Simulation of co-operative strategies in the cross-border region Vienna – Bratislava

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Abstract:
The two capitals Vienna (Austria) and Bratislava (Slovakia) form a unique region. They have been separated by the Iron Curtain for decades. The Slovak accession to the EU in 2004 ended the enforced isolation and created a bi-polar region populated by about 3 million inhabitants (1.6 million of them in Vienna and 400,000 in the city of Bratislava). The distance between Vienna and Bratislava is only about 60 kilometres or a roughly one hours ride. Therefore every decision made in one city has a significant influence on the other. As well politicians as the business community agree to the importance of co-ordinated development and cooperation within the region. Several initiatives were and are started off by associations like the Viennese and the Slovak Chambers of Commerce. Many cross-boarder projects are co-financed by the European Union.

The main aim of this paper is to demonstrate and quantify the benefits of a cooperation between Vienna and Bratislava in the field of transport and land use planning. The dynamic land use and transport interaction model MARS of Vienna was extended to cover the whole region Vienna – Bratislava. This model is able to simulate a wide range of competition versus cooperation scenarios. Additionally it allows to assess the results as well with a traditional cost benefit analysis as with a multi criteria analysis.

Keywords:
Land use, transport, city co-operation
Introduction

The enlargement of the European Union is a great challenge for the economy, the transport system and land in the region of Eastern Austria and the neighbouring regions of the Czech Republic, Slovakia and Hungary. The EU enlargement in 2004 ended the enforced isolation. Customs formalities and waiting times are eliminated. After a transition period the new EU-citizens have the right to migrate freely within the European Union. These changes have significant effects on land use, freight and passenger transport. The distance between Vienna and Bratislava is about 60 kilometres or a roughly one hours ride. Due to this proximity Vienna and Bratislava form a unique bi-polar capital region (Figure 1). After decades of separation caused by the Iron Curtain the retrieved proximity is seen as a challenge by the majority but on the other hand also as a threat by a significant minority. But no one doubts that Vienna and Bratislava will form an agglomeration with about 3 million inhabitants. Within this dynamic environment numerous initiatives encouraging economic and political cooperation between Vienna and Bratislava exist. For example the web based cooperation platform of the Viennese chapter of the Austrian Federal Economic Chamber and the Slovak Chamber of Industry and Commerce chapter Bratislava. Another example is the cross border timetable information of the Austrian and Slovak public transport providers Verkehrsverbundes Ost Region GmbH (VOR) and Verkehrsbetriebe Bratislava (DPB) which was developed within the EU co-financed project FIRST (Feasibility of InterRegional information Services for Travellers). Representatives of commerce and industry furthermore claim an integrated planning approach.
The Vienna – Bratislava region

(Mitropolitski, 2005)

After recent EU expansion many dreams have been replaced by economic reality. Reality sometimes has been worse than expectations, but sometimes may be better. We have shown how cities from different countries within Western Europe have utilized some opportunity of closer cooperation. Another big opportunity is to integrate residential, industrial and business areas that were once part of countries lying across the Iron Curtain. Vienna (Austria) and Bratislava (Slovakia) or as they are unofficially called now "Twin City Vienna-Bratislava" can illustrate that such integration isn't only possible but is already taking shape. With population of almost 5 million (9 million with surrounding regions within 2 hours by car or train) this new common urban area may be one of the largest Central European metropolises.

The famous European historian of British origin Norman Davis has tried to understand the 20th century European history as a long way back toward the normalcy of shared political, economic and cultural norms that have existed before the WWI. What he sees in the European development after the end of the Cold War is precisely such return toward shared values and interests that were lacking for most of the century. Two medieval cities, Vienna and
Bratislava, which for decades were artificially separated by ethnic and ideological divides, are now successfully thriving in their common desire to overcome these past divisions. By creating a common urban area, these two capitals, which 100 years ago have been part of the larger Austro-Hungarian Empire were already linked with a regular tramway system, are once again showing Europe and the world the benefits of cooperation and mutual integration.

Each of these "just-married" has something special to offer for common good. Vienna has a well-developed sector of high-tech biotechnologies. Many world-known companies are already producing and exporting from there. Bratislava and surrounding regions have recently attracted many first class automobile producers. Two countries boast to have first grade education system by any European standard. The economic location of this new "Twin City" is ideal for businesses that are both developing European and Euroasian projects. There is a tough competition from other nearly located metropolises and this competition will help producing one of them as a leader of regional economic development.

First results of this common cooperation are already here. Two international airports that once served mainly domestic customers are increasingly turning into new regional air hubs serving tens of millions from all over Central and Southeast Europe. Given its good location on some of European busiest rivers, the new Twin City has all opportunities to become once again, as it did 100 years ago, a focus of Central European economic life.

**Vienna’s point of view**

(PriceWaterhouseCoopers, 2005)

**Global and international trends**

European enlargement in 2004 had, and still has, a significant impact on Vienna. As a result of its geographical location and historical background, the city is a melting pot of citizens from new and old member states, who increasingly commute across borders. Due to different cost levels (see Net-Income 2003) between Austria and the new member states, outsourcing and relocation will increasingly take place. This is especially likely with the migration of multinational enterprises to cheaper Eastern European locations and is a key issue for Vienna. Other trends are the ageing population and weakening family ties, which result in a growing municipal budget for social help and welfare as the need for more residential homes for elderly and nursing homes rises.
**Internal trends**

For Vienna, it is increasingly necessary to maintain or even expand the public transport network as more and more citizens of Vienna will not be able to afford their own car and the proportion of elderly people in the population is growing. Thus, about EUR 3.6 Billion is being spent on the 4th expansion stage of the subway system to develop peripheral areas. Furthermore, the educational level of the Viennese population is very high, resulting in an excess supply of highly-qualified labour.

New practices in public management, e.g. the introduction of flatter management structures are aimed at improving the performance and efficiency of the municipal administration. However, a key issue regarding personnel policy in administration in Austria is the legally limitation to reduce staff numbers. Many organisations are over-staffed, which of course means inflated costs. Due to the social function of local authorities, rationalisation goals are sometimes not pursued as stringently as in the private sector.

**External and internal challenges**

The two major challenges for the city are to maintain the current high educational standards and to attract international enterprises to keep their production sites in Vienna. In this context, public procurement law in Austria is regarded as conservative, with strict interpretations. Furthermore, ongoing outsourcing creates more liberal entrance to the market as seen with the outsourcing of museums and the Stadtwerke Holding AG (municipal utilities).

There are major opportunities for Vienna including:

- developing its housing stock;
- playing a key role as an administrative centre for companies active in CEE countries; and
- attracting high-tech companies.

The related risks are a possible downturn in the housing market and affordability. Vienna's strength is its sound financial base, especially compared to other federal states. (Note: Vienna is not only the capital of Austria but also represents an individual federal state).

As the predominant urban centre in Austria, Vienna attracts many immigrants from national and international territories, many of whom are financially dependent on the state, causing increased pressures on the cities finances and services. Furthermore, the responsibility for the construction and maintenance of federal roads was transferred from the federal authorities to
each federal state. Consequently, the respective roads have to be financed by the city of Vienna as the federal authorities will not pay beyond 2008.

**Meeting the challenges**

The city of Vienna is intensifying its efforts to motivate its citizens to engage in municipal issues. These efforts include placing a post-box for complaints in the city hall, special complaint-oriented departments, special services for citizens and increasingly citizen-friendly administrative processes. Furthermore, the municipal administration will become more decentralised. In general, the population regards Vienna as a city with a well-working and functioning administration.

**Priorities for the next decade**

The following are major priorities and visions for Vienna for the next decade, which were developed in the city development plan and finalised in detail by experts in the administration according to politically predetermined requirements:

- Vienna will become an example of environmental protection within its financial possibilities (e.g. construction of a third incineration plant);
- Vienna stands for a balance between affordability and high standards regarding housing stock (e.g. the avoidance of slums and ghettos; a social mix on the one hand but attracting socially stable and financially sound inhabitants);
- Vienna city council aims to create and maintain employment (e.g. establishing a foundation, which encourages the settlement of high-tech enterprises);
- Vienna will achieve a permanently balanced administrative budget (e.g. engaging in Public Private Partnerships only if the realisation of the project is impossible otherwise); and
- Vienna is to outsource tasks only when economically positive effects will be achieved.
Key indicators

In the following section some information regarding the region under investigation is provided. These data comprise the population (Figure 2, Figure 3, Figure 4), economic situation (Figure 5, Table 1) employment (Figure 6) and unemployment (Figure 7).

Population

Figure 2: Population trends in the Vienna – Bratislava region (% change p.a.); data source: (CENTROPE 2003)

Figure 3: Share of population younger than 15 years living in the Vienna – Bratislava region; data source: (CENTROPE 2003)
Figure 4: Share of population older than 60 years living in the Vienna – Bratislava region; data source: (CENTROPE 2003)

### Economic situation

Figure 5: Gross domestic product per head in the Vienna – Bratislava region (Index EU=100); data source: (CENTROPE 2003)
Net-Income 2003

<table>
<thead>
<tr>
<th>Profession</th>
<th>Bratislava</th>
<th>Vienna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>10.096</td>
<td>37.722</td>
</tr>
<tr>
<td>Engineer</td>
<td>6.139</td>
<td>24.147</td>
</tr>
<tr>
<td>Loan officer</td>
<td>6.139</td>
<td>21.760</td>
</tr>
<tr>
<td>Cook</td>
<td>4.229</td>
<td>21.487</td>
</tr>
<tr>
<td>Craftsman</td>
<td>3.956</td>
<td>18.622</td>
</tr>
<tr>
<td>Teacher</td>
<td>3.070</td>
<td>18.486</td>
</tr>
<tr>
<td>Secretary</td>
<td>2.865</td>
<td>17.735</td>
</tr>
<tr>
<td>Bus driver</td>
<td>3.820</td>
<td>16.371</td>
</tr>
<tr>
<td>Auto mechanic</td>
<td>3.752</td>
<td>15.894</td>
</tr>
<tr>
<td>Sales person</td>
<td>2.797</td>
<td>14.325</td>
</tr>
<tr>
<td>Construction worker</td>
<td>2.933</td>
<td>12.210</td>
</tr>
<tr>
<td>Blue-collar worker</td>
<td>2.115</td>
<td>11.323</td>
</tr>
</tbody>
</table>

Table 1: Net-income in €/year in Bratislava and Vienna, data source: UBS AG, Preise und Löhne 2003

Employment situation

Figure 6: Employment trends in the Vienna – Bratislava region (% change p.a.); data source: (CENTROPE 2003)
Figure 7: Share of unemployed population living in the Vienna – Bratislava region; data source: (CENTROPE 2003)

**Transport projects in the Vienna – Bratislava region**

During the next ten years numerous infrastructure projects will be realized within the Vienna – Bratislava region (see Figure 8 for more detail).

The aim is a belt system to connect Vienna and Bratislava on the road as well as with the railway north and south of the Danube. After realization the journey time will be reduced to approximately 35 minutes.

**Road:**

- A freeway surrounding Vienna counter clockwise from the South up to the North West combining already existing roads to the so called “regional belt”.
- An upgrade of the existing A4 motorway to the Vienna airport.
- A freeway through the Marchfeld, the northern half of the region between Vienna and Bratislava eventually meeting the “O-Ring” surrounding Bratislava.
- The “O-Ring”, a beltway surrounding Bratislava North – East – South, connecting the Bratislava airport to the region.
- A6, a motorway connecting the A4 with the Bratislava beltway.

**Railway:**

- The Vienna Central Station, combining Vienna’s southern and south eastern railway station.
- Electrification of the line Gänserndorf – Marchegg – Devinska Nova Ves
- Electrification and upgrade of the “Marchegger Ast”, a railway line going through the northern half of the region, meeting the line going from Gänserndorf to Devinska Nova Ves.
- The newly constructed “Link Götzendorf”, linking the southern half of the region to the Vienna airport and the city of Vienna as well as connecting the Bratislava airport via railway to the Vienna airport.
- A new station in Bratislava “Filiaka” and another bridge over the Danube.

**Waterway:**
- The “Twin City Liner”, a shuttle boat connecting Vienna and Bratislava 3 times a day.
- Upgrading the Danube to be navigable the whole year over.

![Figure 8: Transport infrastructure projects in the region Vienna – Bratislava](Krichmayr 2006)

### The land use and transport interaction model MARS

#### The context of land use and transport interaction modelling

Probably the first operational land-use model was presented by (Lowry 1964). The early land use models drew solely on analogies to physics, e.g. the law of gravity. Today’s state-of-the-practice models have their foundation in random utility theory. Random utility theory is based on the principle of utility maximization originating from micro-economics. Nevertheless it
has been shown by (Anas 1983) that the two modelling types – gravity models and random utility models - are formally equivalent. Typically, land use and transport interaction models combine at least two separate components: a land-use and a transport sub-model, which generate dynamic behaviour based on time lags between the two systems. State of the art models feature a modular structure, which allows the flexibility to include further aspects such as imperfect markets (David Simmonds Consultancy 1999). However (SACTRA 1998) raises concerns that land use and transport interaction models focus mainly on the redistribution of activities, neglecting aggregate effects, e.g. on employment, as overall economic activity is usually exogenously specified. Some of the most advanced European land use and transport interaction models are IRPUD (Wegener 1998; Wegener 2004), DELTA (Simmonds 1999; Simmonds 2001), MEPLAN (Echenique et al. 1990) and MARS (Pfaffenbichler 2003).

**Structure of the MARS model**

MARS is a dynamic Land Use and Transport Integrated (LUTI) model. The basic underlying hypothesis of MARS is that settlements and activities within them are self organizing systems. Therefore MARS is based on the principles of systems dynamics (Sterman 2000) and synergetics (Haken 1983). A comprehensive description of MARS can be found in (Pfaffenbichler 2003). To date MARS has been applied to seven European cities (Edinburgh - UK, Helsinki - FIN, Leeds - UK, Madrid -ESP, Oslo - NOR, Stockholm – S, and Vienna – A) and 3 Asian cities (Chiang Mai and Ubon Ratchathani in Thailand and Hanoi in Vietnam). A case study investigating the effects of public transport infrastructure projects in Madrid has been presented at the 45th Congress of the European Regional Science Association in Amsterdam (Pfaffenbichler and Mateos 2005).

The present version of MARS is implemented in Vensim®, a System Dynamics programming environment. This environment was designed specifically for dynamic problems, and is therefore an ideal tool to model dynamic processes. The MARS model includes a transport model which simulates the travel behaviour of the population related to their housing and workplace location, a housing development model, a household location choice model, a workplace development model, a workplace location choice model, as well as a fuel consumption and emission model. All these models are interrelated with each other and the major interrelations between the different sub-models are shown in Figure 9.
Main cause effect relations

This section uses the Causal Loop Diagram (CLD) technique to explain two of the core sub-models of MARS namely the transport model and the land use development model. Figure 10 shows the CLD for the factors which affect the number of commute trips taken by car from one zone to another. From Figure 10 we start with loop B1 which is a balancing feedback loop, commute trips by car increase as the attractiveness by car increases which in turn increases the search time for a parking space which then decreases the attractiveness of car use – hence the balancing nature of the loop. Loop B2 represents the effect of congestion – as trips by car increase speeds decrease, times increase and so attractiveness is decreased. Loop B3 shows the impact on fuel costs, in our urban case as speeds increase fuel consumption is decreased – again we have a balancing feedback.

Loop B4 represents the effect of congestion on other modes and is actually a reinforcing loop – as trips by car increase, speeds by car and public transport decrease which increases costs by other modes and all other things equal, would lead to a further increase in attractiveness by car. The other elements on Figure 10 show the key drivers of attractiveness by car for commuting. These include car availability, attractiveness of the zone relative to others which is driven by the number of workplaces and population. The employed population drives the total number of commute trips and within MARS the total time spent commuting influences
the time left for other non-commute trips. Similar CLDs could be drawn for other modes and for non-commute trips as MARS works on a self-replicating principle applying the same approach to all sub-models.

Figure 11 shows the CLD for the development of housing in MARS. Loop H1 is a balancing feedback loop which shows that the attractiveness to the developer to develop in a given zone is determined by the rent which can be achieved which is driven by the excess demand for housing which in turn is related to the housing stock and new housing developments. As new houses are developed the stock is increased which reduces the excess demand which then reduces the rent achievable which reduces the attractiveness to develop – hence we have a balancing loop.

Loop H2 is a reinforcing loop as new housing reduces the excess demand which reduces rent and hence land price which in turn makes development more attractive all other things being equal. Loop H3 represents the restriction of land available for development as land available is reduced then the attractiveness to develop is reduced. Loop H4 extends H3 to represent the effect of land availability on land price. Finally the drivers of demand for housing are shown to be population, amount of green space and accessibility to activities from that zone.

Figure 10: CLD for the transport model – commute trips by car in MARS
Award of the Viennese chamber of commerce 2006

This project will be funded by the chamber of commerce of Vienna and has two objectives. The first one is to give an overview of completed, existing and planned co-operations between the cities Vienna and Bratislava.

Both cities, Vienna and Bratislava, had – until recently – their own purpose within each country. Now – in the European Union – both have to adjust and find their new places. The “Twin-City” project is praised by nearly every economist and seen as a last resort for cities to gain importance in the greater European context.

Around 50 interregional projects – infrastructure, labour market as well as research and development – have been set off in a first phase. Now the objective is a well-regulated “city-to-city” strategy for the administration.

The main objective is, with help of the land use and transport interaction model MARS, to quantify, compare and appraise the economic assets and drawbacks of different co-operative strategies. For this purpose – against the background of different frameworks (competition versus co-operation) – the traffic volume, workplace and resident migration within the region will be forecasted.

Every infrastructure project – regardless of the mode – has an impact on the economy, the community and the development of each city.
We want to point out strengths and weaknesses of the planned projects in the transport, land use and economic context.

The Vienna-Bratislava MARS model

Figure 12: Model zones of the original MARS model of the functional urban region (FUR) Vienna and the extension to Bratislava

The “Award of the Viennese chamber of commerce 2006” project just has begun, so there is no essential outcome yet. At the conference we will have a calibrated and validated model to show results over a 30 year period regarding

- spatial housing market development,
- spatial business development,
- spatial employment development,
- spatial population development,
- used means of transport and
- environmental impacts.
Outlook

The first step will be a literature research in the broader sense to survey completed, existing and planned co-operations between the cities Vienna and Bratislava. An objective is the compilation of theories and basic principles of the advantages of coordinated planning. The starting point will be the research project BENEFICIAL (Economic Benefits of an Efficient Institutional Co-ordination between Transport and Land Use policy Illustrated on Austrian Level) (Knoflacher and Pfaffenbichler 2000; Knoflacher et al. 2000; Pfaffenbichler 2001). The second step will be the acquisition of project relevant transport and socio-demographic data for the MARS model. The result of this working stage is a cartographic illustration of different indicators, e.g. Figure 13.

This information is used to set up a MARS model for the Vienna – Bratislava region. MARS is capable of simulating competition scenarios in a bi-polar region and will be used to simulate and assess the infrastructure projects planned to be implemented in this region as
mentioned before. It is assumed that these projects will have not only a major impact on the cities itself, but also influence the development of the housing market, businesses, employment, population, means of transport and the environment within the rural region between these two cities.

A major outcome of the project therefore will be a quantification of these developments over time. By September we are positive to present some of the results.

References


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