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Spatial Effects of Transport Infrastructure: The Role of Market Structure

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Abstract

Theoretical reasoning shows that spatial effects of transport cost reductions may crucially depend on market structures in the tradables sector (degree of market power, strength of economies of scale, free or no free entry). The aim of this paper is to compare empirically the effects of transport cost reductions due to infrastructure investments, emerging under different market structures. To this end, a computable spatial general equilibrium model with costly interregional trade is presented, which is calibrated for a large number of regions covering Europe. Applying this model, transport cost reductions are simulated under two different assumptions with regard to the market structure prevailing in the tradables sector: (1) perfect competition with constant returns to scale, and (2) monopolistic competition with increasing returns and free entry. Results are compared in terms of money-metric measures of regional welfare changes.

Keywords: transport, spatial computable general equilibrium, welfare, market structure.

1 Theoretical background

Welfare effects of transport cost reductions crucially depend on whether or not the assumptions of perfect competition hold in the economy under study. In a perfectly competitive economy, the social marginal money-metric utility gain due to a cost reduction anywhere in the economy is just the marginal cost reduction itself. No indirect effects have to be taken into consideration, because of the efficiency of the allocation. Any marginal allocation change brought about by the respective cost reduction has a zero impact on welfare. Otherwise, the allocation would not be efficient. This fundamental result is sometimes called the "cost of a cost is its cost"-theorem.

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If the cost change is larger than marginal, it is still true that the social benefit of a cost reduction on a certain transport link is totally covered by the direct benefits of the users of the respective link. The area left of the transport demand curve between the old and new marginal user costs now measures the welfare gains correctly (LESOURNE [7]). A rigorous proof requires a precise notion of a demand curve in a general equilibrium setting, but for practical purposes the distinction between different concepts needs not concern us. The traditional cost benefit approach is essentially correct, even if it uses a crude rule of a half, which is to multiply the unit cost reductions with the average of old and new flow quantities along a link.

If competition is imperfect on some market affected by the cost reduction, however, the true monetary benefit may be larger or smaller than the direct effect, as already noted by HUSSAIN & WESTIN [5] and VENABLES & GASIOREK [9]. This is because with distorted prices marginal variations of the allocation do have a welfare effect, in general.

This is easily stated, but analysing the deviance of total from direct benefits in an imperfect competition world is more complicated. We try to explain the relevant effects, though a precise study requires a well specified modelling framework. Let $\boldsymbol{x} = (x_1, \dots, x_n)$ denote the output vector in the economy, and let $\boldsymbol{p}$ and $\boldsymbol{c}$ denote the respective vectors of relative consumer prices and relative marginal costs. Furthermore, let $\boldsymbol{x}_k = (\partial x_1/\partial k, \dots, \partial x_n/\partial k)$ denote the vector of partial derivations of outputs with respect to transport costs k.[1] $\mathrm{d}k$ is the marginal transport cost change (marginal cost reductions for all flows across a certain link, say). Then total marginal welfare gain is

$$\mathrm{d}W = -[1 + \boldsymbol{x}_k \cdot (\boldsymbol{p} - \boldsymbol{c})]\mathrm{d}k.$$

Following HUSSAIN & WESTIN [5] we call the expression in brackets the total benefit multiplier (TBM). It is equal to one under conditions of perfect competition, because the second term vanishes. Under imperfect competition it may be larger or smaller than one, depending on whether and to what extent a transport cost decline makes output increase or decrease in sectors with consumer prices exceeding marginal costs.

There are three effects making $\boldsymbol{x}$ change as a consequence of a transport cost reduction, a substitution effect, an income effect, and a competition effect. Take a transport cost decline for goods delivered from r to s as an example. Here the substitution effect means that in s it becomes more attractive to buy goods from r, and r will produce more goods delivered to s. There are also indirect effects, because producers in r will buy more inputs for producing more for s, and possibly less inputs for producing for others. Price changes will eventually induce real income changes (incomes probably rise in r as well as in s, and they may rise or fall elsewhere), and these in turn induce demand and output changes. These are the income effects.

The substitution and income effects can have a positive or negative welfare impact, depending on whether the cost decline favours output in sectors, where the excess of price over marginal cost is relatively high or relatively low. The papers of HUSSAIN & WESTIN [5] as well as VENABLES & GASIOREK [9] find a positive welfare effect, because the design of their models implies that transport costs are saved in the distorted tradables market,

[1] The vector $\boldsymbol{x}$ may also include components for labour supply. Then the respective p_i is understood as the wage rate, and the respective c_i as the marginal willingness to pay for working less.

while the non-distorted market is not directly affected. The non-distorted market is the factor market in Hussain's & Westin's and the non-tradables market in Venables' & Gasiorek's paper.

Up to now we have claimed that reallocations affect welfare through output changes of an existing bundle of goods. With an endogenous product diversity, however, there is a second channel. A larger output can allow for a larger product diversity, if each product brand is produced under increasing returns. Under special conditions it happens that any output change comes as a change in the variety measure, while the output per variety remains the same. This is the well known Spence/Dixit/Stiglitz case (see [6]). Even though there is no output change for any existing good in this case, the story is essentially as before. Income and substitution effects generate a welfare increase, if they induce an expansion in those sectors, where the degree of monopoly is high. Here the welfare gain does not stem from the excess of customer price over marginal cost, however, but from increased product diversity. The lower the elasticity of substitution, the higher is the degree of monopoly, and the higher is the welfare again brought about by increasing the measure of diversity.

Beyond the income and substitution effects, there can exist a further effect, which is absent in the Spence/Dixit/Stiglitz framework, the competition effect. Up to now we took market power as exogenous. In the Spence/Dixit/Stiglitz framework, for example, market power is a parameter, appearing in preferences and technologies. Market power, however, could itself be a function of transport cost. Reducing transport cost reduces a barrier protecting a local monopoly from outside competitors, thus keeping the excess of price over marginal cost up. As a case in point, consider a two regions two sectors economy. Let the regions be identical and assume a local monopoly delivers one of the two goods in each region, respectively. Potential competitors within each region are kept away from the market by sunk costs, and the local monopoly in one region cannot undercut the Cournot price in the other region due to transport cost, even if it reduces its mill price to marginal costs. Hence, Cournot prices survive in the monopoly sector in both regions. Note also, that by symmetry there is no interregional trade, even though transport costs are not prohibitive.

If transport costs for potential trade now are reduced to a sufficient degree, a competitive thread is generated reducing the local monopoly power and increasing welfare, even though there will be no trade after the reduction either. How precisely the story goes on after the cost reductions depends on specific assumptions about conjectural variations and pricing strategies. The essential conclusion, however, remains the same: If transport costs are causal to monopoly power, a transport cost reduction generates a welfare enhancing competition effect, except from the extreme case, that the local Cournot monopolies remain untouched even after the cost reduction. It may come as a surprise that the competition effect can make the TBM even infinitely large, as our example shows. There is a welfare gain even though the actual cost reduction $\mathrm{d}k$ is zero, because there is no trade. This is because it's not actual, but potential cost reduction generating the welfare gain.

2 A spatial CGE analysis

In the following we present a numerical experiment on the effects of the competitive regime, based on real world data. We set up a computable equilibrium model for Europe, subdivided into a large number of regions. It is used for calculating welfare effects of establishing new international road links in central and eastern Europe. These links are part of the Transeuropean Network (TEN) project of the EU. The model comes in two varieties. In one version all markets are perfectly competitive, while in the other the market structure in the tradables sector is monopolistic competition of the SPENCE/DIXIT/STIGLITZ type. Except from this distinction, both models are identical, and they are calibrated to the same data.

The models are large, as far as the number of regions is concerned (more than 800), but small in terms of sectoral detail. There is a single factor of production (with a fixed supply in each region) and two types of goods, tradables and non tradables. Households consume both types of goods, and firms use both types of goods plus the single production factor for producing a non tradable local good and a regional subset of tradables.

Regions only interact through trading tradables among each other.[2] Transferring goods between regions is costly, the costs depending on transport distance, inter alia. The models are static. Welfare effects of new road links are obtained from introducing the new links into the network and calculating new counterfactual equilibria with reduced distances.

Subsection 2.1 explains the monopolistic competition version of the model. The model is like the one applied to the integration issue in [3], with a few minor modifications. The application to the transport issue is explained in [4]. The reader is referred to these papers regarding details of model specification, calibration, and data. Subsection 2.2 explains the modifications leading to the perfect competition version. Section 3 briefly explains the calibration. Section 4 then reports the welfare effects of establishing new autobahns through the so-called Crete-Corridors in central and eastern Europe. It is shown how the results vary between the two model variants. A sensitivity analysis for a key parameter, the elasticity of substitution between tradable goods, is also presented.

2.1 Monopolistic competition

2.1.1 Final demand

Consider a closed system of n regions, each covering a representative household and a production sector. The household in region r owns the fixed regional factor stock F_r giving him a factor income $Y_r = w_r F_r$, with factor price w_r. The households' total disposable income N_r is Y_r plus a net income flow from other regions, G_r (possibly negative), which is exogenous for the sake of simplicity.[3] The household spends this income totally for local non-tradable goods and for a composite of tradables. His preferences have COBB-DOUGLAS form, such that fixed shares ϵN_r and $(1-\epsilon)N_r$ are spent for non-tradables and

[2]For technical reasons, a further form of interaction, namely interregional income flows, are introduced. They are exogenous, however, and need not concern us here.

[3]Strictly speaking, it's not G_r but the real flow $\tilde{G}_r$, which is exogenous. G_r is defined as $G_r = \tilde{G}_r \bar{p}$, with a price index $\bar{p}$. This price index is a linear-homogeneous function of prices.

tradables, respectively. This demand represents all kinds of final demand of the real world, including public consumption and private and public investment. The composite tradable is composed of a large number of tradables stemming from all regions of the system. The composition index is a symmetrical CES index with elasticity of substitution σ.

2.1.2 Production

Firms use the same composite tradable as an input, combined with the service of the regional factor stock and with the local non-tradable good, which they produce themselves. They produce an intermediate good by a constant returns COBB-DOUGLAS technology with cost shares α, β and γ, $\alpha+\beta+\gamma=1$, for factor service, local goods and tradables, respectively. This homogeneous intermediate serves a double purpose: first, it is one-to-one transformed to the local good, second it is transformed to different brands of tradables. Tradable brands are produced with a certain amount of fixed costs per brand and with constant marginal costs. Costs are measured in terms of the intermediate good.

Firms are price taking on the input markets and on the market for the local good, and act under monopolistic competition with free entry on the market for tradable outputs. Here the SPENCE/DIXIT/STIGLITZ formalism applies, which implies (1) that the price of a tradable output p_r equals[4] the costs per unit of the intermediate good (i.e. it equals the price of a non-tradable good) and (2) the number (or more precisely the measure) of brands equals[5] the real output of tradables, S_r/p_r. S_r is the output value of tradables.

These assumptions allow to derive supply and demand of tradables as functions of regional prices p_r and q_r. q_r is the price per unit of a composite tradable. From the cost share α we infer that the output value of firms is Y_r/α. It is used for final demand of local goods ($\epsilon(Y_r+G_r)$) and for local goods used as input ($\beta Y_r/\alpha$). The rest is the value of tradables supplied, which is

$$\begin{aligned} S_r &= \left(\frac{1-\beta}{\alpha}\right) Y_r - \epsilon(G_r+Y_r) \\ &= (\nu-\epsilon)Y_r - \epsilon G_r, \end{aligned} \tag{1}$$

with $\nu=(1-\beta)/\alpha$. Demand for tradables equals demand of households ($(1-\epsilon)(Y_r+G_r)$) plus demand of firms ($\gamma Y_r/\alpha$), which yields

$$\begin{aligned} D_r &= \left(1-\epsilon+\frac{\gamma}{\alpha}\right) Y_r + (1-\epsilon)G_r \qquad (2) \\ &= (\nu-\epsilon)Y_r + (1-\epsilon)G_r \\ &= S_r + G_r. \end{aligned}$$

Hence, S_r and D_r are linear in Y_r and G_r. Y_r is log-linear in the prices p_r and q_r, because

$$p_r = \frac{1}{\mu_r} w_r^\alpha p_r^\beta q_r^\gamma$$

[4]Equality here means equality up to a constant factor depending on the arbitrary choice of units.
[5]See footnote 4.

due to the COBB-DOUGLAS technology. Solving for w_r and inserting into $Y_r = w_r F_r$ yields

$$Y_r = L_r p_r^{\nu} q_r^{1-\nu} \tag{3}$$

with elasticity $\nu > 1$. L_r is a constant depending on regional factor stock and productivity. It is calibrated such that Y_r equals observed regional GDP in the benchmark equilibrium.

2.1.3 Transport cost and equilibrium

The final step is to introduce transport costs in interregional trade. Assume that transferring a good, worth of one \$, from r to s requires a transport service worth of $(\tau_{rs} - 1)$ \$. The transport service is performed by using up composite tradables in the region of destination. Then $p_r \tau_{rs}$ is the price to be paid in s for a brand from r, and the trade flow from r to s (in value terms) is (see [3])

$$t_{rs} = \frac{p_r l_r (p_r \tau_{rs})^{-\sigma}}{\sum_r p_r l_r (p_r \tau_{rs})^{-\sigma}} D_s, \tag{4}$$

with elasticity of substitution $\sigma > 1$. l_r is the measure of brands in r, which is $l_r = S_r / p_r$. Hence we obtain

$$t_{rs} = \frac{S_r (p_r \tau_{rs})^{-\sigma}}{\sum_r S_r (p_r \tau_{rs})^{-\sigma}} D_s. \tag{5}$$

According to the CES index, the price of a composite tradable is

$$q_s = \psi \left[\sum_r l_r (p_r \tau_{rs})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{6}$$

with an arbitrary constant ψ fixing units. With $l_r = S_r / p_r$ this becomes

$$q_s = \psi \left[\sum_r S_r p_r^{-\sigma} \tau_{rs}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{7}$$

Finally, the equilibrium condition

$$S_r = \sum_s t_{rs} \tag{8}$$

closes the system.

For τ_{rs} we chose the specification

$$\tau_{rs} = \exp \left[\frac{\rho}{\sigma} (g_{rs})^{\omega} \right] \delta_{kl}. \tag{9}$$

g_{rs} is the transport distance from r to s, δ_{kl} represents costs for overcoming international trade impediments, if region r and s belong to different countries k and l, respectively. ρ and ω are parameters.

Equations (1), (2), (3), (5), (7) and (8) give us supply S_r, demand D_r, factor income Y_r, trade flows t_{rs}, and prices q_r and p_r as functions of exogenous variables L_r, G_r, τ_{rs} and parameters ν, ϵ and σ.

2.1.4 A gravity interpretation

It is interesting to observe, that the equilibrium has some similarities with ALONSO's theory of movement [1], which is based not on microeconomic assumptions, but on gravity analogies. ALONSO proposed to make constraints in a doubly constrained gravity model depend on balancing factors, whose inverses have an accessibility interpretation. To detect this similarity, write (5) and (8) as

$$t_{rs} = S_r a_r (\tau_{rs})^{-\sigma} D_s b_s, \tag{10}$$

$$\sum_s t_{rs} = S_r, \tag{11}$$

$$\sum_r t_{rs} = D_s, \tag{12}$$

which is obviously a doubly constrained gravity form. The supply side balancing factor is inversely related to the supply price $p_r = a_r^{-1/\sigma}$. Note that a high price p_r (a low a_r) means a good accessibility to sales markets. The demand side balancing factor b_s is not quite a monotone transformation of q_s, but something very close to that:

$$b_s = \left[\sum_r S_r p_r^{-\sigma} (\tau_{rs})^{-\sigma} \right]^{-1}.$$

Compare this with

$$\left(\frac{q_s}{\psi} \right)^{\sigma - 1} = \left[\sum_r S_r p_r^{-\sigma} (\tau_{rs})^{1-\sigma} \right]^{-1}. \tag{13}$$

The only difference is the exponent for τ_{rs}. Note that a high price q_s and a high balancing factor b_s mean bad accessibility to markets supplying tradables.

ALONSO lets supply and demand be decreasing functions of their respective balancing factors. An analogous property holds in our case. Due to equation (3), supply is increasing in the supply price p_r (i. e. decreasing in a_r). Demand is decreasing in the demand price q_s (i.e. decreasing in the indicator on the RHS of (13), which is close to the balancing factor b_s).

2.2 Perfect competition

Now we assume tradables to be produced under constant returns to scale. The intermediate good is transformed to tradable goods one to one. As before, tradables are produced in a large number of symmetrical variants, but for each variant, there is a sufficient number of producers to make each of them behave as a price taker. There is no endogenous mechanism determining the number of brands per region. Hence, these numbers are regarded as exogenous. This leads to the so-called ARMINGTON assumption [2] in interregional trade.

As before, the supply price of a tradable, p_r, equals the unit cost of the intermediate good (and, hence, it als equals the price of a non-tradable good). But this is the case now for a different reason. In the monopolisitc competition case this holds because output per variety is a constant, and profits are zero due to free entry. Now it holds beause of constant returns to scale. Furthermore, as before, in real terms the input-output ratio in the tradables industry is independent of output and is the same everywhere. Again, however, this is true now for a different reason. In the monopolisitc competition case input and output vary in proportion, because only the number of brands varies, while the quantity per brand remains constant. Now we have a constant number of brands, but constant returns in the production of each brand.

Only minor modifications in the formal structure lead to the perfect competition case. Instead of (5) and (7) we have to use (4) and (6) now, respectively, with fixed constants l_r.[6] In the gravity form of the model, S_r in equations (10) and (13) (but not in the constraint (11)) has to be substituted by an (arbitrary) constant (S_r^0, say).

Though this seems to be a tiny variation, it can make a severe difference in the working of the model, at least in principle. The difference is, that in the perfect equilibrium world there is no market size effect. An increase in tradables supply from a certain region neither increases the willingness to buy goods from that region, nor does it improve market accessibility of regions near by. It's only a price decline, which could bring about such effects. In the monopolistic competition case not only a price decline, but also an output increase of tradables makes a region more attractive for choosing it as a supplyer.

This generates a forward linkage effect. Let, for example, output of tradables increases in a region r, after accessibility has improved due to new roads connecting it with some other region. Then the price of tradables increases in r because of limited factor supply, but product diversity also increases . For others buying tradables in r, the former effect is bad news, but the latter is good news. In a perfect equilibrium only the former, but in a monopolistic competition equilibrium also the latter effect exists.

3 Calibration

We will be brief on this point. The reader is referred to [3, 4] for details. If we know σ and the transport cost factors τ_{rs}, calibration essentially consists in solving the doubly constrained gravity system (10) to (12), with observed data inserted for S_r and D_s. The solution delivers a base year equilibrium.

Given σ, the transport cost factor τ_{rs} is obtained by estimating a regression based on the gravity equation (10), with τ_{rs} inserted from (9). As we have no interregional flows on a subnational level, we use international trade flows instead for estimating this regression.

There is one remaining unknown parameter, playing a decisive role for the issue at hand, the elasticity of substitution σ. The higher σ, the lower is the monopolistic price mark-up and, hence, the degree of competition. Recent OECD estimates [8] render mark-ups (price to marginal cost ratios) in the order of 1.2, averaged over industries. There are strong variations over sectors, of course, but minor ones over countries. This estimate corresponds to a σ estimate around 6.

There is another independent piece of information, however, letting this estimate of σ appear rather low. Holding other parameters constant in equation (9), we can calculate

[6] It can be shown, that the constants can arbitrarily be chosen. The choice affects calibrated base year prices, but not relative price changes obtained in comparative statics. In the welfare estimates only these changes matter.

transport costs from (9) as a function of σ. Given the estimated impact of distance on interregional trade, represented by the parameters ρ and ω, transport cost estimates are the lower, the higher is σ. Figure 1 plots the transport cost intensity C over σ. C is defined

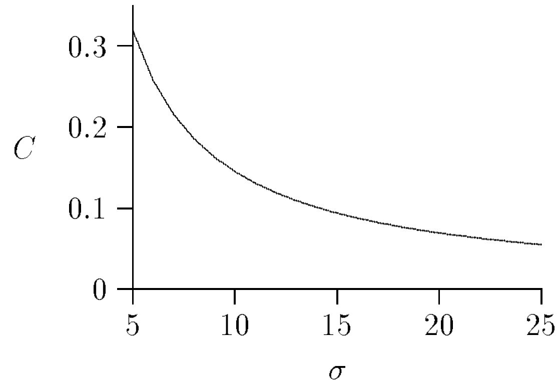

Figure 1: Transport cost intensity

as the ratio of total transport costs (only the distance related part, not international trade impediments) to the value of interregional trade. Following the literature, this ratio should be smaller than 0.1 (see [10] for a survey), implying a σ larger than 13. We cannot offer a resolution of the puzzle yet. Hence, we will vary σ over a plausible range in order to demonstrate the impact on welfare effects under different competitive regimes.

4 Results

We present results on welfare effects generated by building autobahns along each of the so-called "Crete-Corridors". After the EU launched its TEN programme in the Maastricht treaty, the European Conference of Ministers of Transportation (ECMT) added a further initiative in 1995 to define a set of international transport corridors connecting the EU with central and eastern Europe. There are 8 combined rail/road corridors (plus the Danube inland water way), called Crete-Corridors after the place, where the ministers made the decision in 1995.

Figure 2 shows results for imperfect competition with σ equal to 5, which is clearly at the lower bound of a plausible range of σ-estimates. We dispense with a corresponding figure for perfect competition, because it looks almost the same. Welfare gains are almost perfectly correlated, as shown in the scattergram in figure 3. With increasing σ, i.e. with decreasing degree of monopoly, results for the two regimes come even closer together. Hence, our first conclusion is that, at least in the framework of our model, the competitive regime has a negligible impact on the spatial distribution of welfare effects.

There is a non-negligible, though still moderate, effect on the level of welfare effects, however. Figure 4 shows welfare effects of all Crete-Corridor autobahns as a share in GDP, aggregated over all regions of our system. Welfare effects decline, of course, with increasing σ, because a larger σ implies a lower level of transport cost, if other parameters in equation

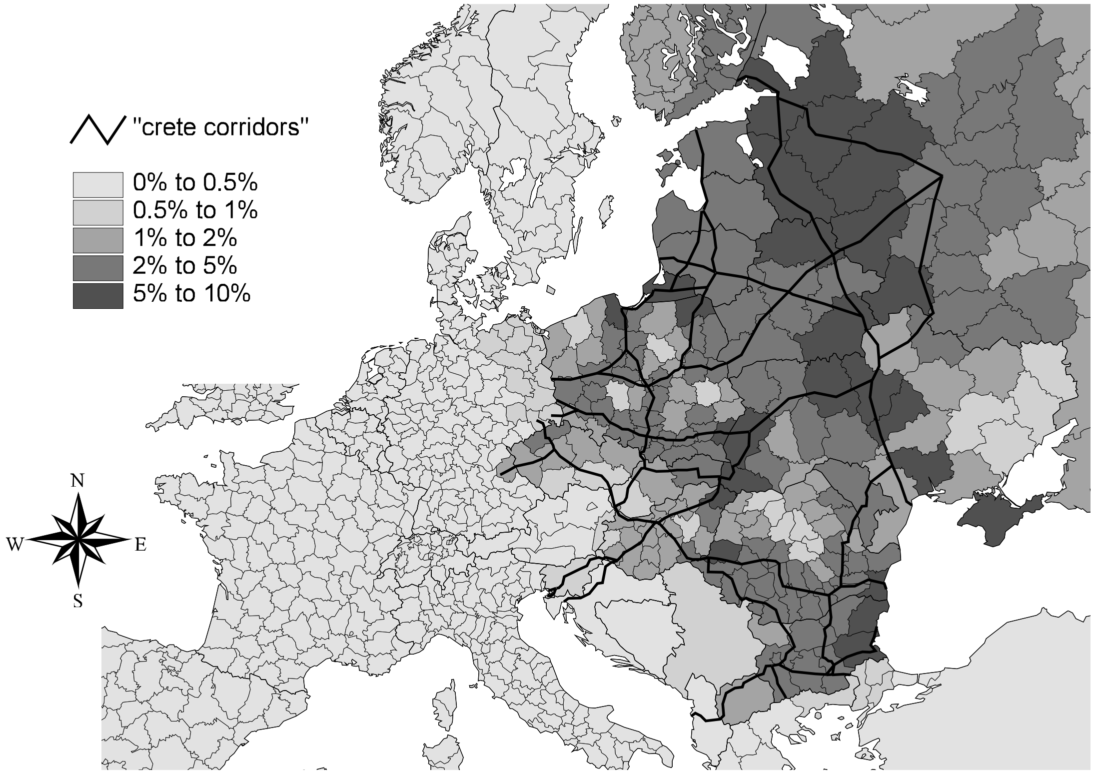

Figure 2: Crete-Corridors, welfare effects, percent of GDP

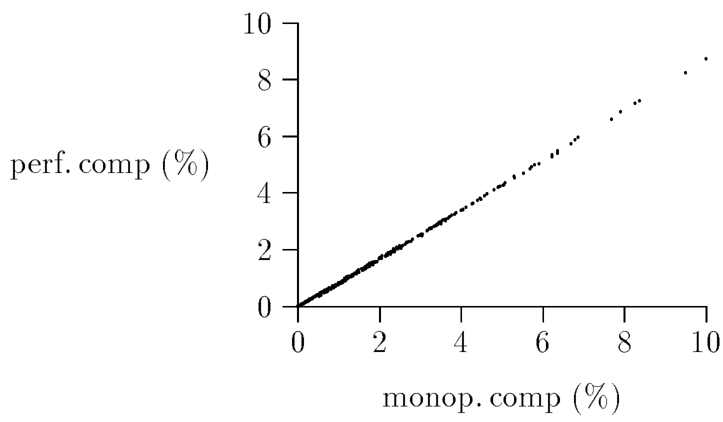

Figure 3: Correlation between welfare effects under perfect and imperfect competition

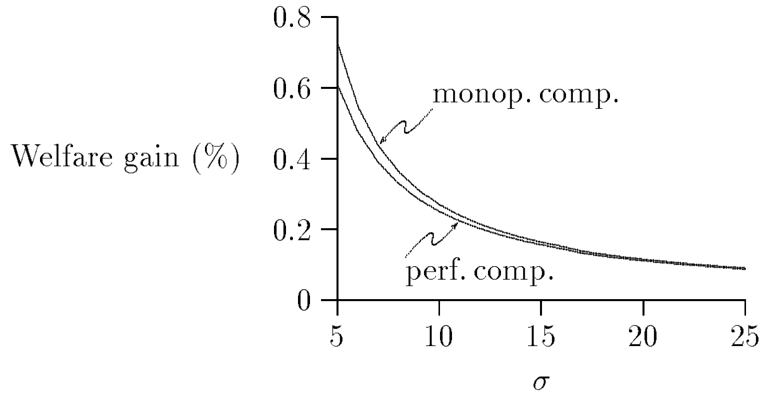

Figure 4: Crete-Corridors, aggregated welfare effects, percent of GDP

(9) are held constant. This has been explained already above. Furthermore, the gap between effects under monopolistic and perfect competition shrinks with increasing σ, as expected. This is more clearly revealed in figure 5, showing the total benefit multiplier (TBM), which is here simply defined as the ratio of welfare gains under monopolistic competition to those under perfect competition.

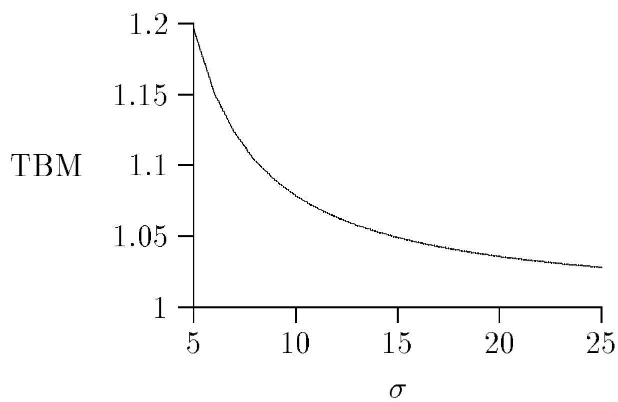

Figure 5: Total benefit multiplyer (TBM)

5 Conclusion

This paper argued that benefits from new transport capacities under conditions of imperfect competition might differ from those under perfect competition. The reason is that substitution effects, income effects and competition effects can lead to expansion or contraction in those sectors showing a comparatively high excess of price over marginal cost.

A numerical experiment with a case from the real world, namely building autobahns through the so-called "Crete-Corridors" showed a negligible impact of the competitive regime on the spatial distribution of welfare effects, but a significant effect on the levels. Still, however, the total benefit multiplier is not too far from unity, even for unplausibly high degrees of monopoly power.

To be sure, the generality of the numerical results is limited. Whether and to what degree the total benefit multiplier exceeds unity strongly depends on assumptions about competitive regimes in different segments of the economy. In our experiment, transport cost declines shift resources from the perfectly competitive local sector to the monopolistic tradable sector. Hence, output increases in a sector, where output falls short of its efficient level. Different results would be obtained, if high cost savings typically occur in sectors with particularly small (or even vanishing) excess of price over marginal cost. Further theoretical inquiries as well as numerical experiments are needed for a better understanding of these issues.

References

[1] W. Alonso. A theory of movement. In N. M. Hansen, editor, *Human Settlement Systems*, pages 195–212. Ballinger, Cambridge, Mass., 1978.

[2] P. S. Armington. A theory of demand for products distinguished by place of production. *International Monetary Staff Papers*, 16:159–76, 1969.

[3] J. Bröcker. How would an EU-membership of the Visegrád countries affect Europe's economic geography? *Annals of Regional Science*, 32:91–114, 1998.

[4] J. Bröcker. Spatial effects of new transport links: preliminary results from a spatial computable general equilibrium analysis. Paper presented at the "Seminar in Regional Economic Modeling" in Chicago, November 10 1998.

[5] I. Hussain and L. Westin. Network benefits from transport investments under increasing returns to scale. Umeå Economic Studies No. 432, Umeå Univesity, 1997.

[6] P. Krugman. Increasing returns, monopolisitc competition, and international trade. *Journal of International Economics*, 9:468–480, 1979.

[7] J. Lesourne. *Cost-Benefit Analysis and Economic Theory.* North-Holland, Amsterdam, 1975.

[8] J. O. Martins, S. Scarpetta, and D. Pilat. Mark-up ratios in manufacturing industries: estimates for 14 OECD countries. OECD Working Papers, Vol. IV, Economic Department Working Papers. No. 162, Paris, 1996.

[9] A. J. Venables and M. Gasiorek. The welfare implications of transport improvements in the presence of market failures. SACTRA Working Paper A, Revised 4/1/98, London, 1997.

[10] J. Weber. *Logistikkostenrechnung.* Springer, Berlin, 1987.