Economic analysis of out-of-town establishments in the retail industry

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Abstract

The structural changes in retailing towards out-of-town establishments over the last few decades have affected the attractiveness of towns and cities and the urban transport system profoundly. Many countries in Europe have implemented policies and planning guidelines that reflect a more restrictive attitude towards out-of-town establishments. This has been done, however, without an in-depth economic analysis. This paper will discuss the research agenda in this field with examples and applications from the grocery sector. The main focus is tackled from two complementary perspectives: the construction of a spatial general optimisation model and identification of potential “social dilemmas” associated with the structural changes. The results show that out-of-town stores are not efficient when the available streets and roads are congested, even when economies of scale are considered. The hypothesis that social dilemmas influence household’s choice of stores is supported by the results. Together with the problems of varying preference structures between individuals in the same residential areas, it seems that town planning, and other institutional measures, should be employed to prevent an excessive dominance of out-of-town stores in grocery retailing and support more variety in local retail service.
Introduction

The structural changes in retailing towards out-of-town establishments during the latest decades have affected the attractiveness of towns and cities and the urban transport system profoundly. Increasing car-usage and dependency, decreasing production of retail services in residential areas, degeneration of inner cities and costly revitalisation programs, reduced demand for public transport with negative consequences for the quality, are some of the factors that can be observed and, in part, linked to the changes in retailing.

Increasing access and usage of the private car, in combination with a historic record of accommodating town planning, has enhanced the exploitation of scale economies within distribution firms.

As a reaction to this development, many countries in Europe have implemented policies and planning guidelines with a more restrictive attitude towards out-of-town establishments in retailing. This has been done, however, without an in-depth economic analysis capable of ranking different systems of distributing (transportation, storing, handling etc.) goods in urban areas, according to their overall socio-economic efficiency, when relevant externalities, distribution costs in the informal sector etc., are incorporated in the analysis.

There is a strong ambiguity concerning the overall efficiency of the distribution system when the costs associated with, for example, travelling and purchasing performed by households are treated as an integrated part of the total distribution cost function.

This paper will discuss the research agenda in this field with examples and applications from the grocery sector, where wholesaling and retailing of groceries are defined as parts of an integrated urban production system. The paper will also present some recent findings from the research performed by the authors. The focus of the research, which is partly based on surveys, is on modelling the consequences of different types of store locations in cities, and identifying the relevant external costs associated with a decreasing production of retail services in residential areas. The paper will also discuss the economic potential of Internet shopping.

Research questions

The research questions dealt with in this paper concern the overall economic efficiency of grocery distribution systems in towns and cities. This main focus is tackled from two complementary perspectives:
The construction of a spatial general optimisation model capable of evaluating different distribution systems in urban areas and identification of potential "social dilemmas" associated with structural changes in grocery retailing.

The aim is to bring together these perspectives in an integrated and comprehensive analytical framework, as well as identifying relevant questions for further research.

**Theoretical and methodological considerations**

The research is based on economic theory, where distribution of goods is conceptualised as an integrated system with firms and households as the relevant actors performing distribution activities associated with different cost components. The nucleus of the system is the costs for transportation, storing and handling goods, activities carried out by production firms, distribution firms, i.e. wholesalers and retailers, and household members. Institutional and organisational barriers between firms and households, formal markets and informal sectors etc., must be handled in the analysis, where the system as a single entity defines the analytical framework. This approach has been developed in earlier research performed by the authors of this paper [1]. The driving forces behind and consequences of out-of-town establishments in retailing are frequently analysed and debated, with focus on car-usage and environmental effects, consequences for other stores and inner-cities, price-levels and competition and so on [1]. The strategy in current research discussed in this paper is, however, to integrate several relevant aspects of the structural changes in grocery retailing into one integrated and comprehensive framework. This line of investigation is of course inspired by other attempts in the research field such as the CREATE model, i.e. combined retail, economic and transportation evaluation, discussed in [2].

The analysis starts with the most obvious and accessible cost items, such as in firm costs registered by price-levels for different categories of stores and generalised transportation costs for private car-traffic. The data can be collected from governmental bodies, official calculation recommendations for public infrastructure investments, earlier research etc. When this possibility is exhausted, data has to be generated from primary sources such as questionnaires to households.

The ultimate objective is to construct a model that is capable of handling all relevant costs in one single analytical device. This target has, however, not been reached yet but setting the agenda and pointing out the directions for future research can be a valuable support for planning authorities and policy makers.
This paper proceeds with a discussion of the necessary foundation that has
been developed when modelling urban distribution systems with spatial
optimisation models. Then the results from a complementary pilot study,
discussing the identification of social dilemmas connected with decreasing
production of retail services in residential areas, is presented and elaborated. The
paper finishes with a tentative discussion of the economic potential of Internet
shopping, and conclusions and questions for future research.

Modelling urban distribution systems

In Haraldsson [3] the foundation of a spatial optimisation model, which defines
the most efficient distribution system, is developed. The underlying idea is that
the optimal localisation and size of grocery stores is a function of economies of
scale within firms and distributions costs, transportation costs for example, within
households. The optimal system, i.e. the solution of the model, minimises the
overall distribution costs, assuming a determined number of shopping trips. Each
store in the model has a hexagonal market area and the optimisation is carried out
within the boundaries of four systems of store structures, representing different
combinations of store size and location. This means, of course, that the entire city
has a hexagonal shape. The generalised transportation cost function includes
parameters representing distance, parking, time usage and differences between
taxed and non-taxed labour costs.

In principle the problem is to find a cost minimising balance between
economies of scale and generalised transport costs for customers. Larger
distribution nodes (stores) imply that potential economies of scale can be realised,
which generates lower prices, but also that customers have to travel longer
distances. Thus, increased store size means lower prices, while the consumers
have to contribute with a larger share of the total distribution costs. The basis for
the model is a function that reflects the price level for different store sizes, and a
generalised transport cost function. The price level function, which is estimated
on data collected in 202 Swedish stores, describes the relationship between the
price level and the turnover. Therefore the function in principle resembles
average cost functions, normally used in the literature to illustrate scale
economies. The price level is a sum of 282 different item prices, with weights
based on a monthly consumption pattern for a family with two adults and two
children. The Swedish Consumer Agency collected the data [4]. The estimated
function in eqn (1), where $x$ is annual store turnover and $y$ is price, shows that the
price level decreases with higher turnover and asymptotically reaches 3000 SEK.
The regression model is significant on the 99 percent level.
The cost function shows that there is a welfare benefit to exploit by reducing the number of grocery stores in the modelled city. The reduced number of stores, however, increases the average distance between customers and stores. Within the hexagonal city model, with hexagonal market areas with radius $r$, the distance is measured by eqn (2).

\[
\text{tot.dist.} = r^3 \sin 30 \cos 30 \left[1 + \cos^2 30 \frac{1}{\sin 30} \left\{ \frac{1 + \sin 30}{\cos 30} \right\} \right] \tag{2}
\]

The model consists of three levels of stores: large stores ("hypermarkets"), medium sized stores in district (neighbourhood) centres and small stores in residential areas. The largest stores can be located in the inner city or out-of-town, which in this case is "edge-of-town". To handle these levels within the model, constraints are imposed that limits the market area radius. This also means that a minimum number of stores are imposed implicitly in the model. The endogenous variables are number of stores in each category, and percentages of the total amount of groceries purchased in the different categories. There is also a constraint attached to these shares. The minimum share of the total amount allowed at every store level is 10 percent. The model is best suited for analysing city locations, i.e. inside the hexagons, but is fully capable of handling out-of-town establishments. These are located on the outskirts of the city, and therefore have market areas that are parts of hexagons rather than complete hexagons. In this model setting the number of out-of-town stores can not be specified as continuous variables. Instead the distances and costs are evaluated for a limited number of stores, located evenly on the boundaries of the city. Then the cost-minimising number of stores is found through discrete optimisation, where the discrete set consists of alternatives with different numbers of stores, market areas and average distances.

The implicit assumption that all relevant costs on the supply side are included in the price-level function gives us a simple and one-dimensional measure of costs within the distribution firm. The consumer costs are, however, comprised of transportation costs, i.e. fuel costs and capital depreciation of cars, as well as time usage. They also include parking costs, which in terms of welfare economics is the alternative cost for parking lots. One must also take into account the tax wedge between the work performed in firms, and similar work performed by households. In the model two traffic scenarios are evaluated. As road-pricing theory shows, the cost associated with car-traffic on a specific street is dependent on the traffic flows. Thus, the cost of travelling to a store depends on the amount of free road capacity. Consequently, the outcome of the optimisation is not static;
instead it is dependent on the traffic load. The costs of distributing groceries are therefore computed with low traffic-flow costs as well as high traffic-flow costs.

The inhabitants in the city model are uniformly distributed with a density of 3,000 individuals per square kilometre. The area of the city is about 65 km², which gives a total number of inhabitants of around 200,000.

Model optimisations show that a distribution system with large stores located in the inner city is not efficient. The fact that a central location minimises the travel distances are more than counterbalanced by parking costs, which are considerable in inner cities. To fully exploit the scale economies, out-of-town establishments are necessary. With a moderate transportation cost the most efficient distribution system sustains 3 out-of-town stores, 30 stores in district centres and around 100 stores in residential areas. Higher kilometre costs changes the optimal solution, however. When transport costs reach high levels, due to traffic volumes near the capacity limit, it is no longer efficient to concentrate the stores to a few large units. The transport costs are too high, which makes the large stores inefficient. Hence, the optimal solution contains only two levels, district centre stores and stores in residential areas. The number of stores is 25 and 157 respectively.

A strong tendency in the model is the rationality in concentrating the main purchases to the larger units in each scenario. Even if small stores are visited frequently and the roads are congested, it is efficient to use the smaller stores for complementary shopping only.

The model is basic and conclusions should be drawn with care. The total costs associated with specific store combinations are rough approximations and should only be used for qualitative interpretations. We have shown, as expected, that high transport costs make a more dense network of smaller stores the most efficient from a welfare perspective, while low transportation costs imply the opposite. Furthermore, the opportunity cost of parking lots in the inner city is an almost prohibitive factor in locating large stores there. There seems to be a need for policies and incentives that encourage more efficient developments in grocery retailing. In reality, of course, the distribution system in a city cannot be altered to accommodate short-term transport cost fluctuations. In the long run, though, the distribution system can adapt to relevant transport costs. To achieve this long-term equilibrium, relevant costs need to be internalised in the actor's goal functions on perfectly functioning markets. An optimal solution demands prices that give complete and correct information about all the costs associated with the distribution of groceries in towns and cities, e.g. with road-pricing measures. The alternative, or in some cases the necessary complement, to efficient pricing is town planning.
Several studies have evaluated the traffic volumes generated by different numbers of stores, as well as their size and locations in cities [5]. Despite the results from this research the debate has focused on competition between firms. In Sweden, the main reason for the laissez-faire policy towards out-of-town establishments has been a desire to increase the rivalry between firms. There is, however, no evidence of increased competition. The number of firms on the market, and their market shares, has been roughly the same since the 1950's. Instead, the new and large stores decrease the price-levels due to scale economies. When these economies are taken into account, the efficiency problem turns out to be a trade off between producer and consumer costs. The model outlined here will hopefully focus attention on this important economic problem. A research project is planned where the model will be further developed in an attempt to make shopping trips endogenous and to evaluate different types of city designs, with more realistic characteristics. The enlargement and improvement of the model will enhance analyses of Internet shopping, see below, which is a strategy for the distribution of groceries that has been widely discussed but only sparsely implemented.

Decreasing production of retail services as a social dilemma

According to, for example, Ostrom [6], a social dilemma can be broadly described as a situation where benefits achieved from the consumption of a public good is hindered because the unique equilibrium for rational egoists in a single-shot game is to contribute, or pay, nothing at all. This means that a Pareto-sanctioned transaction that would yield a social payoff way above every actor’s own contribution is not accomplished and results in a social efficiency loss.

The question is if this line of argument has any bearing on the social and economic consequences of the structural changes towards larger and more distant food stores in grocery retailing. The answer should in principle be yes. The problem can be discussed and conceptualised using a household’s choice of stores when purchasing groceries. Assume that a household originally can use only one store, which is located in the residential area. Assume further that a new out-of-town supermarket is established, say 10 kilometres from the residence of the household. The factors that should decide which store to use and to what extent are possible, but somewhat tricky, to define following economic cost minimising principles, see [7]. The important conclusion from that exercise is, however, that a “rational egoist” household has no reason to let the risk of a vanishing “accessibility component”, caused by a deteriorating production of retail services in the residential area, influence the decision. One reason for this is, of course,
that one isolated household can not by itself influence the volume and quality of the local retail service.

If this “accessibility component” were internalised with a positive value, a rational household would buy more in the local store, or participate in some other institutional arrangement with the aim of keeping or improving local retail services.

**Empirical tests of social dilemmas in grocery retailing**

In order to find out if there is any empirical equivalence to the theoretical discussion above, a pilot study was carried out. This was done by means of a postal questionnaire with hypothetical questions about household’s choice of stores, together with questions about socio-economic conditions and actual purchasing behaviour. The questionnaire was sent out to 400 individuals, living in the same district in a small Swedish city. The hypothetical questions were constructed as choices of shares of the total amount of groceries purchased by the household in two different stores: a local neighbourhood store and a distant out-of-town store. The local store was more expensive than the out-of-town establishment. The price-differences were based on the cost functions discussed above. The respondent could choose to buy 0%, 10%, 25%, 50%, 75% or 100% of the groceries in the local shop, and the remainder, of course, in the larger store.

After a first round of questions options were altered. The consequences of different purchasing shares were described in a table, with the assumption that everybody in the area would choose the same alternative as the respondent. It is plausible to assume that the distant large store is unaffected by the behaviour of the residents in the particular area, but that the outcome concerning the local store is directly in proportion to the chosen share. Larger share means lower prices and higher quality in other respects, particularly as regards the range of products, in the local shop. The share “0%” implies, of course, that the local store is forced to close. The share “100%” implies that the local store is unaffected by the arrival of the new out-of-town establishment.

When the respondent had been informed of the consequences, the same question was asked again: “How much groceries do you want to buy in the local store?” This means that the respondent now chooses a scenario for the level of retail service in the area, knowing that everyone else will behave in the same way. The accessibility component discussed above is now internalised, hypothetically, in the household decision making.

Thus, we got a “before” and an “after” scenario, which can be compared with each other. This is done in the following figure:
The columns show, in percentages, the shares chosen by the interviewees in the survey “before” and “after” the information of the consequences for the local store. For example: 49% of the respondents “before” and 37% “after” chose the share 10% in the local store. There is a clear overall tendency in favour of the local store in the “after” scenario. The average market share for the local store increases from 31% “before” to 39% “after”. The increase is statistically significant (p<0.05). Around 37% percent of the individuals choose to buy half or more of their groceries in the local store in the “after” case, compared to 29% “before”. The result implies that the hypothesis about social dilemmas in this field is relevant, but has to be scrutinised further in forthcoming research.

**A scattered preference structure**

The distributions of shares, shown above, were analysed with the aim of finding the reasons behind the actual choice and the differences between “before” and “after”. It was not possible to explain this difference with regression models. Although the difference between the two distributions is statistically significant, most of the interviewees preferred to choose the same alternative in the two cases.

The research effort was therefore directed towards the distributions as such. To compensate for the rather small sample (400 questionnaires, with an answering frequency of ca 56%) “pooled” regression models were used, which means that the data described in the two distributions above were combined into one data set. [8]. A dummy variable with the value 1 for the “after” observations, and the value 0 for the “before” observations, was incorporated in the model.
In a first step only socio-economic variables and the dummy variable were used in the models. The determination coefficient was low in all specifications, less than 0.1, but the F-value was significant and some of the explanatory variables were estimated with significant coefficients: sex, income, age and numbers of household members. Lower income, lower ages, fewer household members, and if the interviewee is a woman, are factors that increase the share of groceries purchased in the local store.

By dividing the material in half, those in favour of the out-of-town establishment in one, and those who prefer the local store in the other, two more variables seems to influence the choice in the hypothetical questions. These variables are car-access or ownership, and type of housing. Car-ownership and living in detached housing, as opposed to flats, was significantly lower in the “local store” half of the material. The dummy variable was significant in all specifications which, again, proves that the difference between the “before” and “after” case is statistically significant.

By adding variables which describes the actual buying behaviour, such as frequencies, modes of transportation, actual store category used by the household etc., the determination coefficient in the regression models was improved dramatically, up to 0.4. These variables are of course not explanatory variables in a theoretical sense, only based on the plausible assumption that there is a correlation between revealed and stated preferences, which also leads to some conclusions from the analysis.

The results clearly show that individuals living in the same residential area have varying preferences about the demanded level of retailing service in the neighbourhood. Some prefer local stores and are willing to pay for this service, and some prefer to drive their car to more distant stores and take advantage of lower prices. By using regression models, and other methods, it is possible to link these differences in preferences to socio-economic background variables.

It is also clear that the actual situation in grocery retailing in the investigated area, and elsewhere, accommodates the preferences of those who prefer to do most of their grocery shopping in out-of-town establishments. The large stores attract customers from the entire city, which implies a diminishing market for the smaller local stores in residential areas. If individuals with more similar preferences lived in the same areas, the potential for a higher level of local retail service would have been larger. This is of course not easy to accomplish, and might also lead to negative consequences for other aspects of society. To sum up, it seems that two kinds of efficiency problems have been identified, which are necessary to tackle in further research: social dilemmas impacting on the choice of which store to use, and consequences of geographically scattered preference structures among neighbours.
Is Internet shopping efficient?

From a welfare point of view there is much uncertainty concerning the potential of Internet grocery shopping. Some basic investigations have been performed and there is some evidence that Internet shopping of groceries reduces energy consumption and emissions from combustion engines [9]. Other studies merely report the present volumes traded in this sector and the potential accessibility to Internet shopping. Compared to the present system with ordinary stores, it is more difficult to evaluate Internet shopping on an empirical basis. From a more theoretical point of view though, one can hypothetically conclude that there might be a considerable potential in Internet grocery shopping. The potentials consist for instance in the possibility of co-ordinating the transports in the last link of the distribution chain, i.e. between stores and houses, and utilising scale economies [10]. Other possible welfare gains are reduced space for storing and exposure of goods. With Internet shopping the only interface needed between the distribution firms and the consumer is a web site. Therefore the nodes can be designed to enhance efficient storing and handling by firms, with more capital-intensive production methods. Internet shopping also facilitates the information flow from consumers to firms. This means that marketing can be based on true knowledge about demand rather than uncertain estimates, which will decrease costs and make just-in-time procedures more efficient.

Of course there is also a cost side in the analysis of Internet shopping. One cost component is the planning needed in order to purchase groceries from web stores. The spontaneity in consumption must be reduced to facilitate co-ordination and planning of the transportation activities, now performed only by firms. There is some evidence that Internet shopping reduces frequencies and is less spontaneous and better planned than traditional shopping.

We have discussed costs and benefits, which on a theoretical/hypothetical basis can be relevant for Internet shopping as an economic phenomenon. To fully evaluate this alternative from a welfare perspective, it is necessary to develop a quantitative model with a set of relevant cost functions. Even without model support, there is some evidence that turning Internet grocery shopping into a profitable or even break-even enterprise is a difficult task. The structural changes of grocery retailing, observed in Sweden and other countries, are partly driven by the tax wedge between the formal and informal sectors of the economy. Due to the lack of taxation on household work, a large part of grocery distribution is performed by untaxed, unspecialised labour in households. Internet shopping on the other hand implies that more work would be performed by taxed labour, which is the main explanation of the observed difficulties in creating profitable, and, in other respects, successful Internet-based systems in grocery retailing.
However, if model simulations show that Internet shopping has a higher benefit/cost ratio than traditional shopping, modifications of the fiscal legislation might be considered. A conclusion based on the discussion so far is that model-based analysis of Internet shopping would be a valuable and necessary contribution to the research. An expanded version of the model presented earlier in this paper could be used for this purpose.

Conclusions

The results discussed here are preliminary outcomes of pilot studies and should be interpreted with care. Nevertheless, the approach of appraising the economic efficiency of urban distribution systems with the comprehensive framework used in the studies seems promising. The ongoing trend towards more out-of-town establishments in grocery retailing raises some questions about the overall economic efficiency of the distribution system. The results show that out-of-town stores are not efficient when the available streets and roads are congested, even when scale-economies are considered. The transport reducing characteristics of a tighter network of stores, with locations in district centres and residential areas, is more efficient under these circumstances. Establishing large grocery stores in city centres, with widespread markets, is in all circumstances a waste of scarce resources, due to the dominance of the car in the present transportation system.

The hypothesis about social dilemmas influencing household's choice of stores, is supported by the results, which casts further doubt on the efficiency implications of some of the presents trends in grocery retailing. Together with the problems of varying preference structures between individuals in the same residential areas, it seems that town planning, and other institutional measures, should be employed to prevent an excessive dominance of out-of-town stores in grocery retailing and support more variety in local retail service.

The economic efficiency of an Internet based distribution system in urban settings can be judged with the same kind of model approach that is outlined in this paper. It is an unlikely scenario that the market shares for Internet retailing will grow dramatically in the short term. A tentative hypothesis is that Internet shopping and traditional stores are substitutes, not complements, in the scale-dependent grocery-retailing sector. Therefore, it is necessary to perform economic evaluations of alternative distribution systems with the same approach used in this paper, where Internet shopping is one of the relevant alternatives.
Questions for further research

The research discussed in this paper will continue. The spatial optimisation model will be developed further and additional cost elements will be specified. To collect the necessary data, postal questionnaires to households will be used. Consumer cost items such as transportation costs when using other means of transportation than the private car, and planning costs need to be scrutinised. On the system level it would be useful to describe the congestion cost with a continuous function, and add the externalities associated with goods deliveries by heavy lorries to the price-level function for different store categories. It is also necessary to develop the analysis of actual purchasing behaviour. We are constructing a database with primary data describing how households purchase groceries, e.g. frequencies, means of transportation, volumes, errand combinations, store choice etc. When it is possible, all model specifications should be profoundly anchored in empirical facts. We have recently formulated the first steps in an activity-based demand model, with the aim of gaining knowledge about household's purchasing trips in cities [11].

The data about purchasing behaviour will be combined with data about preference structures and preferred scenarios describing alternative developments of grocery retailing in the future. The strategy is to collect data about purchasing behaviour, e.g. revealed preferences, and stated preferences in the same surveys. We are continuously developing questionnaires suited for this purpose. The research into social dilemmas needs to be more stringent and linked to logical reasoning founded on economic theory. It is also important to use a wider approach, and focus on other criteria relevant for efficient design of residential areas, such as the transportation system, leisure and entertainment, and other socio-economic aspects. [12].

References

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