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Summary:

Productivity growth in the Norwegian ferry industry 1988 - 1996

Introduction

Ferry links play a vital role in the national road network of Norway. Fare revenues do not cover operating costs, so the ferry operators receive a total subsidy of approximately 600 MNOK per year. This amount has been constant throughout the nineties. Up to 1990 costs were reimbursed at the end of the year. From 1990 on, the subsidy is contracted on in advance.

In this report we study how the productivity of the ferry links has developed from 1988 to 1996. According to Førsund (1993) productivity in the ferry industry declined in the eighties. Has it improved since then? Has the effect of the fixed subsidy reform in 1990 petered out from 1993 to 1996? If so, what more can we do to improve efficiency, and what is the potential for improvement?

Given the high degree of control which the National Road Authority exerts over the stock of ferries, fares and investment policy, it is by no means obvious that the productivity development that we find can be ascribed to the ferry operators' own decisions and acts. We try to discuss the causes of the observed development and give advice on regulatory reforms based on our findings.

Problem formulation

Our study covers the period from 1988 to 1996. Efficiency in the four years 1988,1989, 1993 and 1996 has been studied. The units studied are ferry links in the national road system, not single ferries. The following questions are treated at the industry level:

1. Has cost efficiency in the production of the ferry transport *supply* improved in this period? What has been the role of the fixed contract reform in this?
2. Has efficiency improved in the use of a certain ferry transport supply to produce ferry transport *services* (actual passenger kilometres and car kilometres)? What has been the role of the fixed contract reform in this?
3. Has *cost efficiency* in the production of ferry transport services improved in the period? What has been the role of the fixed contract reform in this?
4. How could the regulation of the national roads ferry industry be improved, based on what we find in this study?

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Method and data

We used Data Envelopment Analysis (DEA) for this study. This method was introduced by Charnes, Cooper and Rhodes in 1978. It has given rise to a large field of research and applications. To study productivity growth over time, we use Malmquist indices calculated from the efficiency measures for the single years. Chapter 3 is devoted to these methods.

A ferry company produces ferry transport services. It operates one or more ferry links. A ferry link can be seen as a production unit of the ferry company. Its productivity is its ability to tranform inputs to products (ferry transport services).

But what is ferry transport services? From a technical point of view, the number of crossings per time unit and the capacity provided per crossing may be measures of how much is produced of ferry transport services. The productivity of the link is then its ability to perform crossings with a given stock of ferries, labour and energy use.

But at a closer look, it is not this activity level in itself that is important. The activity must be suitable, which means that it is carried out at the times of day when travellers need it, and with a quality that suits them. How many that will actually want to use the ferry link is usually a good measure of how suitable its activity is. From this point of view, the number of passenger and car trips may be a better measure of ferry services than the number of crossings. The productivity of a ferry link will then be its ability to carry out passenger and car trips with a given stock of ferries, labour and energy use.

In short, we regard the production of ferry transport services as a two-stage production process. In the first, inputs like labour, capital and energy is used to produce a ferry transport supply, and in the second, a ferry transport supply is used to perform ferry services.

Three DEA models are set up. The first studies cost efficiency in the production of crossings, capacity per crossing and the length of the crossings. The reason why we do not multiply these three products to get the total number of capacity kilometres per time unit of the link, is that how the capacity kilometres are composed of these three factors makes a difference for costs and for travellers.

The second studies how the ferry transport supply defined by the three products of the first model is used to produce trips for passengers and cars. More precisely, we use two inputs, the number of crossings and the number of capacity kilometres per crossing, to produce passenger kilometres and PCE-kilometres (PCE = private car equivalents). The third model studies cost efficiency in the production of ferry services, as defined by the three products passenger trips, PCE-trips and ferry trip length.

The three DEA models are tailored to provide the answers to the three first questions above. As it turns out, we also need some information at a more aggregate level to provide the clues to the answers. Two important quality aspects - the frequency at low traffic periods and the number of cars left behind in peak traffic conditions - could not be included in the models for lack of reliable data. Thus we cannot be entirely sure that productivity growth in the second model is not achieved at the expense of these quality aspects.

The National Road Administration keeps a database of information about the ferry links. It also receives accounts and financial information from the ferry companies and produces accounting statistics (not public). From these sources we extracted data on 43 links which were unaltered in the period 1988-96 and had a full set of fairly reliable data. These links turn out to be representative for the industry as a whole in important respects, although they were not selected at random.

As a result of our analysis, possible errors in the passenger data were detected. We have no explanation for them as yet. The implication is that we must be more cautious about some of our conclusions than we would have been else.

Results and conclusions

With regard to cost efficient production of the ferry transport supply, we find that three tendencies have counteracted each other to produce a Malmquist index close to 1, that is, a zero productivity growth.

One is the introduction of new ferry models that cost more per unit of capacity. This tendency acts from 1993 on. The other is the tendency to reduce frequency - obviously to keep control of the costs under the new fixed contracts and the new ferry models. This tendency exerts itself only in the period 1989-93. Together, these two tendencies pull towards a less cost efficient ferry transport supply in the 1989-96 period, if the ferry transport supply is defined by three products as above.

The third tendency is cost reductions by other means than frequency reductions. They may have been caused by the fixed contract reform. We think such cost reductions have counteracted a decline in the Malmquist index for the period 1989-93. In the period 1993-96, however, productivity has probably declined somewhat in a situation where neither of the first two tendencies can explain it. Thus the third tendency must have been weaker.

Capacity kilometres have increased appreciably from 1988 to 1996. This is caused by larger ferries, and only to a very small degree by more crossings. This way of providing more capacity may reduce the number of cars left behind in peak periods, but does not reduce waiting time for the majority of cars and passengers.

At the aggregate level, increased ferry sizes combined with the economic downturn of 1988-93 to reduce capacity utilisation. Even so, productivity in the production of ferry transport services grew. One possible explanation for this is that the fixed contract reform triggered new schedules and other measures that counteracted the potential reduction in capacity utilisation as far as the *heavy traffic links* are concerned. During the economic upturn from 1993, frequency did not increase at the same rate as demand. This may be due to government policy. The result was strong productivity growth in the production of ferry transport services.

However, there are indications that productivity growth actually was negative for links with little traffic. During the 90-ies, they may have acquired ferries that were too large, while their potential to adapt their schedules was very restricted. As a consequence, the need for subsidies in the industry as a whole may not have been reduced.

There is a potential for efficiency increase in the ferry industry. As nothing much can be done about the transport distance and demand conditions of each particular link,

however, the scale inefficiencies that exist cannot be eliminated. As a consequence, the potential is less than the 30% found in Førsund (1993). From a practical point of view, it is probably 15% at most for the industry as a whole.

The answers to the questions asked in the study are therefore:

1. There has been zero growth in productivity with regard to cost efficient production of the ferry transport *supply*. The fixed contract reform has probably contributed to not making it negative, but this effect has diminished after a few years.
2. There has been a productivity growth with regard to the efficient use of the ferry transport supply to produce ferry transport *services*. This is probably due to the heavy traffic links. Productivity in the light traffic links may have declined. The fixed contract reform may have contributed to the observed development either by inducing the operators to adjust their schedules to achieve higher capacity utilisation, or by inducing government to be more restrictive with frequency increases. The details of supply in high and low demand periods have not been studied, which makes it difficult to say if the observed productivity growth is accompanied by unwanted quality reductions.
3. There may have been a productivity decline in the cost efficient production of ferry transport services. If so, this is mainly due to the low demand links, which are also the links with the highest relative subsidy levels. The need for subsidies for the industry as a whole may therefore not have been reduced.

What are the implications of these results for the regulation of the industry?

At the moment, the use of auctions to allocate ferry links to operating firms is a hot issue. We do not intend to take it up here, but we may note that to the degree that auctions are seen as a way to circumvent the rather cumbersome system of ferry renewal and allocation in place now, there is the obvious alternative to change those rules. As a start, it must be recognised that the economic life of a ferry is 30 years ore more. This should be reflected in the depreciation rules. Much longer periods of depreciation will give government and operators alike a better grasp on the real cost of capital. Secondly, the current very low maximum level of return on own capital should be abolished. It means that the operators are reluctant to invest their own capital in new ferries, and come to rely on a programme of state guaranteed loans for this purpose. This lifts the decisions to acquire new ferries to a level where it does not belong, as the huge growth in ferry sizes and close to zero growth in crossings show.

Government must of course set standards for ferries to ensure that they can be used in as many links as possible, here and abroad. This will give us a functioning second hand market for ferries, laying the foundation for increased competition in the long run. Government must also set quality standards. Beside this, decisions on ferry sizes, acquisitions etc. belong at the company level.

Government should retain control over maximum prices and subsidies. The subsidy mechanism can probably not be based on a common formal norm, as our study shows that ferry links produce under widely varying conditions, and cannot be expected to all achieve the same unit costs. It is recommended to include a premium for frequency increases in the subsidy mechanism to get the operators to internalise the open and hidden waiting costs of travellers. As for prices, it is a good idea to allow peak load pricing in the form of summer prices or in other ways, to prevent the use of too much unutilised capacity during large periods of the year.

A freer allocation of ferries and correctly designed subsidy mechanisms and price regulations will open the way for realising a part of the potential for efficiency improvements that we have found. We leave it for the future to design these regulatory measures in detail.

We warn against the combined use of a ferry renewal programme that gives us larger and larger ferries and some form of common cost norm. This will either mean reduced frequencies or bring about increased subsidies over time. The same tendency that was observed for the fixed contract reform might as well be observed for more sophisticated schemes to provide incentives to reduce costs. That is, it takes only a few years before any scheme that seems to give every incentive to the operator to reduce costs, transforms into a virtual cost plus contract. The reason is that the contract negotiations is a game that is repeated each year. The solution is to offer longer term contracts that leaves as much as possible of the responsibility of cost overruns to the operator, and gives him a large part of any cost savings. To avoid the possibility that such contracts will be very costly to the government, they should either retain their present possibilities to learn as much as possible about costs and revenue of each link, or introduce auctions.

We think the model apparatus built up in this project to analyse the productivity growth in the ferry industry in the 90-ies might also be useful in the future. Among other things it can be used to assess the total subsidy requirement of the industry in a fairly objective way. A precondition, however, is that a high quality of the data in the ferry database can be secured. We also need a DEA data programme can combines variable returns to scale with the calculation of Malmquist indices.