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### Abstract

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**Keywords:** Freight Transport, Inland Waterway Transport, Danube, Employment Modelling

**JEL-codes:** O18, R15, R48

## Inland waterway transport: part of a strategy to face European freight transport challenges

Land freight transport[1] in Europe – which covers around 60% of the total continental transport[2] – is dominated by the operation of heavy duty vehicles (HDV), with a modal share of about 75% (in tkm; *European Union*, 2014). The growth of HDV transport over the last 20 years reached on average +1.6% per annum which exceeded the development of the competing freight transport modes by far.

Despite its undisputed advantages in flexibility and access, HDV transport requires a comparably high level of energy and causes more negative externalities per transport unit (e.g. tkm) than rail and inland navigation (*Maybach et al.,* 2008). Technological progress notwithstanding, the total emission of noise, air pollutants or greenhouse gases caused by HDV transport is still immense (see e.g. *AEA, 2011*). Taking the ambitious energy efficiency/saving and climate protection objectives of the European Union into account (*European Commission*, 2010B), a comprehensive strategy of technological and operational measures need to be taken to tackle the emission problem of road freight transport. On a more general note, the transformation of freight transport towards more sustainability while ensuring the competiveness of the economy remains a major challenge for European and national policy (*Banister et al.,* 2000; *Helmreich – Keller,* 2011). This mainly includes influencing modal share but also the spatial structure of the supply chain, vehicle routing or fuel efficiency (*McKinnon,* 2010).

The promotion of inland waterway transport (IWT), which is hoped to result in the absorption of a bigger share of predicted total transport growth in Europe, could be part of the solution to the outlined challenges. A majority of the EU member states have inland waterways, some of them even interconnected waterway networks. IWT exhibits a range of positive features of which its environmental performance, i.e. the provision of energy efficient and less greenhouse gas intensive transport services, is one of those emphasized most often (*CE Delft et al.,* 2011). The appeal of IWT is furthermore based on

- low (specific) shipment costs which is especially important in the bulk commodity market (e.g. coal, agricultural goods or primary products of steel production),
- high transport capacities of the vessels,
- high level of traffic safety in relation to shipped volume and
- absence of congested infrastructure, high transport reliability.

The advantages are partly impaired by the mode's low speed, the limited size of the network, which requires that goods have to be loaded and unloaded between different modes, the restricting impact of weather conditions and the fluctuating water levels of the navigable rivers. These general issues – which are systemic given IWT's "natural prerequisites" – are

[1] Total territorial transport (internal, bilateral and transit); including inland waterways, excluding pipelines.

[2] Including maritime transport.

accompanied by supply-side restrictions in the European IWT market – especially outside Rhine basin, where market conditions are comparably favourable. The difficulties include, inter alia,

- overcapacities,
- a continued fragmentation of market players,
- the fact that, while in the Rhine area container shipping is highly developed, in the Danube basin IWT has so far not succeeded in entering this market[3],
- an ageing fleet (in particular on the river Danube) and
- qualification and general employment restrictions due to poor labour supply, caused by low job attractiveness (long time onboard vessels, discrepancy between high skills and low wages).

In spite of these constraints, policy makers value the advantages of IWT and its (potential) role in a (more) sustainable freight transport system – especially as part of multi-/intermodal operations (*European Commission*, 2011). As infrastructural and organisational conditions for an efficient and profitable IWT operations still are not adequate, the European Commission has launched and supported various programmes/projects to create better framework conditions for inland navigation transport over the last years (such as NAIADES 1/2 and the PLATINA programme to implement NAIADES). These programmes address combined packages of infrastructure, fleet, jobs and skills, image of the sector, and tackling other market challenges. Actions include introducing new services, implementing modern communication schemes and the development of green shipping technologies.

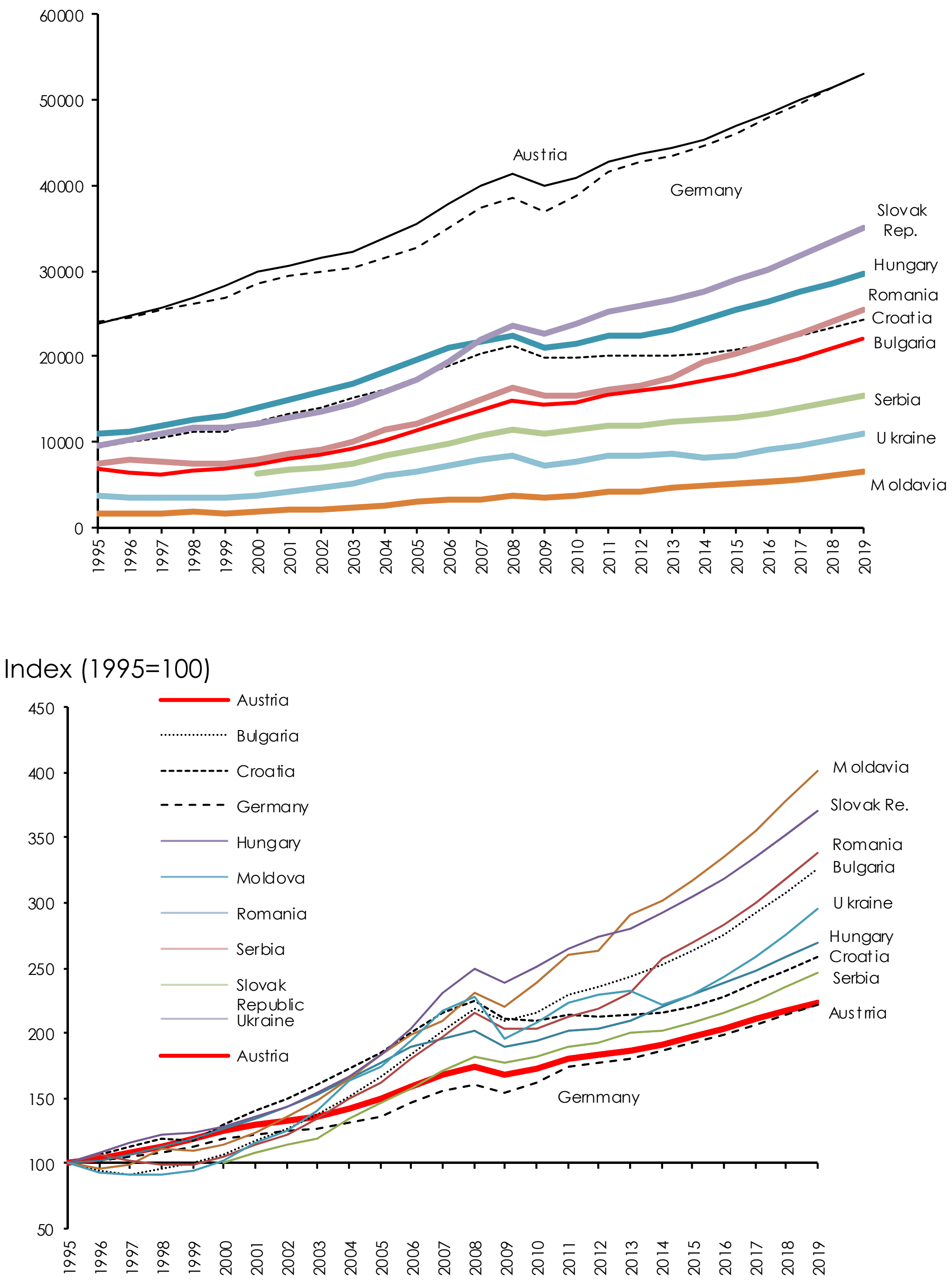
## Measures to promote IWT in the Danube region

Stimulating IWT and increasing its market shares is a priority of transport as well as economic and regional economic policy especially in the Danube region. The river Danube which stretches about 2.800 kilometres from Germany in the West to the Ukraine and the Black Sea in the East is the common bond of a heterogeneous region formed by countries and regions with enormous differences in industrial structure, economic power and growth perspectives. Economic performance still varies a lot between the countries, with Germany and Austria still way ahead in terms absolute GDP levels (Figure 1)[4]. These two Western Danube countries, however, are falling short of most East European countries' recent growth rates. A greater convergence between the Danube countries is on track, however, probably not at the speed that was expected when the EU enlargement process was started.

[3] The COLD-Study (*Viadonau et al.*, 2006) shows the obstacles for establishing container transport on inland waterways from Constanta to Austria. At the moment Asian container are transported over Hamburg and then by rail e.g. to Krems. The shorter route would be from Asia to Constanta and then by inland vessel to Krems.

[4] Please note: Total country's figures shown in Figure 1 and 2.

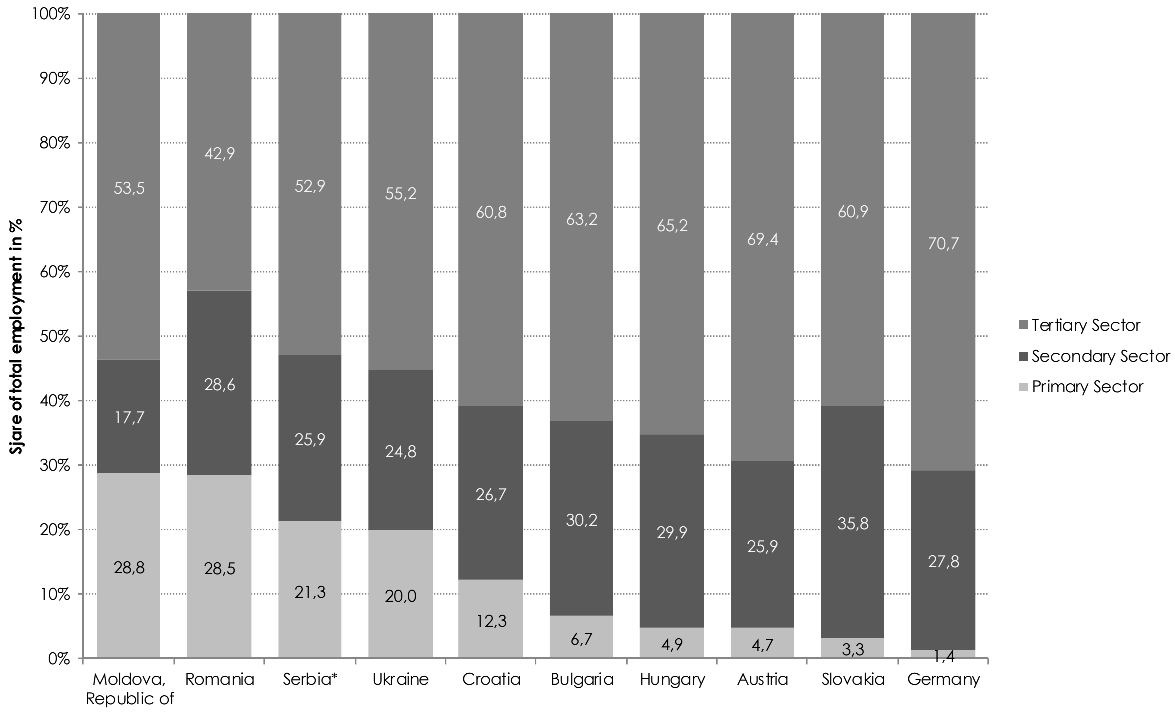
*Figure 1: Gross domestic product based on purchasing-power-parity (PPP) per capita GDP*




Source: IMF, WIFO calculations (http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/download.aspx).

Also the employment structure in the Danube region differs significantly (Figure 2). Most Danube countries show a typical employment structure of modern/developed economies with most employees working in the tertiary sector and meanwhile only about 25%-30% in the secondary sector. Primary sector employment in countries like Germany, Austria, Slovakia and Hungary is marginal. The Danube countries towards the East, however, which are all post-communist, still have a considerable employment share in the primary sector (agriculture and mining). In Romania, for example, which is EU member since 2007, almost 29% of employees are still working in the primary sector (2013), however, this share has been decreasing rapidly over the last two decades (2003: 37,7%).

*Figure 2: Sector shares of total employment in %, 2013*

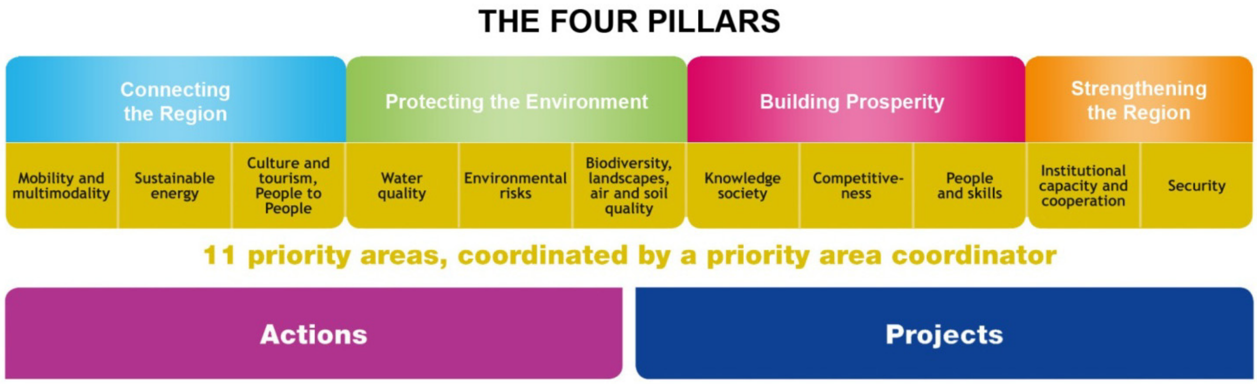



Source: ILO (Labour force survey), WIFO calculations.

In 2010, the European Commission, together with the 11 Danube riparian states, developed the Danube Strategy[5] (*European Commission*, 2010A) – a strategic policy document which is covering various policy areas and aims at delivering a range of economic gains and promoting territorial cooperation across borders. The Danube Strategy consists of four pillars and eleven priority areas (see Figure 3) and is complemented by an "Action Plan" outlining the path to reach targets set in the strategy.

[5] European Union Strategy for the Danube Region.

*Figure 3: The 4 pillars and priority actions of the EUSDR*




Source: Ecorys *et al.*, 2014a based on *European Commission*, 2010A.

The proposed actions focusing on IWT and its market condition involve

- infrastructural improvements, e.g. the elimination of bottlenecks (such as Straubing-Vilshofen or the Vienna-Bratislava sectors) or the upgrading of existing multi-modal ports necessary to bundle cargo flows and to link modes (especially IWT and rail),
- the modernisation of the current fleet,
- a better coordination of national transport/IWT policies,
- measures to expand and train human resources in the industry,
- the improvement as well as the better coordination of already existing waterway management systems and
- harmonisation of national river information systems which provide shipping companies with real time information about the current usage of the river, river safety and other nautical features.

Concerning implementation, the strategy concentrates on coordinating existing EU and national approaches (such as usage of Structural Funds and the implementation of Trans-European Networks (TEN-T) projects) and more cooperation between stakeholders in the Danube region, rather than providing new legislation, institutional set-up or money. A specially appointed coordinator of Action 1A (the IWT component of the strategy) ensures monitoring of progress, regular exchange between countries and facilitates discussions aiming at further advancement of the action.

**Assessing the economic impacts of an increased IWT market share**

One strong argument of Action 1A of the Danube Strategy is that a growing IWT share in the freight transport market would have a positive impact on the regional economic development in the Danube region. This is mainly because improved transport conditions for inland waterway transport may lead to a lower level of transport costs for existing and potential customers and as a consequence, the ability to offer goods at lower product prices. This would increase the international competiveness of the regional producers and the regional economy as a whole.

To analyse the extent of the economic effects induced by a 20% increase in IW freight transport volume by the year 2020 (compared to 2010), the European Commission in 2013 tendered the study "Danube+20"[6]. After an international tendering procedure, it was awarded to and subsequently implemented by a consortium of Ecorys (NL), WIFO and Planco (DE) as the main contractors[7]. The consortium was asked to look especially at the potential job creation effects of growing IW freight transport volumes which in total were estimated at 43.6 mio. tons in 2010 (using Viadonau data)[8].

In order to estimate the employment effects, the consortium applied a two-step simulation approach making use of models stemming from two different "disciplines". First, the estimation of how an assumed growth path of transport can be reached was done applying the Europe-wide traffic network model TRANSTOOLS[9]. TRANSTOOLS has been developed and successfully deployed in earlier European research projects also dealing with the forecasting of freight demand (see *Hansen – Rich*, 2011, for a compact description). Second, to estimate employment effects associated with transport growth the macroeconomic model ADAGIO was used, which has been developed at WIFO over the last years (see *Kratena – Streicher*, 2014 and *Streicher – Stehrer*, forthcoming for the overall methodology). This paper mainly deals with the implementation and the results of the second modelling stage, whereas the transport modelling approach is described in summarised fashion, only.

**TRANSTOOLS**

TRANSTOOLS is an open-software passenger and freight transport model developed by a consortium of international researchers funded by the European Commission's JRC-IPTS and DG MOVE (TRANS-TOOLS, 2008). It is mainly used to simulate changes in transport networks, especially TEN-T, changes in transport demand and its distribution, changes in logistics and distribution systems and impacts of pricing and taxation policies. TRANSTOOLS is based on a multimodal transport network comprising the modes road, rail, air and waterway. Other main drivers of the model are socio-economic data (population, workplaces, car ownership etc.), regional GDP and congestion. In the Danube 20+ study, Rapidis, a Danish transport planning consultancy and subcontractor of the study, helped to run the model.

[6] Job creation scenarios from a 20% increase of IWT on the Danube by 2020 compared to 2010; EC reference 2012CE160AT074

[7] See Ecorys *et al.* (2014B) for the final report.

[8] The effects of passenger transport growth on the Danube was a side aspect covered in the study, however, results are not presented in this article.

[9] See http://energy.jrc.ec.europa.eu/transtools/TT_model.html for more information about this model.

TRANSTOOLS' underlying networks consist of a set of links which are connected to transport zones equivalent to the European NUTS-III zones. The model assigns transport demand of passengers and shippers to the links of the networks, i.e. it simulates the traffic flows in the network and calculates related effects such as congestion effects, average travel times and distances etc. (*Frederiksen*, 2011). The assignment procedures are mainly standard stochastic user-equilibrium assignment algorithms. Here, the network user's utility to use a given route depends on various parameters (link length, travel times etc.) but also has an (unexplained) stochastic part which follows a known distribution (see *Sheffi*, 1985).

Transport demand is generated and distributed to the different modes by multi-stage modelling procedures which involve various iterations and feedback loops. The TRANSTOOLS' freight module is based on a three -step modelling approach (trade, mode choice and logistics) whereas trade volume depends on zonal GDP. The spatial distribution of trade mainly follows the principles of the law of gravitation and the transport network's *level of service*[10]. The generated volume is then split into the main modes truck, rail, IWT and maritime – again on the basis of level of service. Here, the relative 'attractiveness' of the modes is used which is defined by an indicator of 'generalised costs' (see also below). Finally, a logistics sub-model calculates the use of distribution centres and the chaining of shipments to reduce the logistics cost. Finally, freight transport demand is assigned to the network links.

TRANSTOOLS is capable of analysing a wide range of different scenarios. Any baseline or policy scenario that can be specified within the assumptions or its exogenous data is conceivable. Typical types of scenarios include (*Hansen*, 2011):

- Economic development (such as high/low economic growth);
- Infrastructure (major network analysis, TEN-T, corridor analysis etc.);
- Strategy and policy (fiscal policies, taxation, regulatory scenarios etc.).

**ADAGIO**

ADAGIO is "A DynAmic Global Input-Output" model with econometrically estimated behavioural equations. These include Translog[11] specifications for the production side (where, based on input prices and technology, factor and investment demand as well as output prices are determined) and a (quadratic) AIDS[12] specification for consumption demand. Based on appropriate purchaser prices, this model determines the share of 12 consumption categories, distinguishing between durables and non-durable consumption goods. Additional

[10] The *level of service* determines the accessibility of the single zones.

[11] Translog is a functionally flexible form to estimate and simulate (e.g.) production and cost functions in economic modelling. Mathematically, it is based on the taylor expansion (in the form of a linear approximation of non-linear equations).

[12] "Almost Ideal Demand System", a framework to estimate the structure of private consumption, which exhibits nice properties such as the "adding up-constraint" - i.e. it makes sure that the sum of the shares of all the commodities which are consumed is equal to 100.

econometric equations determine wages and skill shares with three skill levels in labour demand.

Prices are determined endogenously: based on output prices (which are determined in the production block), purchaser prices are derived by taking into account commodity taxes (and subsidies) as well as trade and transport margins. For international trade, the model applies cif/fob correction by explicitly incorporating international trade and transport costs.

ADAGIO is part of a family of regional models with a common modelling philosophy which might be described as "Dynamic New Keynesian" (DYNK) (*Kratena – Streicher*, 2014). DYNK shows important aspects of equilibrium behaviour; however, the dynamic aspect differentiates DYNK from a static long-term equilibrium usually applied in Computation General Equilibrium (CGE) approaches. This feature is most pronounced in the consumption block, where ADAGIO applies a dynamic optimization model. But it equally applies to the equilibrium in the capital market as well as to the macroeconomic closure via a well-defined path for the public deficit.

- ADAGIO's input-output core is based on the data base compiled in the international WIOD project ("World Input-Output Database")[13]; the 40 countries included in this data base (EU member states and large economies such as the US, India or Brazil) are complemented by an additional group of 17 countries (including the Danube countries not included in WIOD: HVR, YUG, MDV, UKR)[14]. The base year of the model is 2007 and the simulation horizon extends to 2030. The model distinguishes between 58 Commodities (2-digit NACE 2) and 35 Sectors (58 for the EU 27 countries). Furthermore, ADAGIO is based on a fully consistent trade matrix for all goods and services, including trade in international trade and transport margins (i.e. fully endogenous cif/fob correction).

*Potential effects analysed by ADAGIO*

The estimation of the employment effects associated with IWT growth can be distinguished by three levels of potentials impacts. They are

- the *direct effects* on the providers of transport services which is linked to increased output of sector 61 (water transport) and a resulting expansion of employment in this sector. On the other hand, if the IWT gains are brought about by pure modal shift (which however is not the case in the scenarios presented here), the competing

[13] See www.wiod.org. WIOD was funded by the European Commission, Research Directorate General, as part of the 7th Framework Programme.

[14] The IO tables of the additional countries were informed by national accounts data and IO tables of the United Nations Statistic Division as well as GTAP (the Global Trade Analysis Project). Additionally to the supply and use tables, the new countries had to be integrated into the trade representation of the original ADAGIO model, i.e. the trade flows between the original and the new countries had to be determined. This task was implemented using UN COMTRADE trade data as well as the IMF's Balance-of-Payments database for trade in services.

modes of transport will experience a proportional decline in their output and, hence, employment

- the *indirect effects* which pertain to the providers of intermediate inputs for the transport sectors (the "upstream industry" – providers of fuel, maintenance and investment goods, among others);
- the *induced effects* from changes in average transport costs. This is first and predominantly a "downstream effect": potentially (and actually), this affects the whole economy, by altering the relative prices of commodities. As IWT is the cheapest mode of transport, a modal shift towards IWT will ceteris paribus result in lower average transport costs. IWT-affine commodities will therefore gain more from improvements in IWT, benefitting the producers of such commodities (their wares will now be cheaper at the point of usage, or, alternatively, at the same cost, they can now be transported for longer distances). But it is also good for the users of these commodities, lowering the costs of such inputs – which in turn implies a competitive advantage, resulting in lower output prices (and/or, in the case of less-than-perfect competition, an increase in operating surplus).

The induced effects can be conceptually split up into two stages:

- The first stage presents the immediate impact on the users of transport services – it is a kind of "ceteris paribus" solution, assuming that the rest of the economy (specifically, final demand) remains unchanged as compared with the "baseline solution";
- The second stage goes beyond this ceteris paribus assumption: if some sectors of the economy are now more competitive due to changes in average transport costs, this will likely lead to an economic expansion. The reasoning is this: the decrease in transport costs will certainly lead to a displacement effect – a mere geographical shift of production – but, by lowering the general price level, will also lead to an expansion of the economy as a whole (if certainly not equally for all economic sectors). An expanding economy, however, will generate more final demand – private consumption will go up due to an increase in wages and profits; government consumption will expand due to an increase in taxes (or, alternatively, public budgets could shrink); exports will increase as the economy becomes more competitive; demand for investment goods will rise as a consequence of improved economic performance.

**Scenario, simulation issues and employment results**

The simulation of employment effects in the Danube+20 study was based on the development of different scenarios in order to assess the sensitivity of results to different paths of IWT growth[15]. The results presented here are based on a scenario where a (transport) base

[15] For details and results of the single scenarios see final report (*Ecorys et. al.*, 2014B).

run was combined with the implementation of various transport cost-saving measures in IWT. In the following, the combination is referred to as "Danube+20" scenario. The TRANSTOOLS baseline mainly represents an "autonomous growth" with the probable development of the freight transport market between 2010 and 2020. The transport model uses economic forecasts from various sources (e.g. growth scenarios developed JRC) and the existing European transport network as implemented in 2010. It is assumed that the navigability of the river Danube is properly maintained and has the standard in 2020 as it had in 2010. The second element of the Danube+20 scenario, considers various measures related to the mentioned Action Plan of the Danube strategy to be effective in or before 2020. These are expected to improve the attractiveness and competitiveness of the IWT system. Examples are water depth improvements along the river and supporting the generation of reliable water level forecasts[16]. Technically, the measures were implemented as transport network amendments which lead to decreasing "generalised costs". The transport simulation yields origin-destination specific cost reductions in IWT to a maximum extent of about –11% (here: Romania to Serbia and vice versa). The mean cost reduction in IWT for all country-by-country pairs in the Danube region averages about –4%.

As a result of the transport model runs, the IWT volume on the Danube in 2020 increases by +25% compared to 2010 (Table 1, right column). Achieving 20% IWT growth in 2020 – as desired by the European Commission – can be even realized under the given conditions, i.e. where GDP real growth for the period ranges from about 1% for Germany up to more than 5% for the non/EU countries in the Eastern Danube corridor. Autonomous growth would provide an increase of IW transport volume of 21.9%. Improving the current market conditions of IWT by implementing cost-saving measures would have an extra, however small, growth effect.

Table 1: Transport model simulation results

| | **Autonomous growth** | **Danube+20 scenario (Autonomous growth + projects + proper maintenance)** |
|---|---|---|
| Average annual growth | 2.0% | 2.3% |
| Total growth 2010-2020 | 21.9% | 25.0% |
| Danube IWT volume in 2020 (mil. ton) | 53.2 | 54.5 |

Source: *Ecorys et al.* (2014B).

[16] See "Danube+20" final report for more details.

*Simulation setup*

Translating transport volume growth from TRANSTOOLS into suitable input for the ADAGIO model required an explicit simulation setup: To assess the magnitude of the effect on the output of the transport sectors (as well as to estimate the average cost of some new modal mix), assumptions had to be made about the monetary transport costs by mode. Costs were not directly available from TRANSTOOLS because – as a transport model – it works with a different concept of "transport costs". TRANSTOOLS sums up monetary costs, "shipment time", "reliability", "convenience" and other factors into so called 'generalised costs'. For ADAGIO however, only monetized costs are relevant which were approximated using specific costs (in cent/tkm) for the three relevant modes of transport, road, rail and IWT. The figures in Table 2 were provided by Planco and are based on experiences made in transport planning projects and expert judgements.

Table 2: Assumptions about average transport costs by mode (cent/tkm)

| | < 500 km | > 500 km |
|---|---|---|
| Road | 10 | 8.7 |
| Rail | 3.5 | 1.5 |
| IWT | 2.7 | 1.4 |

Source: Planco.

Using these assumptions on specific costs by mode of transport, calculation of the direct economic effects was straightforward: they are the changes in predicted transport volumes (in tkm) multiplied by the respective specific transport cost (in cent/tkm), which gives the change in output by transport sector due to changes in transport flows. The direct effects are therefore implemented as exogenous shocks to the respective transport sectors (IWT: sector 61, water transport[17]; both road and rail: sector 60, land transport). In this way, ADAGIO "produces" the output (i.e. the services) in the transport sectors which are necessary to move the transport volumes as simulated by TRANSTOOLS.

In contrast, indirect and – even more so – induced effects cannot be estimated that easily: they depend on the sectoral linkages within and between economies (via intermediate

[17] Given the pre-determined structure of the IO tables used in ADAGIO, the analysis of economic effects of growing IW transport is not entirely perfect: that is because the applied sectoral disaggregation identifies "Water transport" without distinction between maritime transport and inland water transport on the one hand and freight and passenger transport on the other. The first issue is much mitigated by the fact that most of the countries along the river Danube are inland countries without direct access to the sea,the most important exceptions being Germany and Croatia (for the countries along the Danube delta, this problem is generally less pronounced). The other issue, freight vs. passenger transport, is common to all countries considered in the model and could not be resolved within the Danube+20 study. The other issue, freight vs. passenger transport, is common to all countries; also, it could not be resolved within this project (data availability is simply too poor). Given the simulation setup, however, this issue, if not exactly resolved, is at least avoided.

linkages and trade flows). Instead, a model-based approach was needed – this is where ADAGIO with its capability to deal with these linkages and interdependencies came into play. The implications of the new modal mix for the main scenario, which implies changes in average transport costs, are introduced as a change in trade costs by commodity and OD-relation. ADAGIO features a trade matrix which represents monetary trade flows in the base year as well as a matrix representing transport costs as a mark-up on basic prices "at the factory door". Together with any taxes and tariffs associated with the purchase of a commodity, the transport costs determine the final purchaser price. If transport prices decrease, so will the purchaser price. If the buyer of the commodity is another firm, lower transport prices for intermediate inputs will feed through to lower output prices, which implies that a reduction of on transport costs has an impact on a downstream sector – even if this sector is not a direct user of IWT.

*Technical implementation of the simulation and employment results*

To technically implement the simulation of the scenario, counterfactuals have to be introduced. The "counterfactual" is the state-of-the-world which would have prevailed had the measures under investigation not taken place – if, in our case, the 20% increase in IWT traffic would not occur. The impact of the investigated measures is then the difference between the "actual" outcome and the "counterfactual" outcome.

According to the transport model outcome, the increase of IWT in the Danube axis was 25% in tonnage. As counterfactual, the IWT volumes are kept constant at their 2010 levels. The IWT transport volume in 2020 over and above their 2010 level are distributed to road and rail. Hence, the transport costs which are implied by the modal mix in 2020 as compared to the modal mix which would result when we hold IWT volumes constant at their 2010 levels were compared. The counterfactual modal mix of 2020, therefore, has a lower share of IWT and, as a consequence, total trade costs are higher – resulting in lower competitiveness.

In the Danube countries, total employment would be around 8.000 jobs higher than in the counterfactual. This concerns new jobs of all considered skill levels. The highest effects are simulated for Germany, Hungary and Romania, whereas employment in Austria and Croatia is slightly negative. Outside the Danube region, the largest employment effects can be found in the Netherlands, where employment is higher by almost 1.000 jobs. For the rest of the EU28, ADAGIO also estimates higher employment compared with the counterfactual situation. This is not an intuitive result as the countries outside the reference region do not share the competitive advantage of lower transport costs. Two effects, however, work against the displacement of trade from countries with an unchanged costs structure: for one, if it becomes cheaper to get things out of a country due to improvements in transport infrastructure, it also becomes cheaper to get things into this country – which makes imports cheaper, benefitting these imports' producers. Secondly, and at least partly as a consequence, reduced transport costs will lower the purchaser prices of goods; if some goods become cheaper, the price level will fall, with resulting real income effects (this constitutes a positive economic shock).

Table 3: Regional employment effects in the Danube+20 scenario

| Region | Direct & indirect | Induced effects | Total effects | Skill levels | | |
|---|---|---|---|---|---|---|
| | | | | Low | Medium | High |
| DE | 140 | 1,830 | 1,975 | 310 | 1,170 | 500 |
| AT | -60 | 260 | 200 | 40 | 110 | 40 |
| SK | -30 | 480 | 450 | 20 | 360 | 80 |
| HU | 40 | 1,420 | 1,450 | 170 | 960 | 320 |
| HR | 10 | -60 | -50 | -30 | 0 | -10 |
| YU | -70 | 660 | 600 | 450 | 70 | 70 |
| RO | -280 | 2,110 | 1,825 | 1,370 | 270 | 190 |
| BG | 0 | 550 | 550 | 420 | 80 | 50 |
| MD | 0 | 10 | 0 | 0 | 0 | 0 |
| UA | -50 | 430 | 375 | 270 | 50 | 50 |
| ***Total*** | **-290** | **7,670** | **7,375** | **3,010** | **3,070** | **1,300** |
| BE | 10 | 80 | 75 | 20 | 50 | 20 |
| NL | 0 | 980 | 1,000 | 250 | 430 | 300 |
| FR | 10 | -200 | -175 | -50 | -80 | -60 |
| CH | 0 | -10 | 0 | 0 | 0 | 0 |
| LU | 0 | -10 | 0 | 0 | 0 | 0 |
| *IWT countries* | -270 | 8,530 | 8,250 | 3,240 | 3,470 | 1,550 |
| *Rest EU 28* | *10* | *1,790* | *1,800* | *100* | *1,280* | *440* |

Source: own calculations; rounding errors are not compensated.

Directly, the increase in IWT market share actually leads to job losses – mainly in the sectors competing for transport contracts (i.e. land transport). A sectoral disaggregation of the simulated employment effects in the Danube region and beyond (Table 4) illustrates this finding: Intuitively, employment in water transport (sector 61) will grow by 600 jobs following the increase in IWT demand. Land transport, in contrast, suffers job losses as transport demand is redistributed away from land transport. The reason why a decrease in land transport employment is larger than the increase in IWT has to do with costs and employment: road and rail are both more costly than IWT; so, shifting freight from road and rail leads to a decrease in costs and, therefore, a reduction of output in the transport sector as a whole – which in turn is accompanied by a decrease in employment.

Table 4: Sectoral employment effects in the Danube+20 scenario

| Economic Sector | Direct & indirect | Induced effects | Total effects | Skill levels | | |
|---|---|---|---|---|---|---|
| | | | | Low | Medium | High |
| Agriculture, Forestry, Fishing | 0 | 1,095 | 1,095 | 955 | 115 | 30 |
| Mining | –10 | 55 | 50 | 35 | 5 | 5 |
| Manufacturing - low Tech | 0 | 685 | 685 | 340 | 275 | 70 |
| Manufacturing - Medium Tech | –20 | 630 | 615 | 280 | 265 | 65 |
| Manufacturing - High Tech | 0 | 45 | 45 | 25 | 15 | 5 |
| Energy | –20 | 195 | 175 | 50 | 90 | 35 |
| Construction | –50 | 615 | 560 | 235 | 275 | 50 |
| Trade | –5 | 1,005 | 1,000 | 365 | 545 | 105 |
| Tourism | 15 | 325 | 340 | 130 | 190 | 20 |
| Land Transport | –870 | 320 | -550 | –330 | –165 | –55 |
| Water Transport | 630 | 5 | 635 | 265 | 300 | 70 |
| Air & Auxiliary Transport | –20 | 115 | 100 | 15 | 70 | 10 |
| Business Services | 40 | 695 | 735 | 130 | 355 | 245 |
| Public Services | 0 | 1,535 | 1,535 | 395 | 575 | 570 |
| Personal Services | 10 | 345 | 360 | 140 | 150 | 70 |
| *All Sectors - Danube Region* | –290 | 7,675 | 7,385 | 3,015 | 3,070 | 1,305 |

Source: own calculations; rounding errors are not compensated.

The small negative effect in direct and indirect employment (–290 jobs), however, are more than compensated for by the induced effects in downstream sectors (appr. +7.700). Sectors which can benefit from better IWT services are in particular agriculture, trade and public services.

**Discussion**

Transport and transport related measures such as infrastructure development are strategically often associated with regional economic strategies, hopefully adding to growth and development. The empirical assessment (ex-ante or ex-post) of their impact on employment, growth and development is challenging, especially if the transport-economy mechanism is to a lesser extent based on significant accessibility gains of regions such as provided by European motorway and high-speed rail networks (*Bröcker*, 2002; *Bröcker et al.*, 2004).

The Danube+20 study adds to the research into transport-economy interactions by focussing on the analysis of employment effects due a growth of inland waterways freight transport in the Danube region. An approach was developed to translate the growth of IWT volumes into suitable input for a macroeconomic regional model which allows analysing sectoral and spatial interlinkages. Basically, IW transport demand growth and modal shifts from road and rail were transformed into corresponding scenarios of output growth and commodity price changes. The model ADAGIO was then used to estimate direct, indirect and induced effects on employment in transport sectors and the wider economy.

According to the ADAGIO simulation, IWT offers a yet underused employment potential for the river's bordering regions. From an overall European perspective, the unused potential is small; however, up to more than 7.000 extra jobs could be potentially created. The employment growth will mainly occur as a result of an autonomous development of GDP, even under mainly unchanged transport networks conditions. However, employment effects can be augmented (by around 10%) if IWT cost reductions measures such infrastructural improvements are implemented.

The above assessment, building on the Danube+20 employment study, focused on the economic advantages of developing efficient IWT services which mainly comprise of costs advantages for existing and future operations. The employment effects of IW transport growth are moderate, however, from a more comprehensive perspective of European regional development further possible impacts should be given attention. IWT is known to be more environmentally friendly (per transport unit) than other modes of transport, in particular due to its advantages of scale providing for lower per unit $CO_2$ emissions. The promotion of IWT might be therefore also seen as part of a strategy which aims at creating a more sustainable freight transport system in Europe. Our results indicate that achieving a double-dividend of providing greener transport services and employment growth is possible. Beyond this, also environmental benefits will occur as in addition, as rivers like the Danube provide for a natural infrastructure with excess capacity, improving its use contributes to lowering demand pressure on other land infrastructure providing for congestion reduction. Taking these aspects into account, the contribution of IWT to solving the European freight transport problems should not be underestimated.

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