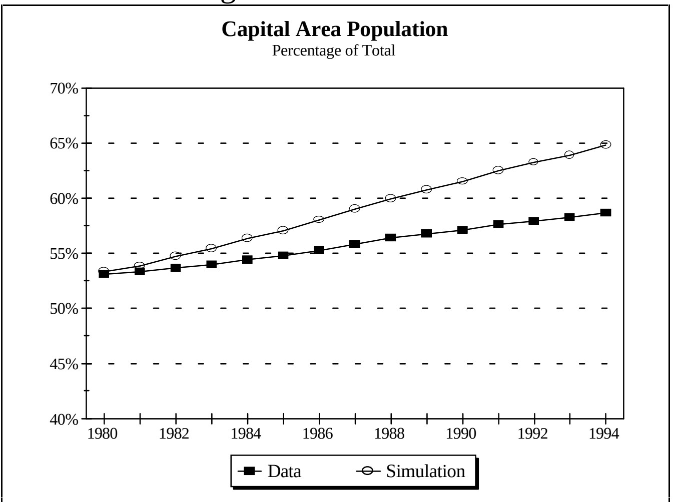

Fig. 16 Results from Simulation 3: Steadily increasing subsidies/taxes favoring the capital region. Maximum subsidy 0.095 per capita.

The results from applying the subsidy scheme were not surprising. The subsidy did somewhat reduce overall migration rates. Gross migration declined by 9,794 or 5.8%. It did however also reduce the flow of utility somewhat.[68] The total reduction in utility due to this was equivalent to the cost of 4,642 people migrating. For comparison, in the base simulation (without taxes/subsidies), a little over 170,000 people migrated in 1980-94.

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[68] The term 'flow of utility' is used here to refer to annual income or $\tilde{\pi}$. The reported changes in the flow of utility due to the implementation of the various government policies discussed refers to the difference between the sum of annual utility for all individuals for the time period 1980-94 for on the one hand the base simulation (without any taxes/subsidies) and on the other hand simulations with taxes/subsidies. The figure reported here for Simulation 1 and comparable figures for the other simulations are based on the sum over all years, without performing any present value calculations. Present value calculations are however performed for the numbers in Table IV.

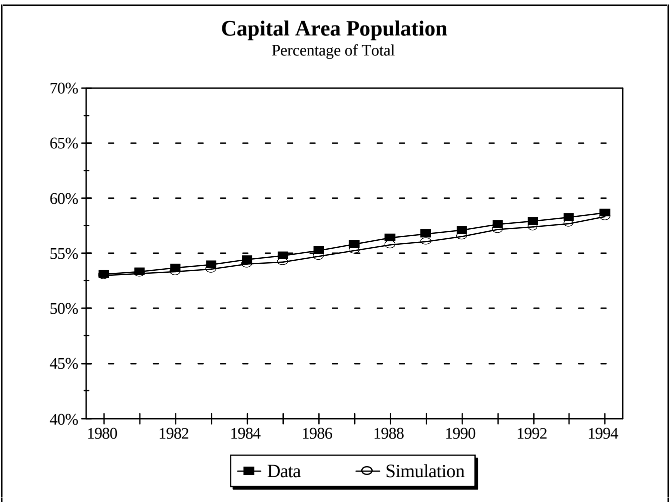

Fig. 17 Results from Simulation 4: An almost threefold increase in the cost of relocation.

The fact that the cost savings due to less migration seem to outweigh the loss in benefits due to the distortion of the subsidies and taxes may seem to suggest that this sort of social engineering can actually increase total utility, even in the absence of externalities. That is however not the case, migrating is a form of investment and under this scheme fewer people invested in migration. This means that in the short run individuals' income seems to go up since fewer people spend resources migrating but in the long run that is not to be expected. In the long run, the savings from reduced migration dwindle but the distortion from having people not move, even if it is socially optimal, becomes gradually worse. In the simulation there was very little difference in the flow of utility in the first years that the subsidies were in effect but the difference had become substantial near the end of the period as individuals were more likely than otherwise to be living in a village that did not have the highest annual utility for them (excluding taxes/subsidies which are only transfer payments and net out).

Calculating the value functions for individuals in 1994 confirmed that individuals would indeed 'invest' less in migrating if the subsidy scheme was in effect than if it was not and thus expected future income was lower. The effect of this easily outweighed any earlier savings due to reduced migration. The program therefore reduced total utility.

Looking at the change over time in the value functions, the flow of utility and migration showed that the distortionary effects of the program increased significantly over time.

Simulation 2 was set up so that the share of the population living in the capital decreased during the period. A similar scheme to that in Simulation 1 was in effect but with the taxes and subsidies doubled. The resulting changes in the population of the capital region are depicted in Fig. 15. The results were as expected, gross migration rates decreased even more than in Simulation 1, by 18,578 or 10.9%. The flow of utility decreased likewise or by 13,532, again using the cost of migration as the unit of measure. Taking into account the change in value functions more than outweighed the initial benefits from reduced cost of migration as in Simulation 1 and this tax/subsidy scheme reduced total utility even more than the one in that simulation.

Fig. 16 shows the results from Simulation 3. In this simulation the taxes and subsidies were reversed so that people were rewarded for moving to the capital area. The maximum subsidy was 0.095 so this scheme was the reverse of the one that Simulation 1 was based on. The results were as expected, the population of the capital area grew even faster than otherwise, gross migration rates increased and the flow of utility increased slightly. In particular, gross migration increased by 12,102 or 7.1% and the flow of utility increased by 3,149 units.

Taking into account the changes in the value functions did however more than outweigh the cost of added migration. The implementation of such a scheme thus seems to increase total utility. This may seem puzzling since a government action that distorts incentives normally does not lead to an increase in utility in economic models without externalities or other factors that can lead to market failure. The explanation is however simple, the tax/subsidy scheme increased utility because it gave individuals incentives to migrate to the capital early in the period. This turned out to be a good 'investment' because conditions improved considerably in the capital region relative to other regions during the period. The government can of course increase utility by providing incentives to invest in projects that perform better than expected or, in our context, migrate to locations where the standard of living improves more than expected. If the government however has information on which investments are going to do better than others, then no special incentives are needed to induce individuals to invest in them, it is sufficient for the government to make this knowledge public.

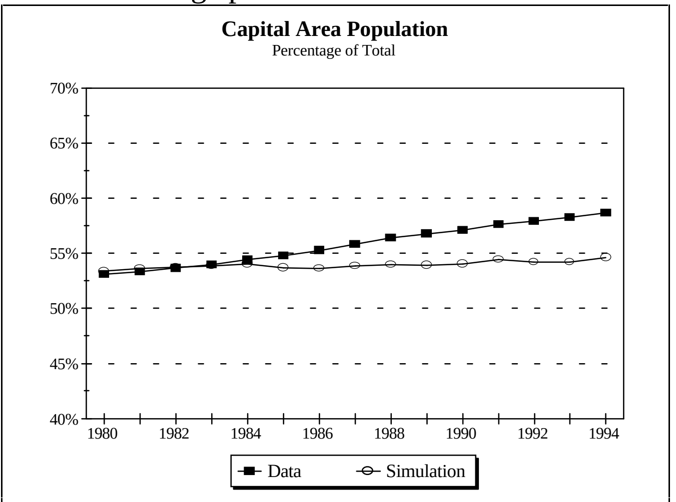

Fig. 18 Results from Simulation 5: An infinite cost of relocation.

It is conceivable that the government can not only subsidize living in certain regions but also tax or subsidize migration *per se*. Several simulations were run changing Δ. The results from only two of them are reported since it became clear quickly that changing Δ was not a very effective tool to affect settlement patterns. Fig. 17 depicts the results from an experiment where the cost of migration was increased to 24 from 8.4. This is a very substantial increase but did not affect the population of the capital region much, it only decreased from 58.7% in the data to 58.3% in the simulated sample. This did however decrease gross migration rates significantly, by 68,045 or almost 40%. The flow of utility also decreased significantly or by 33,515 units.[69] Smaller changes in Δ had even smaller effects on the share of the capital in the total population. The value functions at the end of the period were, as expected, lower than if the government did not intervene since the

[69] The unit of measurement is the same as before, i.e. pre-tax Δ. Likewise, the cost of migration that is used for the welfare analyzis in Table III uses the social cost of migration, not the private cost with tax.

intervention reduced 'investment'. The total effect of the program on utility was fairly small.

Fig. 18 depicts the results from imposing a ban on migration or, equivalently, an infinite Δ. This did of course mean that the share of the population living in the capital region did not change much.[70] The flow of utility decreased drastically or by 313,665 units and the value functions at the end of the period were similarly affected. Of all the policy schemes simulated, this one had by far the most detrimental effect on utility. One can infer from this that the option of migrating is very valuable for many inhabitants.

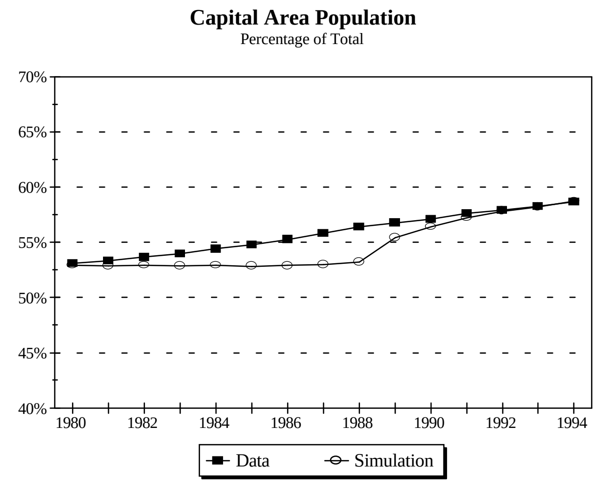

Fig. 19 Results from Simulation 6: Taxes and subsidies in effect for 1980 - 1988. Maximum subsidy 0.054 per capita.

Lowering Δ did not significantly increase net migration to the capital but did somewhat increase gross migration and the flow of utility.

It therefore seems that policies that raise or lower the cost of migration are an ineffective way of controlling net migration. Such policies can however shift the cost of migration and could therefore be used to change income distribution without significantly affecting the population distribution. In particular, subsidies to those who migrate could alleviate some of their cost of migration and shift it to tax payers without significantly affecting settlement patterns.

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[70] It increased slightly in the simulation due to differences in the age composition between the capital region and other areas and thus different birth/death rates.

Finally, attempts were made to assess the consequences of policies that are only in effect for a limited time. Simulation 6 was based on the same policy as Simulation 1 but this time the program of taxes and subsidies was abolished after 1988. Likewise, Simulation 7 was based on the same policy as Simulation 2 until 1988 with no taxes or subsidies after 1988. The resulting effects on the share of the population living in the capital region are depicted in Figs. 19 and 20.

Table III - Result of Simulation

	Capital's share in population 1994	Gross migration	Change in annual utility due to lower flow	Change in total utility
Data/Base Sim.	58.69%	170,236		
Simulation 1	52.93%	160,442	-4,642	5,152
Simulation 2	47.38%	151,658	-13,532	5,046
Simulation 3	64.80%	182,338	3,149	-8,953
Simulation 4	58.32%	102,191	-33,515	34,530
Simulation 5	54.57%	0	-313,665	-143,429
Simulation 6	58.71%	168,924	-951	361
Simulation 7	58.61%	168,326	-3,515	-1,605

The most interesting result from those two simulations was that hysteresis did not prevent the share of the capital region in the total population from eventually becoming almost exactly the same as in the case where taxes/subsidies were never applied. The consequences of the taxes/subsidies were only felt while they were applied and for a few years thereafter but six years or so later their effects had completely vanished.

The consequences for gross migration were fairly small, it decreased by 1,312 or 0.8% in Simulation 6 and 1,910 or 1.1% in Simulation 7. The effects on the flow of utility were also small, it decreased by 951 units in Simulation 6 and 3,515 units in Simulation 7.

Table IV - Accumulated Welfare Effects, in Present Value

	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
1980	-4,967	-12,305	4,600	5,884	7,762	-4,966	-12,305
1981	-11,805	-22,931	9,173	-3,959	-27,098	-11,804	-22,931
1982	-19,057	-33,405	15,184	-10,561	-65,396	-19,057	-33,405
1983	-23,654	-44,903	19,274	-10,038	-103,049	-23,653	-44,903
1984	-29,445	-56,318	26,242	-11,554	-146,279	-29,445	-56,318
1985	-34,682	-70,950	33,857	-7,999	-189,974	-34,681	-70,950
1986	-41,805	-83,830	39,542	-5,342	-236,454	-41,805	-83,830
1987	-45,922	-94,154	51,110	-3,787	-287,672	-45,922	-94,154
1988	-53,721	-109,668	59,190	95	-338,336	-53,721	-109,668
1989	-59,163	-123,322	69,446	2,877	-392,591	-2,523	-14,341
1990	-70,588	-138,224	75,579	5,561	-450,068	2,642	-759
1991	-76,753	-146,470	82,505	10,866	-506,298	2,854	736
1992	-84,848	-164,140	89,380	13,637	-571,296	3,478	422
1993	-95,603	-179,348	96,252	16,417	-635,109	1,635	-395
1994	-102,179	-199,408	103,337	18,438	-703,303	-790	-1719

The effects on the value functions were also interesting, reduced migration while the temporary policies were in effect did noticeably reduce their value but they 'recovered' quickly after the subsidies/taxes were abolished. At the end of the period, the effects of the policies on utility had been minimal.

Table III summarizes the main results without present value calculations. Table IV takes present value into account. The numbers in Table IV are based on adding up in any given year the sum of the value functions in that year and in present value the changes in utility and cost of migration in that year and previous years. The unit of measure is the cost of migration for one individual.

The effects on net external migration were small in all the simulations except of course Simulation 5 where there was, by design, no migration.

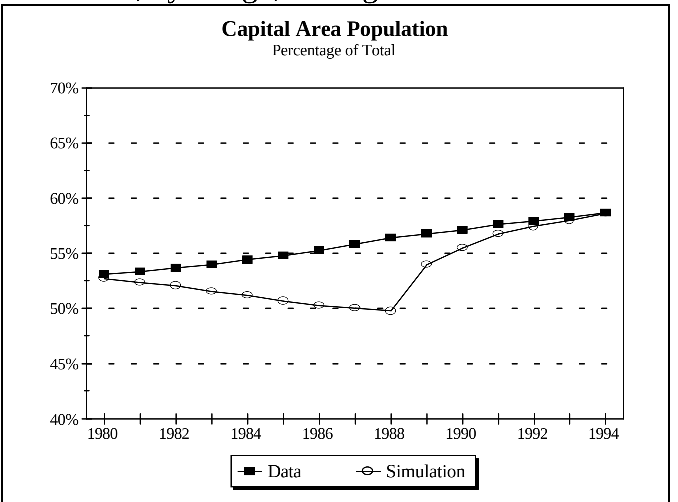

Fig. 20 Results from Simulation 7: Taxes and subsidies in effect for 1980 **-** 1988. Maximum subsidy 0.11 per capita.

It should be kept in mind when analyzing the results from the policy simulations that they are based on the government being able to tax people in one part of the country through a poll tax and give the proceeds to people in another part of the country. It is not obvious that this is a reasonable assumption. On the contrary, one might note that the government currently raises most of its revenues through taxes such as a value added tax and income tax. It is a well known result in economics that raising such taxes distorts incentives and produces a deadweight loss. Furthermore, although governments have come up with many different schemes to stem the flow of people to the capital area, none[71] of them has involved direct payments to people for living outside the capital.

[71] With the possible exception of some aspects of Iceland's farm subsidy programs. In addition, as mentioned in the first chapter, financial incentives seem to be needed to fill some types of government posts in remote areas and there is anecdotal evidence that these have been provided to some professions, e.g. physicians, although the general rule is that the government offers the same wage schedule countrywide.

Instead less direct methods have been used, including subsidies for goods and services to people in rural areas (including electricity, telephone and postal service), financial aid to ailing companies and investment in infrastructure projects that are hard to justify without giving great weight to their beneficial effects on regional development. When price controls were in effect they were also to a degree used to try to benefit consumers in rural areas, mandating the same maximum price for many goods in all locations. Irrespective of whether one supports the aim of programs that subsidize the cost of living in rural areas it is clear from an economics perspective that the programs that have been used are blunt since they distort prices and thus lead to a deadweight loss.

Table V - Brief Description of Simulations

Simulation 1	Steadily (linearly) increasing subsidies to rural areas and taxes in the capital region. Calibrated so that the proportion of the population living in the capital region at the end of the period is the same as at the beginning.
Simulation 2	Same as Simulation 1 but with the taxes and subsidies doubled.
Simulation 3	Same as Simulation 1 but with the taxes and subsidies reversed (now favouring the capital region).
Simulation 4	No taxes or subsidies but a threefold increase in the cost of relocation.
Simulation 5	An infinite cost of relocation.
Simulation 6	Same as Simulation 1 up to 1988, no taxes or subsidies after that.
Simulation 7	Same as Simulation 2 up to 1988, no taxes or subsidies after that.

5. Conclusion

This part concludes the paper. It summarizes the main results and discusses the implications of government policies aimed at affecting migration and their potential justification.

Changes in the structure of the Icelandic economy have resulted in the migration of a large share of the population to one city. About three fifths of the population now live in the capital region while the rest is distributed among almost 200 municipalities in rural areas. As late as at the beginning of the last century there was practically no urban population in Iceland.

The Icelandic labor market seems to be efficient in the sense that regional disparities in wages and unemployment are small. Migration has no doubt played a significant role in achieving this as the decline of rural industries has not pushed wages there noticeably below those in the rapidly growing capital region.

Governments have tried various measures to influence migration and in particular to slow the flow to the capital region and improve the standard of living in other regions. No attempt is made here to quantify the effects of previous government actions but it is clear that the instruments used have been blunt.

The bulk of migration is driven by individual specific events. The net flow has however been determined by changes in the structure of the Icelandic economy. The collapse of agriculture as a source of employment and the much more gradual relative decline of fishing and fish processing has eroded the comparative advantage of rural regions over the capital region in the competition for labor.

More varied opportunities for leisure in the capital region also seem to play a significant role. A disproportionate share of Iceland's cultural and entertainment institutions are based in the capital region. As a result, this region offers far more varied leisure opportunities than other regions. Since most cultural institutions receive substantial government funding, their existence and location is not solely dictated by market forces. This suggests that government policies regarding art and entertainment may have implications for regional development.

If only one, say, symphony orchestra is to get government funding then it is natural that it is based in the largest population center in the country since that is presumably where most people that benefit from its product and talented musicians are likely to be found. Rather than wonder where the only symphony orchestra in the country should be based it is therefore more interesting to consider whether there are economies of scale in producing such publicly supported goods as art and education. Economies of scale would mean that, to stay with the symphony orchestra example, one 'full-size' orchestra should receive government funding rather than several smaller orchestras spread around the country - or even several full-size symphony orchestras, each based in a different village and playing part-time.

Since the political process in Iceland, which gives disproportionate influence to rural areas, has resulted in the concentration of providers of art, entertainment and higher education in the capital area, it is tempting to reason that economies of scale or indivisibilities must make a different arrangement too costly to be practical.

Simulations show the following:

i) Relatively small subsidies and taxes could significantly affect migration patterns but it is not clear whether the use of such focused instruments is feasible.

ii) Taxes that increase the cost of migration seem to be an ineffective way to control net migration.

iii) Subsidies to those who migrate can shift the cost of migration without unduly affecting net migration.

iv) Temporary measures such as taxes and/or subsidies that are only in effect for a limited time do not have a lasting effect on settlement patterns.

Two of the main roles of the government in a welfare state have been to try to alleviate the problems induced by externalities and to affect the distribution of income. Positive economics can of course not give much guidance as to how, if at all, a government should try to redistribute income. Economics can however be used to try to estimate the effects of different government policies on income distribution and in particular whether they are likely to achieve the goals that have been set.

This paper does not attempt to ascertain whether there are any externalities created by changes in settlement patterns. If there are some economies or diseconomies of scale involved so that the population of a village affects either the cost or benefits to living there then migration to or from the village will impose an externality on those who decide not to migrate.

Although the changes in Iceland's settlement pattern have been gradual and taken place over almost two centuries their cost has been substantial and borne disproportionally by one segment of the population, namely those brought up in rural areas. In addition to the cost to those who have migrated, many living in rural areas that have not migrated have suffered a significant loss in utility relative to what they would have experienced living in the capital region. A government with the political goal of more equal income would therefore be justified in trying to either reduce the incentives to migrate or to shift more of the cost of migration to those born in the capital area.

Appendices

Appendix A: Interchangeability of Common and Individual Specific Payoffs

Proposition:

(Lemma 1)

$$U(\tau, X, \Pi, \pi, \cdot) = U(\tau, X, \Pi + a, \pi - a, \cdot)$$

For any vector of constants, *a*.

As before τ denotes age, X location (village), Π a vector of common payoffs, π a vector of individual specific payoffs.

Proof:

The proof is by induction, first showing that this is true for an individual that has one year left in the labor market and then that if it is true for an individual with a given number of years left until retirement then it is also true for an individual that is one year younger. To simplify notation we will look at the case where there are only two villages but it is straightforward to extend the proof to cover any number of villages. We label the village where the individual is currently residing as village number 1.

i) In the last year that an individual is in the labor market, $\tau = \bar{\tau}$, his utility is:

$$U(\bar{\tau}, 1, \Pi_t, \pi_t, \cdot) = \Pi_t(1) + \pi_t(1)$$

Adding any vector of constants to the vector of common payoffs and subtracting the same vector from the vector of individual specific payoffs clearly does not affect the result of the individual's value function:

$$U(\bar{\tau}, 1, \Pi_t + a, \pi_t - a, \cdot) = (\Pi_t(1) + a_1) + (\pi_t(1) - a_1) =$$
$$\Pi_t(1) + \pi_t(1) = U(\bar{\tau}, 1, \Pi_t, \pi_t, \cdot)$$

ii) An individual of age $\tau < \bar{\tau}$ has the following value function:

$$
\begin{aligned}
&U(\tau,1,\Pi_t,\pi_t,\cdot)=\Pi_t(1)+\pi_t(1)+\\
&MAX\left[E_t\beta U(\tau+1,1,\Pi_{t+1},\pi_{t+1},\cdot),E_t\beta U(\tau+1,2,\Pi_{t+1},\pi_{t+1},\cdot)-\Delta\right]=\\
&\Pi_t(1)+\pi_t(1)+MAX\left[\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,1,\Pi_t+\xi^1,\pi_t+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2,\right.\\
&\left.\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,2,\Pi_t+\xi^1,\pi_t+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^{21}-\Delta\right]
\end{aligned}
$$

Adding a vector of constants, *a*, to the vector of common payoffs and subtracting the same vector from the vector of individual specific payoffs gives the following:

If $U(\tau+1,X,\Pi+a,\pi-a,\cdot)=U(\tau+1,X,\Pi,\pi,\cdot)$ for any location, *X*, and any vectors *a*, Π and π we have:

$$
\begin{aligned}
&\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,X,\Pi+a+\xi^1,\pi-a+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2=\\
&\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,X,\Pi+\xi^1,\pi+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2
\end{aligned}
$$

And thus:

$$
\begin{aligned}
&U(\tau,1,\Pi_t+a,\pi_t-a,\cdot)=\Pi_t(1)+\pi_t(1)+\\
&MAX\left[\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,1,\Pi_t+a+\xi^1,\pi_t-a+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2,\right.\\
&\left.\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,2,\Pi_t+a+\xi^1,\pi_t-a+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2-\Delta\right]=\\
&\Pi_t(1)+\pi_t(1)+MAX\left[\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,1,\Pi_t+\xi^1,\pi_t+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2,\right.\\
&\left.\beta\int_{-1}^{1}\int_{-\lambda}^{\lambda}U(\tau+1,2,\Pi_t+\xi^1,\pi_t+\xi^2,\cdot)pdf_1(\xi^1)pdf_2(\xi^2)d\xi^1d\xi^2-\Delta\right]=U(\tau,1,\Pi_t,\pi_t,\cdot)
\end{aligned}
$$

QED

Note that to prove the proposition we do not need any particular assumptions about the pdf's of the shock vectors except that they must be independent of the state variables. This result will thus also hold in more general models as long as the annual payoffs that an agent receives from different sources can be added up like in this model, in particular we need this to hold for utility each year: $u(\tau,X+a,\Pi-a,\pi,\cdot)=u(\tau,X,\Pi,\pi,\cdot)\ \forall a$. It is clear that any linear utility function that gives equal weight to income from all sources will satisfy this, including the one used in the paper. The same will hold for any other utility function formed by a transformation that preserves the preferences of such a linear utility function.

Appendix B: Normalization of Value Functions

Proposition:

(Lemma 3)

$$U\left(\tau, X, \tilde{\pi}-k\cdot\mathbf{1},\cdot\right)=U\left(\tau, X, \tilde{\pi},\cdot\right)-k\frac{1-\beta^{\bar{\tau}-\tau+1}}{1-\beta}$$

For any constant, *k*.

As before, τ denotes age, $\bar{\tau}$ the last year of employment, β the discount factor, *X* location (village). **1** denotes a vector of ones. $\tilde{\pi}$ is a vector, the sum of the vectors of individual specific and common payoffs: $\tilde{\pi}=\Pi+\pi$.

Proof:

The proof is by induction and quite similar to the one in Appendix A, first showing that the proposition is true for an individual that has one year left in the labor market and then that if it is true for an individual with a given number of years left until retirement then it is also true for an individual that is one year younger. To simplify notation we will look at the case where there are only two villages but it is straightforward to extend the proof to cover any number of villages. We label the village where the individual is currently residing as village number 1.

i) In the last year that an individual is in the labor market, $\tau=\bar{\tau}$, her utility is:

$$U\left(\bar{\tau},1,\tilde{\pi}_t,\cdot\right)=\tilde{\pi}_t\left(1\right)$$

And thus:

$$U\left(\bar{\tau},1,\tilde{\pi}_t-k\cdot\mathbf{1},\cdot\right)=\tilde{\pi}_t\left(1\right)-k=U\left(\bar{\tau},1,\tilde{\pi}_t,\cdot\right)-k=U\left(\bar{\tau},1,\tilde{\pi}_t,\cdot\right)-k\frac{1-\beta^{\bar{\tau}-\tau+1}}{1-\beta}$$

ii) An individual of age $\tau<\bar{\tau}$ has the following value function:

$$U(\tau,1,\tilde{\pi}_t,\cdot)=\tilde{\pi}_t(1)+$$
$$MAX\left[E_t\beta U(\tau+1,1,\tilde{\pi}_{t+1},\cdot),E_t\beta U(\tau+1,2,\tilde{\pi}_{t+1},\cdot)-\Delta\right]=$$
$$\tilde{\pi}_t(1)+MAX\left[\beta\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,1,\tilde{\pi}_t+\xi,\cdot)pdf(\xi)d\xi,\right.$$
$$\left.\beta\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,2,\tilde{\pi}_t+\xi,\cdot)pdf(\xi)d\xi-\Delta\right]$$

And likewise:

$$U(\tau,1,\tilde{\pi}_t-k\cdot\mathbf{1},\cdot)=\tilde{\pi}_t(1)-k+$$
$$MAX\left[E_t\beta U(\tau+1,1,\tilde{\pi}_{t+1}-k\cdot\mathbf{1},\cdot),E_t\beta U(\tau+1,2,\tilde{\pi}_{t+1}-k\cdot\mathbf{1},\cdot)-\Delta\right]=$$
$$\tilde{\pi}_t(1)-k+MAX\left[\beta\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,1,\tilde{\pi}_t-k\cdot\mathbf{1}+\xi,\cdot)pdf(\xi)d\xi,\right.$$
$$\left.\beta\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,2,\tilde{\pi}_t-k\cdot\mathbf{1}+\xi,\cdot)pdf(\xi)d\xi-\Delta\right]$$

If $U(\tau+1,X,\tilde{\pi}-k\cdot\mathbf{1},\cdot)=U(\tau+1,X,\tilde{\pi},\cdot)-k\dfrac{1-\beta^{\bar{\tau}-\tau}}{1-\beta}$ for any *k*, *X* and vector $\tilde{\pi}$ then:

$$\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,X,\tilde{\pi}_t-k\cdot\mathbf{1}+\xi,\cdot)pdf(\xi)d\xi=$$
$$\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}\left(U(\tau+1,X,\tilde{\pi}_t+\xi,\cdot)-k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta}\right)pdf(\xi)d\xi$$

And thus:

$$U(\tau,1,\tilde{\pi}_t-k\cdot\mathbf{1},\cdot)=\tilde{\pi}_t(1)-k+$$
$$MAX\left[\beta\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,1,\tilde{\pi}_t-k\cdot\mathbf{1}+\xi,\cdot)pdf(\xi)d\xi,\right.$$
$$\left.\oint_{\xi_j\in[-1-\lambda,1+\lambda],j=1,2}U(\tau+1,2,\tilde{\pi}_t-k\cdot\mathbf{1}+\xi,\cdot)pdf(\xi)d\xi-\Delta\right]$$

$$= \tilde{\pi}_t(1) - k + MAX\left[\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} \left(U(\tau+1, 1, \tilde{\pi}_t + \xi, \cdot) - k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta}\right) pdf(\xi)d\xi,\right.$$

$$\left.\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} \left(U(\tau+1, 2, \tilde{\pi}_t + \xi, \cdot) - k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta}\right) pdf(\xi)d\xi - \Delta\right]$$

$$= \tilde{\pi}_t(1) - k + MAX\left[\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} U(\tau+1, 1, \tilde{\pi}_t + \xi, \cdot) pdf(\xi)d\xi - \beta \cdot k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta},\right.$$

$$\left.\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} U(\tau+1, 2, \tilde{\pi}_t + \xi, \cdot) pdf(\xi)d\xi - \beta \cdot k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta} - \Delta\right] =$$

$$= \tilde{\pi}_t(1) - k + MAX\left[\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} U(\tau+1, 1, \tilde{\pi}_t + \xi, \cdot) pdf(\xi)d\xi,\right.$$

$$\left.\beta \oint_{\xi_j \in [-1-\lambda, 1+\lambda], j=1,2} U(\tau+1, 2, \tilde{\pi}_t + \xi, \cdot) pdf(\xi)d\xi - \Delta\right] - \beta \cdot k\frac{1-\beta^{\bar{\tau}-\tau}}{1-\beta} =$$

$$U(\tau, 1, \tilde{\pi}_t, \cdot) - k\frac{1-\beta^{\bar{\tau}-\tau+1}}{1-\beta}$$

QED

Note that to proof the proposition we do not need any particular assumptions about the pdf of the shock vector except that it must be independent of the state variables. This result will thus also hold in more general models as long as the annual payoffs that an agent receives enter his utility function linearly, in particular we need that this holds for utility each year: $u(\tau, X, \tilde{\pi}, \cdot) = \alpha_0 \cdot \tilde{\pi}(X) + \alpha_1$, $\alpha_0 > 0$.

Appendix C: Probability Distribution Functions Used

For the purpose of integrating out over possible shocks, we need the joint probability distribution function for the following two phenomena:

a) The difference between the payoff one year from now in the current location and the payoff one year from now in the best alternative location at that time.

b) The difference between the payoff one year from now in the current location and the payoff one year from now in the second best alternative to the current location at that time.

Both a) and b) will be contingent on the differences in payoffs this period and λ. Mathematically we need to find:

$$g\left(\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(S_{t+1})-\tilde{\pi}_{t+1}(N)|\tilde{\pi}_t(N),\tilde{\pi}_t(F_t),\tilde{\pi}_t(S_t),\lambda\right)$$

One complication that has to be kept in mind is that the village that is the second best alternative this period can become the best alternative next period. This calls for the time subscripts on *F* and *S*. The solution is:

$$\begin{aligned}
&g\left(\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N),\tilde{\pi}_{t+1}(S_{t+1})-\tilde{\pi}_{t+1}(N)|\tilde{\pi}_t(N),\tilde{\pi}_t(F_t),\tilde{\pi}_t(S_t),\lambda\right)=\\
&p\left(\xi_F+\tilde{\pi}_t(F_t)\geq\xi_S+\tilde{\pi}_t(S_t)\right)\cdot\\
&p\left(\xi_F+\tilde{\pi}_t(F_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N)|\xi_f+\tilde{\pi}_t(F_t)\geq\xi_S+\tilde{\pi}_t(S_t)\right)\cdot\\
&p\left(\xi_S+\tilde{\pi}_t(S_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(S_{t+1})-\tilde{\pi}_{t+1}(N)|\xi_f+\tilde{\pi}_t(F_t)\geq\xi_S+\tilde{\pi}_t(S_t),\right.\\
&\left.\xi_F+\tilde{\pi}_t(F_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N)\right)+\\
&p\left(\xi_F+\tilde{\pi}_t(F_t)<\xi_S+\tilde{\pi}_t(S_t)\right)\cdot\\
&p\left(\xi_S+\tilde{\pi}_t(S_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N)|\xi_f+\tilde{\pi}_t(F_t)<\xi_S+\tilde{\pi}_t(S_t)\right)\cdot\\
&p\left(\xi_F+\tilde{\pi}_t(F_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(S_{t+1})-\tilde{\pi}_{t+1}(N)|\xi_f+\tilde{\pi}_t(F_t)<\xi_S+\tilde{\pi}_t(S_t),\right.\\
&\left.\xi_S+\tilde{\pi}_t(S_t)-\left(\xi_N+\tilde{\pi}_t(N)\right)=\tilde{\pi}_{t+1}(F_{t+1})-\tilde{\pi}_{t+1}(N)\right)
\end{aligned}$$

$$= \int_{-1-\lambda}^{1+\lambda} f\left(\tilde{\pi}_{t+1}(F_{t+1}) - \tilde{\pi}_{t+1}(N) - \left(\tilde{\pi}_t(F_t) - \tilde{\pi}_t(N)\right) + \xi, \lambda\right) \cdot$$
$$f\left(\tilde{\pi}_{t+1}(S_{t+1}) - \tilde{\pi}_{t+1}(N) - \left(\tilde{\pi}_t(S_t) - \tilde{\pi}_t(N)\right) + \xi, \lambda\right) \cdot f(\xi, \lambda) d\xi +$$
$$\int_{-1-\lambda}^{1+\lambda} f\left(\tilde{\pi}_{t+1}(F_{t+1}) - \tilde{\pi}_{t+1}(N) - \left(\tilde{\pi}_t(S_t) - \tilde{\pi}_t(N)\right) + \xi, \lambda\right) \cdot$$
$$f\left(\tilde{\pi}_{t+1}(S_{t+1}) - \tilde{\pi}_{t+1}(N) - \left(\tilde{\pi}_t(F_t) - \tilde{\pi}_t(N)\right) + \xi, \lambda\right) \cdot f(\xi, \lambda) d\xi$$

Where *f* is the pdf of the sum of the common and idio-syncratic shocks to an individual's income in a given location in one year:

$$f(\xi,\lambda) = \begin{cases} 0 \text{ if } |\xi| \geq 1+\lambda \\ \dfrac{\xi+1+\lambda}{4\lambda} \text{ if } -1-\lambda \leq \xi \leq \lambda - 1 \\ 1/2 \text{ if } \lambda - 1 \leq \xi \leq 1 - \lambda \\ \dfrac{\xi+1+\lambda}{4\lambda} \text{ if } 1-\lambda \leq \xi \leq 1+\lambda \end{cases}$$

A software package such as *Mathematica* can be used to find symbolic solutions for *g*. The result is piece wise polynomial but since it is very long it is omitted here. It turned out to be impractical to use this symbolic solution to get a numeric result since that involved checking a large number of conditions to find out which special case applies. Fortunately it is straightforward to solve the integral using numeric methods and this was done. In particular, a solution was found for $g\left(A, B | C, D, E, \lambda\right)$ for all relevant values of *A, B, C, D* and *E* (normalizing *C*=0).

An analogous problem is finding the pdf for the joint distribution of the following two phenomena:

a) The difference between the payoff one year from now in the current best alternative location and the payoff in the best alternative to that one year from now.

b) The difference between the payoff one year from now in the current best alternative location and the payoff to the second best alternative to that location one period from now.

The same numerical results for $g(\cdot)$ can be used to calculate this:

$$g\left(\tilde{\pi}_{t+1}(F_{t+1}) - \tilde{\pi}_{t+1}(F_t), \tilde{\pi}_{t+1}(S_{t+1}) - \tilde{\pi}_{t+1}(F_t) | \tilde{\pi}_t(F_t), \tilde{\pi}_t(S_t), \tilde{\pi}_t(N), \lambda\right)$$

Appendix D: Downward Bias in Value Function

Restricting a utility maximizing individual's choice set must by definition make the individual at best no worse off and in some cases strictly worse off. If this were not the case, the individual would not be maximizing utility in the first place. In the setup in the paper this means that for a given set of structural parameters and state variables the restricted value function, *V*, can never give a higher and will sometimes give a lower estimate of lifetime expected income in present value than the unrestricted value function, *U*, will.

It is fairly straightforward to show this mathematically with a proof by induction similar to that in Appendices A and B. In particular, one can show that:

$$V\left[\bar{\tau}-2,\tilde{\pi}(N),\tilde{\pi}(F),\tilde{\pi}(S)\cdot\right]\leq U\left[\bar{\tau}-2,N,\tilde{\pi},\cdot\right]\ \forall\tilde{\pi}$$

and then that if:

$$V\left[\tau,\tilde{\pi}(N),\tilde{\pi}(F),\tilde{\pi}(S),\cdot\right]\leq U\left[\tau,N,\tilde{\pi},\cdot\right]\ \forall\tilde{\pi}$$

then

$$V\left[\tau-1,\tilde{\pi}(N),\tilde{\pi}(F),\tilde{\pi}(S),\cdot\right]\leq U\left[\tau-1,N,\tilde{\pi},\cdot\right]\ \forall\tilde{\pi}$$

Here we will let it suffice to look at a slightly simpler setup, with three time periods and three locations. We will show that in this setup an individual that only looks at payoffs in his current location and best alternative can be expected get a lower estimate of his lifetime earnings in present value than if he did not exclude the possibility of moving in the future to the village that is now his second best alternative.

In the last two time periods his value function is the same in either case:

$$U\left(\bar{\tau},N,\tilde{\pi},\cdot\right)=V\left(\bar{\tau},\tilde{\pi}(N),\tilde{\pi}(F),\cdot\right)=\tilde{\pi}(N)$$

$$\begin{aligned}&U\left(\bar{\tau}-1,N,\tilde{\pi}_t,\cdot\right)=V\left(\bar{\tau}-1,\tilde{\pi}_t(N),\tilde{\pi}_t(F),\cdot\right)=\\&\tilde{\pi}(N)+MAX\left[\beta\cdot E_t\tilde{\pi}_{t+1}(N),\beta\cdot E_t\tilde{\pi}_{t+1}(F)-\Delta\right]=\\&\tilde{\pi}(N)+MAX\left[\beta\cdot\tilde{\pi}_t(N),\beta\cdot\tilde{\pi}_t(F)-\Delta\right]\end{aligned}$$

In the first time period his value function is however in some circumstances lower and never higher, if he excludes the possibility of moving to his second best alternative:

$$U\left(\bar{\tau}-2, N, \tilde{\pi}_t, \cdot\right)=$$
$$\tilde{\pi}_t(N)+MAX\left[\beta\cdot E_t U\left(\bar{\tau}-1, N, \tilde{\pi}_{t+1}, \cdot\right), \beta\cdot E_t U\left(\bar{\tau}-1, F, \tilde{\pi}_{t+1}, \cdot\right)-\Delta\right]=\tilde{\pi}_t(N)+$$
$$MAX\Big[\beta\cdot E_t\left[\tilde{\pi}_{t+1}(N)+MAX\left[\beta\cdot E_{t+1}\tilde{\pi}_{t+2}(N), \beta\cdot E_{t+1}\tilde{\pi}_{t+2}(F)-\Delta, \beta\cdot E_{t+1}\tilde{\pi}_{t+2}(S)-\Delta\right]\right],$$
$$\beta\cdot E_t\left[\tilde{\pi}_{t+1}(F)+MAX\left[\beta\cdot E_{t+1}\tilde{\pi}_{t+2}(F), \beta\cdot E_{t+1}\tilde{\pi}_{t+2}(S)-\Delta, \beta\cdot E_{t+1}\tilde{\pi}_{t+2}(N)-\Delta\right]\right]\Big]=$$
$$\tilde{\pi}_t(N)+MAX\Big[\beta\cdot E_t\left[\tilde{\pi}_{t+1}(N)+\beta\cdot MAX\left[\beta\cdot\tilde{\pi}_{t+1}(N), \beta\cdot\tilde{\pi}_{t+1}(F)-\Delta, \beta\cdot\tilde{\pi}_{t+1}(S)-\Delta\right]\right],$$
$$\beta\cdot E_t\left[\tilde{\pi}_{t+1}(F)+MAX\left[\beta\cdot\tilde{\pi}_{t+1}(F), \beta\cdot\tilde{\pi}_{t+1}(S)-\Delta, \beta\cdot\tilde{\pi}_{t+1}(N)-\Delta\right]\right]\Big]$$
$$\geq V\left(\bar{\tau}-2, \tilde{\pi}_t(N), \tilde{\pi}_t(F), \cdot\right)=$$
$$\tilde{\pi}_t(N)+MAX\Big[\beta\cdot E_t\left[\tilde{\pi}_{t+1}(N)+MAX\left[\beta\cdot\tilde{\pi}_{t+1}(N), \beta\cdot\tilde{\pi}_{t+1}(F)-\Delta\right]\right],$$
$$\beta\cdot E_t\left[\tilde{\pi}_{t+1}(F)+MAX\left[\beta\cdot\tilde{\pi}_{t+1}(F), \beta\cdot\tilde{\pi}_{t+1}(N)-\Delta\right]\right]\Big]$$

The reason for the inequality is simple, for any three random variables, *A*, *B* and *C*:

$$E_t\,MAX\left[A_{t+1}, B_{t+1}, C_{t+1}\right]\geq E_t\,MAX\left[A_{t+1}, B_{t+1}\right]$$

QED

In particular, the inequality will be strict unless $p\left(C_{t+1}>A_{t+1}, C_{t+1}>B_{t+1}\right)$ = 0. In our setup, the inequality will be strict unless:

$$p\left(\tilde{\pi}_{t+1}(S)>\tilde{\pi}_{t+1}(F), \beta\cdot\tilde{\pi}_{t+1}(S)-\Delta>\beta\cdot\tilde{\pi}_{t+1}(N)|\tilde{\pi}_t(F), \tilde{\pi}_t(N), \tilde{\pi}_t(S), \lambda\right)=0$$

Appendix E: Uniqueness of the Π Estimates

The $\hat{\Pi}$ vector of estimates of Π in any given year (and thus the corresponding matrix of estimates for all the years) can not be unique for two reasons discussed below.

i)

There is a range of solutions that can fit the data. To clarify, take the following example:

Assume there are three villages, *A*, *B* and *C*, $\Delta = 0$. There are two individuals, individual number one moves from village *A* to *B*, the other from *A* to *C* in the same year. Assume that the individual specific payoffs in the three villages are as follows: $\pi^1(A) = \pi^1(B) = \pi^1(C) = 0, \pi^2(A) = \pi^2(B) = 0, \pi^2(C) = 1$. Furthermore assume that we know that $\Pi(A) = 0, \Pi(C) = 1$. Under this setup, any $\Pi(B)$ where $1 \leq \Pi(B) \leq 2$ is compatible with the data on migration. This does not cause any significant problems in practice, since with approximately 150,000 individuals making decisions on migration the bounds for the estimates are quite tight, except perhaps for villages with very few inhabitants.

ii)

If $\hat{\Pi}_t$ is a solution then $\hat{\Pi}_t^{'} = \hat{\Pi}_t + \alpha \cdot \mathbf{1}$ is also a solution where **1** is a vector of ones and α is a constant sufficiently close to zero, i.e. so that $\left|\hat{\Pi}_t^{'}(X) - \hat{\Pi}_{t-1}(X)\right| \leq \lambda \; \forall X$.

To clarify, change the setup in part i) so that $\Pi(A) = k, \Pi(C) = k+1$. Then any $\Pi(B)$ where $k+1 \leq \Pi(B) \leq k+2$ is compatible with the data. The reason for this is that individuals base their migration decisions on differences in payoffs between villages, not on the levels of payoffs *per se*.

This calls for some sort of normalization and I chose $\Pi(\textit{Foreign}) = 0$ for all years. This means that all the $\hat{\Pi}_t$ estimates should be looked at as relative to changes in the 'village' specific payoff abroad.

Table I
Shock Estimates

	SE	1970	1971	1972	1973	1974	1975
Capital area	0.050	0.206	0.032	0.068	0.118	0.083	0.120
Keflavík	0.050	-0.272	0.089	-0.018	0.010	-0.057	-0.019
Grindavík	0.062	-0.453	0.058	0.007	-0.044	-0.047	-0.082
Njarðvík	0.066	-0.437	0.123	0.043	-0.026	-0.175	-0.105
Hafnir	0.162	-0.790	-0.308	-0.304	-0.346	-0.100	-0.276
Sandgerði	0.082	-0.496	0.034	-0.144	0.123	-0.277	-0.093
Garður	0.091	-0.531	-0.020	-0.092	-0.071	-0.057	-0.173
Vogar	0.107	-0.670	-0.124	-0.092	-0.044	-0.149	-0.120
Akranes	0.049	-0.312	0.031	0.003	-0.014	-0.109	0.047
Ólafsvík	0.092	-0.503	-0.068	-0.071	-0.133	-0.175	-0.052
Borgarnes	0.081	-0.483	0.022	-0.104	-0.073	-0.136	0.019
Hellissandur/Rif	0.100	-0.531	-0.015	-0.191	0.025	-0.338	-0.103
Grundarfjörður, Eyrarsveit	0.092	-0.531	-0.005	-0.117	-0.030	-0.201	-0.054
Stykkishólmur	0.082	-0.478	0.037	-0.071	-0.036	-0.152	0.011
Ísafjörður/Hnífsd.	0.064	-0.342	0.107	-0.067	-0.036	-0.186	0.019
Bolungarvík	0.095	-0.494	-0.055	-0.054	-0.109	-0.148	-0.069
Patreksfjörður	0.088	-0.483	0.001	-0.112	-0.022	-0.142	-0.083
Tálknafjörður	0.151	-0.724	-0.172	-0.180	-0.127	-0.124	-0.134
Bíldudalur, Suðurfjarðarhreppur	0.134	-0.652	-0.072	-0.042	-0.072	-0.355	0.017
Þingeyri	0.122	-0.613	-0.071	-0.239	0.031	-0.228	-0.071
Flateyri	0.112	-0.566	0.046	-0.192	0.015	-0.296	-0.140
Suðureyri	0.105	-0.600	-0.043	-0.139	-0.000	-0.224	-0.124
Súðavík	0.118	-0.741	-0.147	-0.214	-0.118	-0.269	-0.060
Drangsnes/Kaldrananeshreppur	0.139	-0.742	-0.216	-0.432	-0.176	-0.100	-0.182
Hólmavík	0.109	-0.648	-0.110	-0.067	-0.153	-0.190	-0.148
Siglufjörður	0.065	-0.401	0.133	-0.150	0.003	-0.152	-0.084
Sauðárkrókur	0.055	-0.423	0.028	-0.093	0.026	-0.174	-0.065
Hvammstangi	0.113	-0.606	-0.029	-0.133	-0.050	-0.243	-0.047
Blönduós	0.070	-0.533	-0.032	-0.083	-0.022	-0.147	-0.087
Skagaströnd/Höfðahreppur	0.105	-0.555	0.037	-0.219	-0.020	-0.170	-0.105
Hofsós/Hofshreppur	0.139	-0.566	-0.058	-0.233	-0.129	-0.131	-0.252
Akureyri	0.047	-0.202	0.064	0.030	0.060	-0.088	0.059
Húsavík	0.063	-0.382	0.050	-0.069	0.014	-0.154	-0.085
Ólafsfjörður	0.087	-0.478	0.031	-0.147	-0.023	-0.179	-0.125
Dalvík	0.096	-0.451	0.073	-0.124	-0.036	-0.160	-0.038
Grímsey	0.179	-0.884	-0.299	-0.286	0.002	-0.196	-0.259
Hrísey	0.124	-0.635	-0.162	-0.232	-0.033	-0.243	-0.108
Árskógsströnd/Árskógshreppur	0.136	-0.634	-0.123	-0.263	-0.167	-0.141	-0.221
Grenivík/Grýtubakkahreppur	0.117	-0.603	0.019	-0.186	-0.118	-0.210	-0.161
Kópasker/Öxarfj.hr./Presthólahr.	0.172	-0.798	-0.311	-0.305	-0.006	-0.300	-0.092
Raufarhöfn	0.102	-0.588	-0.057	-0.219	0.041	-0.332	-0.027
Þórshöfn	0.113	-0.596	-0.116	-0.098	-0.125	-0.077	-0.227
Seyðisfjörður	0.087	-0.499	-0.074	-0.058	-0.110	-0.207	-0.043
Neskaupstaður	0.070	-0.426	0.084	-0.149	0.007	-0.254	-0.030
Eskifjörður	0.086	-0.495	0.089	-0.142	0.072	-0.192	-0.082
Bakkafjörður/Skeggjastaðahr.	0.168	-0.813	-0.337	-0.156	-0.141	-0.318	-0.086
Vopnafjörður	0.115	-0.506	-0.107	-0.113	-0.085	-0.135	-0.121
Borgarfjörður eystri/Borgarfj.hr.	0.148	-0.687	-0.197	-0.245	-0.097	-0.274	-0.107
Reyðarfjörður	0.094	-0.555	-0.010	-0.189	0.155	-0.337	0.012
Fáskrúðsfjörður, Búðahreppur	0.094	-0.510	0.015	-0.186	-0.048	-0.181	-0.124

Stöðvarfjörður/Stöðvarhreppur	0.115	-0.670	-0.219	-0.219	-0.009	-0.304	-0.056
Breiðdalsvík/Breiðdalshreppur	0.122	-0.616	-0.105	-0.088	-0.109	-0.125	-0.119
Djúpivogur, Búlandshreppur	0.103	-0.619	-0.064	-0.055	-0.218	-0.117	-0.240
Hornafjörður	0.083	-0.493	0.004	-0.066	-0.012	-0.124	-0.081
Vestmannaeyjar	0.050	-0.289	0.050	-0.025	-0.219	-0.322	0.140
Selfoss	0.064	-0.375	0.017	-0.027	0.006	-0.014	-0.053
Stokkseyri	0.098	-0.576	0.006	-0.107	0.041	-0.274	-0.103
Eyrarbakki	0.107	-0.570	-0.087	-0.170	-0.011	-0.218	-0.091
Þorlákshöfn, Ölfushreppur	0.136	-0.513	-0.117	-0.052	-0.099	0.048	-0.065
Other Domestic	0.040	-0.043	-0.005	0.004	0.035	0.011	0.006

Table I, continued

	1976	1977	1978	1979	1980	1981	1982
Capital area	-0.017	-0.002	0.036	0.093	0.108	0.113	0.200
Keflavík	-0.099	-0.139	-0.123	-0.174	-0.075	-0.140	-0.042
Grindavík	-0.155	-0.187	-0.244	-0.163	-0.135	-0.208	-0.088
Njarðvík	-0.150	-0.183	-0.222	-0.149	-0.133	-0.127	-0.144
Hafnir	-0.135	0.148	-0.451	-0.420	-0.085	-0.444	-0.418
Sandgerði	-0.148	-0.215	-0.211	-0.227	-0.181	-0.206	-0.110
Garður	-0.170	-0.147	-0.237	-0.094	-0.329	-0.098	-0.167
Vogar	-0.076	-0.208	-0.316	-0.141	-0.301	0.069	-0.412
Akranes	-0.200	-0.200	-0.062	-0.058	-0.103	-0.193	-0.051
Ólafsvík	-0.124	-0.183	-0.257	-0.148	-0.201	-0.217	-0.131
Borgarnes	-0.170	-0.234	-0.112	-0.192	-0.178	-0.232	-0.089
Hellissandur/Rif	-0.257	-0.247	-0.270	-0.235	-0.036	-0.460	-0.102
Grundarfjörður, Eyrarsveit	-0.290	-0.199	-0.277	-0.211	-0.246	-0.227	-0.151
Stykkishólmur	-0.296	-0.196	-0.235	-0.228	-0.155	-0.193	-0.171
Ísafjörður/Hnífsd.	-0.161	-0.181	-0.147	-0.155	-0.107	-0.178	-0.090
Bolungarvík	-0.065	-0.213	-0.229	-0.188	-0.175	-0.253	-0.139
Patreksfjörður	-0.148	-0.244	-0.234	-0.259	-0.182	-0.268	-0.195
Tálknafjörður	-0.236	-0.156	-0.227	-0.213	-0.251	-0.235	-0.347
Bíldudalur, Suðurfjarðarhreppur	-0.463	-0.099	-0.162	-0.347	-0.194	-0.272	-0.217
Þingeyri	-0.293	-0.169	-0.333	-0.137	-0.174	-0.227	-0.302
Flateyri	-0.133	-0.212	-0.205	-0.403	-0.125	-0.216	-0.213
Suðureyri	-0.282	-0.212	-0.149	-0.309	-0.285	-0.289	-0.308
Súðavík	-0.286	-0.266	-0.337	-0.184	-0.194	-0.371	-0.166
Drangsnes/Kaldrananeshreppur	-0.120	-0.318	-0.092	-0.231	-0.296	-0.349	-0.192
Hólmavík	-0.070	-0.353	-0.112	-0.364	-0.189	-0.302	-0.272
Siglufjörður	-0.154	-0.205	-0.174	-0.237	-0.199	-0.144	-0.200
Sauðárkrókur	-0.103	-0.134	-0.190	-0.176	-0.118	-0.235	-0.097
Hvammstangi	-0.064	-0.250	-0.206	-0.195	-0.223	-0.302	-0.188
Blönduós	-0.124	-0.272	-0.204	-0.165	-0.245	-0.201	-0.098
Skagaströnd/Höfðahreppur	-0.162	-0.349	-0.200	-0.226	-0.140	-0.271	-0.249
Hofsós/Hofshreppur	-0.162	-0.168	-0.250	-0.233	-0.108	-0.306	-0.320
Akureyri	-0.080	-0.098	-0.090	-0.078	-0.042	-0.094	-0.013
Húsavík	-0.115	-0.184	-0.190	-0.211	-0.142	-0.148	-0.108
Ólafsfjörður	-0.133	-0.205	-0.245	-0.181	-0.177	-0.237	-0.162
Dalvík	-0.214	-0.222	-0.269	-0.157	-0.188	-0.167	-0.154
Grímsey	-0.121	-0.132	-0.202	-0.390	-0.324	-0.476	-0.391
Hrísey	-0.204	-0.252	-0.245	-0.322	-0.341	-0.350	-0.262
Árskógsströnd/Árskógshreppur	-0.260	-0.110	-0.264	-0.250	-0.220	-0.170	-0.275
Grenivík/Grýtubakkahreppur	-0.128	-0.191	-0.297	-0.170	-0.258	-0.296	-0.143
Kópasker/Öxarfj.hr./Presthólahr.	-0.158	-0.213	-0.086	-0.223	-0.363	-0.475	-0.347
Raufarhöfn	-0.199	-0.186	-0.283	-0.250	-0.326	-0.332	-0.265

Þórshöfn	-0.186	-0.301	-0.353	-0.139	-0.215	-0.373	-0.181
Seyðisfjörður	-0.186	-0.248	-0.066	-0.304	-0.174	-0.262	-0.139
Neskaupstaður	-0.158	-0.221	-0.161	-0.171	-0.232	-0.172	-0.153
Eskifjörður	-0.098	-0.338	-0.207	-0.172	-0.200	-0.213	-0.168
Bakkafjörður/Skeggjastaðahr.	-0.222	-0.374	-0.201	-0.198	-0.400	-0.318	-0.278
Vopnafjörður	-0.167	-0.239	-0.290	-0.155	-0.144	-0.231	-0.120
Borgarfjörður eystri/Borgarfj.hr.	-0.283	-0.236	-0.206	-0.306	-0.194	-0.327	-0.480
Reyðarfjörður	-0.256	-0.204	-0.281	-0.247	-0.119	-0.341	-0.118
Fáskrúðsfjörður, Búðahreppur	-0.069	-0.279	-0.224	-0.351	-0.185	-0.189	-0.194
Stöðvarfjörður/Stöðvarhreppur	-0.143	-0.109	-0.271	-0.387	-0.231	-0.321	-0.175
Breiðdalsvík/Breiðdalshreppur	-0.228	-0.277	-0.250	-0.259	-0.404	-0.129	-0.276
Djúpivogur, Búlandshreppur	-0.201	-0.180	-0.257	-0.171	-0.347	-0.274	-0.159
Hornafjörður	-0.136	-0.269	-0.122	-0.186	-0.165	-0.245	-0.115
Vestmannaeyjar	-0.064	-0.175	-0.174	-0.048	-0.142	-0.126	-0.143
Selfoss	-0.204	-0.175	-0.167	-0.123	-0.097	-0.196	-0.041
Stokkseyri	-0.245	-0.194	-0.271	-0.265	-0.207	-0.378	-0.128
Eyrarbakki	-0.081	-0.365	-0.217	-0.314	-0.131	-0.339	-0.206
Þorlákshöfn, Ölfushreppur	-0.158	-0.232	-0.232	-0.148	-0.255	-0.206	-0.158
Other Domestic	-0.100	-0.089	-0.061	-0.022	-0.060	-0.060	0.050

Table I, continued

	1983	1984	1985	1986	1987	1988	1989
Capital area	0.206	0.134	0.048	0.077	0.167	0.299	0.172
Keflavík	-0.015	-0.121	-0.177	-0.083	-0.076	0.080	0.034
Grindavík	-0.176	-0.212	-0.157	-0.251	-0.108	0.051	-0.076
Njarðvík	-0.085	-0.167	-0.244	-0.215	-0.042	0.015	-0.138
Hafnir	-0.195	-0.397	-0.353	-0.406	-0.292	-0.168	0.163
Sandgerði	-0.193	-0.141	-0.301	-0.159	-0.166	-0.011	-0.150
Garður	-0.170	-0.254	-0.195	-0.264	-0.201	-0.019	-0.107
Vogar	-0.212	-0.172	-0.328	-0.294	-0.142	-0.135	-0.010
Akranes	-0.098	-0.164	-0.091	-0.187	-0.103	0.026	-0.044
Ólafsvík	-0.145	-0.276	-0.222	-0.229	-0.158	-0.018	-0.112
Borgarnes	-0.088	-0.229	-0.278	-0.225	-0.130	-0.022	-0.079
Hellissandur/Rif	-0.212	-0.213	-0.319	-0.121	-0.301	0.004	-0.137
Grundarfjörður, Eyrarsveit	-0.151	-0.269	-0.289	-0.186	-0.102	-0.083	-0.059
Stykkishólmur	-0.053	-0.185	-0.304	-0.270	-0.122	-0.110	-0.105
Ísafjörður/Hnífsd.	-0.126	-0.101	-0.207	-0.197	-0.069	-0.015	-0.034
Bolungarvík	-0.199	-0.197	-0.258	-0.191	-0.239	-0.019	-0.090
Patreksfjörður	-0.153	-0.152	-0.313	-0.208	-0.140	-0.049	-0.217
Tálknafjörður	-0.194	-0.186	-0.374	-0.294	-0.140	-0.127	-0.197
Bíldudalur, Suðurfjarðarhreppur	-0.217	-0.227	-0.361	-0.119	-0.316	-0.056	-0.236
Þingeyri	-0.111	-0.333	-0.210	-0.247	-0.308	-0.110	-0.161
Flateyri	-0.124	-0.435	-0.404	-0.264	-0.051	-0.121	-0.330
Suðureyri	-0.091	-0.215	-0.475	-0.148	-0.200	-0.144	-0.170
Súðavík	-0.257	-0.240	-0.277	-0.374	-0.277	-0.069	-0.313
Drangsnes/Kaldrananeshreppur	-0.337	-0.395	-0.342	-0.329	-0.166	-0.212	-0.172
Hólmavík	-0.091	-0.269	-0.328	-0.180	-0.219	-0.137	-0.054
Siglufjörður	-0.106	-0.164	-0.201	-0.229	-0.119	-0.070	-0.089
Sauðárkrókur	-0.110	-0.152	-0.236	-0.138	-0.136	-0.038	-0.052
Hvammstangi	-0.182	-0.198	-0.236	-0.341	-0.218	-0.015	-0.103
Blönduós	-0.165	-0.220	-0.230	-0.329	-0.088	-0.086	-0.079
Skagaströnd/Höfðahreppur	-0.200	-0.151	-0.208	-0.348	-0.143	-0.019	-0.160
Hofsós/Hofshreppur	-0.084	-0.314	-0.207	-0.461	-0.155	-0.067	-0.270
Akureyri	-0.055	-0.068	-0.094	-0.120	-0.023	0.109	0.012

Húsavík	-0.100	-0.193	-0.214	-0.195	-0.111	-0.028	-0.084
Ólafsfjörður	-0.119	-0.297	-0.198	-0.226	-0.090	-0.074	-0.090
Dalvík	-0.081	-0.258	-0.272	-0.209	-0.108	0.012	-0.096
Grímsey	-0.248	-0.397	-0.262	-0.181	-0.323	-0.126	-0.174
Hrísey	-0.106	-0.269	-0.247	-0.280	-0.219	-0.090	-0.229
Árskógsströnd/Árskógshreppur	-0.240	-0.185	-0.353	-0.314	-0.267	-0.073	-0.076
Grenivík/Grýtubakkahreppur	-0.220	-0.340	-0.329	-0.304	-0.188	-0.087	-0.104
Kópasker/Öxarfj.hr./Presthólahr.	-0.193	-0.267	-0.425	-0.324	-0.200	-0.292	-0.146
Raufarhöfn	-0.157	-0.277	-0.218	-0.284	-0.226	-0.064	-0.188
Þórshöfn	-0.073	-0.437	-0.262	-0.263	-0.244	-0.041	-0.235
Seyðisfjörður	-0.198	-0.206	-0.232	-0.472	0.133	-0.117	-0.112
Neskaupstaður	-0.099	-0.173	-0.253	-0.146	-0.229	0.000	-0.040
Eskifjörður	-0.185	-0.217	-0.201	-0.289	-0.122	-0.041	-0.120
Bakkafjörður/Skeggjastaðahr.	-0.253	-0.324	-0.368	-0.232	-0.309	-0.242	-0.004
Vopnafjörður	-0.196	-0.298	-0.228	-0.227	-0.161	-0.064	-0.085
Borgarfjörður eystri/Borgarfj.hr.	0.097	-0.351	-0.313	-0.465	-0.171	-0.157	-0.126
Reyðarfjörður	-0.149	-0.313	-0.214	-0.226	-0.172	-0.052	-0.187
Fáskrúðsfjörður, Búðahreppur	-0.204	-0.189	-0.322	-0.160	-0.234	-0.060	-0.161
Stöðvarfjörður/Stöðvarhreppur	-0.294	-0.234	-0.239	-0.295	-0.222	-0.103	-0.145
Breiðdalsvík/Breiðdalshreppur	-0.165	-0.249	-0.226	-0.306	-0.204	-0.136	-0.128
Djúpivogur, Búlandshreppur	-0.195	-0.231	-0.268	-0.206	-0.289	-0.013	-0.152
Hornafjörður	-0.153	-0.198	-0.269	-0.188	-0.198	0.100	-0.059
Vestmannaeyjar	0.001	-0.096	-0.227	-0.149	-0.168	0.084	0.002
Selfoss	-0.116	-0.107	-0.210	-0.183	-0.159	0.079	-0.026
Stokkseyri	-0.190	-0.341	-0.240	-0.261	-0.203	0.018	-0.133
Eyrarbakki	-0.198	-0.217	-0.328	-0.210	-0.143	-0.140	-0.168
Þorlákshöfn, Ölfushreppur	-0.166	-0.174	-0.232	-0.176	-0.138	-0.042	-0.073
Other Domestic	0.034	-0.057	-0.084	-0.047	-0.079	0.138	0.056

Table I, continued	**1990**	**1991**	**1992**	**1993**	**1994**
Capital area	-0.081	0.151	0.235	0.026	0.128
Keflavík	-0.294	-0.090	-0.015	-0.136	-0.082
Grindavík	-0.356	-0.145	-0.039	-0.261	-0.152
Njarðvík	-0.293	-0.102	0.004	-0.277	-0.093
Hafnir	-0.480	-0.471	-0.228	0.028	-0.399
Sandgerði	-0.323	-0.152	0.006	-0.321	-0.110
Garður	-0.379	-0.202	0.000	-0.272	-0.175
Vogar	-0.466	-0.174	-0.027	-0.199	-0.252
Akranes	-0.328	-0.062	0.016	-0.210	-0.137
Ólafsvík	-0.351	-0.224	-0.160	-0.182	-0.210
Borgarnes	-0.309	-0.094	-0.075	-0.199	-0.275
Hellissandur/Rif	-0.340	-0.226	-0.067	-0.342	-0.262
Grundarfjörður, Eyrarsveit	-0.424	-0.168	-0.074	-0.170	-0.241
Stykkishólmur	-0.324	-0.149	-0.026	-0.243	-0.193
Ísafjörður/Hnífsd.	-0.298	-0.133	0.014	-0.191	-0.168
Bolungarvík	-0.374	-0.183	0.015	-0.298	-0.235
Patreksfjörður	-0.290	-0.271	-0.006	-0.306	-0.280
Tálknafjörður	-0.312	-0.324	-0.057	-0.270	-0.362
Bíldudalur, Suðurfjarðarhreppur	-0.376	-0.248	-0.177	-0.290	-0.326
Þingeyri	-0.272	-0.289	-0.100	-0.241	-0.263
Flateyri	-0.315	-0.119	-0.137	-0.382	-0.204
Suðureyri	-0.461	-0.284	-0.135	-0.081	-0.444
Súðavík	-0.357	-0.250	-0.094	-0.361	-0.260

Drangsnes/Kaldrananeshreppur	-0.303	-0.315	-0.259	-0.244	-0.251
Hólmavík	-0.368	-0.189	-0.065	-0.360	-0.234
Siglufjörður	-0.291	-0.220	-0.018	-0.169	-0.226
Sauðárkrókur	-0.288	-0.139	0.027	-0.172	-0.183
Hvammstangi	-0.314	-0.292	-0.033	-0.287	-0.236
Blönduós	-0.372	-0.158	-0.099	-0.267	-0.218
Skagaströnd/Höfðahreppur	-0.439	-0.236	0.032	-0.263	-0.245
Hofsós/Hofshreppur	-0.295	-0.283	-0.084	-0.239	-0.318
Akureyri	-0.215	-0.037	0.083	-0.132	-0.065
Húsavík	-0.296	-0.164	-0.019	-0.168	-0.176
Ólafsfjörður	-0.416	-0.123	-0.041	-0.308	-0.194
Dalvík	-0.330	-0.154	-0.046	-0.210	-0.217
Grímsey	-0.290	-0.361	-0.156	-0.390	-0.362
Hrísey	-0.448	-0.217	-0.215	-0.311	-0.145
Árskógsströnd/Árskógshreppur	-0.401	-0.298	-0.013	-0.390	-0.263
Grenivík/Grýtubakkahreppur	-0.432	-0.239	-0.031	-0.337	-0.359
Kópasker/Öxarfj.hr./Presthólahr.	-0.464	-0.191	-0.046	-0.354	-0.193
Raufarhöfn	-0.436	-0.193	-0.157	-0.277	-0.177
Þórshöfn	-0.224	-0.236	-0.057	-0.230	-0.199
Seyðisfjörður	-0.422	-0.267	-0.055	-0.259	-0.239
Neskaupstaður	-0.359	-0.246	-0.028	-0.216	-0.224
Eskifjörður	-0.413	-0.235	0.047	-0.287	-0.154
Bakkafjörður/Skeggjastaðahr.	-0.475	-0.325	-0.062	-0.288	-0.205
Vopnafjörður	-0.384	-0.205	-0.109	-0.206	-0.192
Borgarfjörður eystri/Borgarfj.hr.	-0.333	-0.377	-0.121	-0.305	-0.316
Reyðarfjörður	-0.305	-0.174	-0.111	-0.329	-0.254
Fáskrúðsfjörður, Búðahreppur	-0.301	-0.199	-0.147	-0.251	-0.292
Stöðvarfjörður/Stöðvarhreppur	-0.392	-0.247	-0.237	-0.342	-0.228
Breiðdalsvík/Breiðdalshreppur	-0.475	-0.259	-0.214	-0.192	-0.216
Djúpivogur, Búlandshreppur	-0.419	-0.220	-0.130	-0.267	-0.330
Hornafjörður	-0.372	-0.121	-0.037	-0.254	-0.155
Vestmannaeyjar	-0.280	-0.143	-0.028	-0.149	-0.130
Selfoss	-0.279	-0.135	0.001	-0.182	-0.098
Stokkseyri	-0.414	-0.093	-0.099	-0.308	-0.260
Eyrarbakki	-0.276	-0.298	0.006	-0.306	-0.253
Þorlákshöfn, Ölfushreppur	-0.289	-0.183	-0.030	-0.231	-0.192
Other Domestic	-0.231	-0.035	0.118	-0.100	-0.054

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Translation of titles of publications not written in English is italicized. In the main text, Icelandic authors are referenced by their full name in accordance with Icelandic convention. In the list of references, publications whose author is specified are sorted by the last name of the (first) author. Publications whose author is not specified are sorted by the name of the publication and listed separately at the back.

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