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Road Freight Logistics, Competition and Innovation: Downstream Benefits and Policy Implications[1]

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Abstract

This empirical paper sheds light on a significant element of the debate of whether infrastructure services have a strong impact on economic development by exploring the impact of innovative road freight services on downstream business users. The paper uses a new and purpose-specific survey of 165 logistics service providers and 493 user enterprises in food processing, food distribution and the automotive industry in the Czech Republic, Hungary and Poland. The main findings are that there are substantial downstream benefits from innovations in road freight services, both dampening cost increases and raising sales revenues of business users. The additional finding that increased intensity of competition in road freight services is significantly associated with the provision of innovative services suggests that easing any remaining barriers to competition in upstream business sectors should be a priority.

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Road freight logistics, competition and innovation: Downstream benefits and policy implications

1. Introduction

This paper provides empirical evidence of the significant benefits from competition and innovation in a specific upstream essential business service. In particular, the paper identifies a specific class of gains from innovation in road freight logistics services. The paper looks beyond the direct impact of increased competition on infrastructure prices and quantities, beyond the traditional emphasis of antitrust policy on reducing price-cost margins and Harberger triangles. Instead, the focus is on the impact of competition on upstream innovation and on improved performance in downstream industries. The underlying idea is that even small improvements in upstream business-related infrastructure services can stimulate competition in downstream user industries, allowing new enterprises to enter, incumbent users to lower costs and offer new products, and rivalry to intensify. The upstream improvements thereby propagate through the whole economy and create a sizeable impact on economic efficiency and growth. To the extent that regulatory reforms spur innovations and other improvements in infrastructure business services, and these innovations in turn generate downstream benefits, the economy-wide benefits of increased competition are likely to be substantially greater. The paper focuses on quantifying the impact of innovation in the upstream road freight sector in the Czech Republic, Hungary and Poland on three downstream industries that make intensive use of these services, namely food processing, food distribution, and the automotive industry.

The road freight industry is a key sector of the economy geared to logistics and supply-chain management, distribution and basic physical transport. It plays a major role in market integration and has a direct impact on transaction costs for economic agents. Road freight services (including multi-modal and logistics services as well as traditional road haulage) are an ideal candidate for this type of exploration for several reasons. First, in the

absence of government-imposed regulatory barriers, there is maximum scope for competition. Extensive competition is fully viable in road haulage and logistics services. Second, reforms and technological innovations have grown at a faster rate in this sector than in most others, providing ample scope for examples of increases in both competition and innovation. Third, transport is a type of physical infrastructure that generates economy-wide spillovers and in particular offers strong opportunities for substantial reductions in costs by downstream users. As an illustration, the operational innovations of more competitive logistics providers allow downstream user industries to outsource transport service functions, converting fixed costs into variable costs and thereby lowering entry barriers. By reducing economy-wide transaction costs, these infrastructure services have the potential to affect the interactions of downstream firms in a significant way. Aghion and Schankerman (1999, 2000) provide a rigorous treatment of some of these issues, by focusing on those types of infrastructure that intensify product market competition by lowering transaction costs and reducing local market power. In particular, they model three channels through which infrastructure affects intensity of competition in downstream enterprises: the relative position of incumbents -- infrastructure facilitates the expansion of more efficient relative to less efficient firms; restructuring -- infrastructure facilitates the restructuring of more efficient relative to less efficient firms; and entry -- infrastructure facilitates entry, both the overall level and the entry of more efficient relative to less efficient firms.

The policy relevance of this work is to create a strong case for a new type of competition policy implementation, focusing in a more proactive manner on reducing bottlenecks and facilitating access by downstream entrepreneurial firms to key essential business infrastructure services. To the extent that access barriers to essential business services impede entry of new enterprises or hinder entry of existing enterprises into new lines of business, this line of research suggests a much more activist role for competition agencies

in support of effective regulatory reform and entrepreneurship development, a focus on supply-side stimulus. Although rigid rate and route controls have been abandoned in many countries in Europe and Central Asia, there are a few countries in this region as well as in other parts of the world where such basic regulatory reforms remain a top priority. In a substantial number of countries, privatization needs to be completed and remaining privileges eliminated from state-owned companies. The biggest improvements in this area may come from providing an investment climate that encourages logistics service providers to introduce innovations that are now commonplace in industrialized countries.

In addition, this line of research should help to create a broader empirical foundation for the benefits of regulatory reform and increased competition in infrastructure sectors. In a number of developing countries, regulatory reform and increased competition often appear as top-down technocratic rules without sufficient tangible examples of how they actually benefit the economy at large. Evidence of the benefits of increased competition in upstream infrastructure services on the downstream introduction of new products and business start-ups could help to provide stronger political support for further regulatory reforms and to avoid backtracking of existing reforms. Documentation of the impact of past regulatory reforms on downstream entry is particularly relevant since the new entrants typically are not yet present as forceful reform advocates at the time of initial policy discussions.

The paper's main findings are that there are substantial downstream benefits from innovations in road freight services, both dampening cost increases and raising sales revenues of business users, and that increased intensity of competition in road freight services is significantly associated with the provision of innovative road freight services. Direct feedback from user enterprise managers indicates that costs for the median user were lowered by between 5 and 10% as a result of road freight logistics and sales were increased by between 10 and 15%. Regression results support the thrust of these direct survey responses

by managers: there is a statistically significant negative association in the data between the use of logistics consultant services and cost increases, and a significant positive association between the use of just-in-time (JIT) logistics services and sales revenue increases. Finally, there is a statistically significant positive association between increased competition in road freight services and the provision of innovative JIT logistics services.

2. Methodology

Selection of countries. The study focuses on three countries where there has been a major regulatory regime switch (a natural experiment), where the upstream provision of services has been exposed to significant pro-competition changes in rules within the last ten years. The Czech Republic, Hungary and Poland have been selected as ideal candidates for this work for a number of reasons:

- Road freight transport, which has relatively low entry costs and the potential of offering a quick return, was one of the first sectors to be privatized and liberalized in most of the Central and East European Countries (CEECs). Hungary, followed by Poland and then the Czech Republic, were the earliest adopting pro-competition reforms. Some of the more effective restrictions on road haulage disappeared as early as 1982 in Hungary and by the late-1980s in Poland. Both Hungary and Poland passed laws granting free entry to any prospective trucking company in 1988, and the Czech Republic after 1990. Market forces freely determine transport prices.
- Road freight transport has been a growing sector. There has been an expanding role of road haulage at the expense of rail freight transport, with road haulage in billion tonne-km between 1990 and 1994 increasing from 16.8 to 22.7 in the Czech Republic (rail falling from 38.1 to 23.2), increasing from 40.3 to 45.4 in Poland (rail falling from 83.5 to 65.8) and decreasing from 15.2 to 13.0 in Hungary (rail falling much more sharply from 16.8 to 7.4).

- The remaining scope for outsourcing of trucking fleets by user enterprises was substantial at the beginning of the period of inquiry. CEECs could take advantage of a trend in other EU countries, where own-account operators reduce their fleet size as part of a general pattern towards contracting out of non-essential activities. Whereas own-account haulage accounted for 26% of total road haulage in EU countries by the mid-1990s, it still accounted for 51% in Hungary and 45% in Poland.
- There is overwhelming private sector participation in the provision of road freight services. All 3 countries already had majority private participation in trucking by 1994, with 86% of road haulage enterprises under private ownership in Hungary, 99.5% in Poland, and 99.9% in Czech Republic (versus 25% for FYR Macedonia, 30% for Moldova and 23% for Romania).[1] Hungary has further progressed by privatizing its biggest road transport operator Hungarocamion in February 1998.
- There has been a dramatic increase in the number of enterprises, especially small firms. By 1993, 98% of firms in Czech Republic, 92% in Hungary and 75% in Poland were comprised of small firms with less than 20 vehicles (versus 15% in FYR Macedonia and 18% in Romania).

Selection of intensive road freight user sectors. Key selection criteria in choosing downstream industries for the study were that the industries have highly dynamic market structures, that the industries be economically important, and most importantly that there be a sufficient number of enterprises in each chosen sector that make use of road freight services for their input and output needs (either via own-account or third-party operators) in order to be able to draw a representative sample of small, medium and large enterprises, and local versus foreign companies from the population of enterprises in each country.

[1] Rydzkowski (1996), p 3.

The automobile industry unambiguously meets these criteria in all three countries. The takeover acquisition of Skoda by Volkswagen in the Czech Republic (70% in 1991, the remaining 30% in 2000) has been the second largest foreign investment, representing nearly 20% of total FDI inflows, with 2/3 of its production exported (6% of total Czech exports). And since the early 1990s, foreign component manufacturers have set up over 120 joint ventures and green-fields while the quality and timeliness of local car component suppliers also has steadily increased. Hungary had no automobile industry before 1990 though it was the biggest producer of buses in the former Council of Mutual Economic Assistance (CMEA) area, and also supplied the region with trucks. With investments by Suzuki followed by General Motors/Opel, and Audi, the automobile industry became one of the fastest growing industries after 1992. Through the expansion of joint ventures and foreign owned companies such as Opel, Ford, Audi, Denso and Knorr Bremse, Hungary has become the largest producer of engines in the CEECs. By the end of 1997, the production of auto vehicles and components accounted for 10% of Hungarian manufacturing and also 6% of total exports. Finally, the automobile sector was one of the first industries to be privatized in Poland in the early 1990s, and also has been one of the fastest growing industries in that country, attracting 11% of total FDI inflows. As in the Czech Republic and Hungary, foreign firms have gradually built up networks of local suppliers focused on quality and timeliness.

The food processing and food distribution industries are also both economically important in each country[2] and rapidly changing. Food distribution, including both wholesale and retail trade industrial sub-sectors, is the principal link between producers and consumers, playing a major role in price formation. Pressure for a dynamic evolution of market structure is illustrated by the international trend toward concentration, more marked in food trade than in other distribution sectors: while the 3 largest food distributors in 1996 accounted for at least

[2] Wholesale and retail trade across all sectors (plus hotels and restaurants) in 1997 accounted for 17% of total employment in Czech Republic and Hungary, and 15% of total employment in Poland. See O.Boylaud (2000), Table 6.

60% of retail trade in Australia, Canada, Finland, Norway, Sweden and Switzerland, the 10 largest retail distributors represented less than 20% of the sector in the Czech Republic (16%) and Poland (2%). In contrast, market structure already was more concentrated in Hungary, with the first 10 enterprises accounting for 53% of the sector.[3] The rapid extension of competitive multinational chains in the retail distribution sub-sector in the Czech Republic since 1997 has not only increased competition but also introduced more efficient distribution and management methods.[4] Another evolving feature of market structure in many countries is the formation of joint purchasing groups, with food retailers tending to strengthen their contractual position vis-à-vis major food producers by signing co-operative agreements with other retailers.

Design of detailed enterprise-level questionnaires. Industry-tailored questionnaires were prepared, with separate questionnaires for road freight logistics providers and road freight logistics user enterprises. The questionnaires were developed and refined in the context of an initial empirical study undertaken to quantify the impact of innovations in the Mexican road freight industry on downstream business users. From a particularly extreme degree of rigid regulation with a high degree of government interference, Mexico put in place beginning in 1989 a new policy framework for the road haulage industry based on free entry and market-based price setting. Besides expected gains from reductions in road freight prices, a number of additional sources of gains were systematically quantified. Faster and more reliable trucking has allowed user companies to offer new goods, both introducing previously unavailable products as well as making it possible for existing products to reach new areas. Importantly, the emergence of high-quality logistics service providers has enabled user companies to adopt better logistics practices. Controlling for the effect of other exogenous

[3] Ibid, Table A2.1.
[4] In response to competition from multinational chains, several small but also large retailers have gone bankrupt, including Interkontakt Group, which until 1998 was the biggest retail firm in the Czech Republic. See OECD (2001), p 28.

factors, upstream innovations have permitted a representative Mexican fertilizer company to improve its operating margin by 9.7 percent.[5]

Based on the Mexican case study, it was realized that the only way to get a meaningful sense of what is happening in such economies in terms of upstream-downstream linkages is to design a purpose-specific set of questionnaires. Available enterprise-level panel datasets were not sufficiently detailed to allow econometric analysis of these linkage issues. In particular, panel datasets generally do not include disaggregated data on the number of providers of specific logistics services employed by downstream users and conversely on the number of customers served by providers of innovative services. They do not allow inferences to be made about the relative importance of upstream innovations versus other locality-specific institutional factors on the level of costs and sales, and on the introduction of new goods and services by downstream firms. More generally, manufacturing censuses typically do not ask questions about changes in upstream business service availability and quality. As well, censuses generally are less comprehensive in their coverage of new entrants.

Hypotheses. The analysis begins downstream, by exploring the impact of innovative upstream services on user enterprises. It then explores what factors drive or hinder the development by the upstream service providers of these innovations.

At the downstream user enterprise level, the hypotheses to be tested are:

H1: Improved performance in user enterprises is significantly positively associated with upstream innovations in business service delivery. The focus is to explore the linkages between utilization of innovative road freight logistics services by user enterprises, on the one hand, and various measures of improved performance by user enterprises (especially cost reductions and revenue increases), on the other hand.

H2: The benefits of upstream business service innovations as they impact on user enterprises are skewed towards larger and older, established enterprises within the intensive-use sectors. The focus is to better understand the relative importance of variables such as enterprise size, age (start-ups versus more established firms), foreign ownership, and the legacy of state ownership in facilitating improved downstream performance.

[5] See Dutz, Hayri and Ibarra (2000).

At the upstream service provider level, the hypotheses to be tested are:

H3: The presence of competition-related pressure is the most significant factor associated with the development of innovative road freight service offerings. The analysis will attempt to distinguish the relative importance of different sets of factors in affecting the provision of innovative business services, in particular the most appropriate measure of intensity of product-level competition relative to other factors such as access to finance.

H4: Larger, internationally-connected service providers are more able to offer or respond to innovative business user requests than smaller, locally-based enterprises. The analysis will try to disentangle the relative importance of foreign ownership, enterprise size (only large providers, mix of large and small), the legacy of state ownership, provision of exclusively local, nation-wide and/or international haulage services, and factors such as technology and timing (older firms benefiting from first mover advantages versus recent entrants) in stimulating user-related innovation.

3. The enterprise-based surveys and data description

The survey instruments were implemented in summer 2000 and during the subsequent months to complete all sectoral quotas. The surveys are cross section, though they ask detailed questions not only about the latest full calendar year (end 1999) but also often comparable values for 1997 to allow calculation of changes over three years. By sampling design, the objective was to administer the provider questionnaire to 50 road freight logistics providers in each of the Czech Republic and Hungary and to 60 providers in Poland as the largest economy of the three, with quotas to randomly select an appropriate number of enterprises in each size category to roughly match corresponding population ratios.[6] The only other deviation from full randomization was a requirement to try to include a minimum number of foreign-owned enterprises (company's or mother company's headquarters located in another country) for each of the industrial sectors, in order that a sufficient number of enterprises with linkages to international best practices be represented.[7] A similar approach was taken for the user enterprise questionnaire, with the objective of surveying 50 food processing, 50 food distribution and 50 auto production enterprises in each of the Czech

[6] For the road freight provider sampling, the size quotas were biased towards larger enterprises given the overwhelming number of small operators in the population.

[7] In the end, this foreign-ownership requirement was in any case not met for providers in the 3 countries and for food processing and distribution industries in Poland as very few locally-based enterprises in the population in these industries have their company's or mother company's headquarters in another country.

Republic and Hungary, with a correspondingly higher 60 enterprises for each of these three sectors for Poland.

Size, age and ownership characteristics. The full sample size is 658 enterprises. Table 1 provides an overview of selected key characteristics of sample enterprises, broken down by users of road freight services and road freight providers. The user sample consists of almost 500 enterprises (493 firms), with the Czech Republic and Hungary accounting for 150 and 151 enterprises respectively, and Poland accounting for 192 enterprises. As alluded to, enterprises are spread fairly evenly by sample design across the three user sectors, with a slightly larger number of enterprises in the Polish food distribution sector (72 rather than 60) accounting for a larger-than-planned total number for Poland. Within the three user sectors, there are sufficient enterprises for more detailed separate analysis of the retail and wholesale trade sub-sectors (116 and 57 enterprises respectively across the three countries), though there are not sufficient enterprises for a separate analysis of vehicle assemblers (19 enterprises, with only 1 in Poland). Enterprises also are spread fairly evenly across employment-based size categories. There are a larger number of micro enterprises with between 0 and 9 employees, though by design not as many as in the population (30% of the sample for both the Czech Republic and Hungary, 45% of the sample for Poland). There also are a substantial number of large enterprises (25% of the sample for Czech Republic, 17% for Hungary, 11% for Poland). The median age of user firms ranges between 7 and 10 years. If recent start-ups are defined as new private entrants aged 5 years or less, they account for 19% of the sample in Poland (36 firms), 24% in the Czech Republic (35 firms) and 37% in Hungary (56 firms). While only 5% of Polish user firms are 100% foreign-owned (9 firms), 15% of Hungarian and 17% of Czech user firms are fully foreign-owned (23 and 25 firms, respectively). Finally, whereas a substantial number of enterprises were formerly state-owned (up to almost one-third of Czech

user firms), almost all have been privatized with only 1 to 4 firms per country remaining with significant (+50%) state ownership.

Regarding road freight providers, there are 165 enterprises, with Czech Republic and Hungary accounting for 50 and 52 enterprises, respectively, and Poland 63 enterprises. A few large firms are included for each country (2, 4 and 3 in the Czech, Hungarian and Polish samples respectively) though given the overwhelming number of small, owner-driver enterprises in the population, a larger number of smaller enterprises are represented, with micro enterprises accounting for 54% of the Czech sample, 50% of the Hungarian sample and 41% of the Polish sample. The median age of providers ranges between 7.5 and 9 years. There are proportionately fewer start-ups in the provider sample: 24% of the Czech sample but 17% of the Polish sample and 13% of the Hungarian sample. With respect to foreign ownership, 6% of both the Czech and Polish sample are 100% foreign-owned (3 and 4 firms, respectively), while no Hungarian road freight provider is fully foreign-owned. Finally, with respect to persistence of state ownership, Poland is the only country where there are still state-owned providers in the sample, corresponding to population statistics. Hungary, as previously mentioned, has no state-owned enterprises remaining in the road freight sector since 1998.

Performance of downstream enterprises and use of innovative logistics services. As reported in Table 2, increases in annual total operating costs (including labor, materials, transport and IT-related costs, among others) between 1997 and 1999 range between 10 and 20% for the median firm across the three countries. Hungary had the enterprise with the largest fall in costs (97%) but also the enterprise with the largest increase in costs (447%), resulting in the largest mean increase in costs (31.8%). Transport and logistics-related operating costs (including both own-account and third-party expenditures on transport, warehousing, inventory management, freight insurance, customs brokerage services and related expenditures) for the median enterprise ranged between 6 and 10% of total operating

costs in 1999. Changes in employment are utilized as a proxy for changes in the wage bill, with mean employment increasing between 12 and 16%. The percentage by which investment in IT/telecoms hardware and software is higher or lower in 1999 than in 1997 is used as a proxy for changes in IT-related costs.

In addition to data on possible enterprise-based performance gains from cost efficiencies, data was collected on changes in sales revenues for the most important product line for each enterprise. Changes in sales for the median enterprise and mean values are substantially higher for Hungary than the Czech Republic and Poland, no doubt driven by the relative boom experienced in Hungary at the time: real GDP growth of 4.9% between 1997 and 1998, and 4.2% between 1998 and 1999, with real increases in industrial gross output of 12.4 and 10.4%, versus real increases in industrial gross output of 2.8 and -0.4% for Czech Republic and of 4.8 and 4.4% for Poland.

Two key characteristics of an 'innovative' logistics service is that it not be fully adopted by all users, that is, only adopted by a limited sub-set of enterprises, and that it be relatively recently introduced in the market by providers (or conversely recently adopted by users). Of the logistics-related variables collected in the survey, three variables that meet this requirement are reported in Table 2: use of Just-in-Time consolidation and sequencing services, use of bar coding and tracking services, and use of packaging and labeling services. In the case of JIT services, 43 enterprises or 9% of the full sample make use of these services, while for bar coding/tracking and packaging/labeling the respective figures are 33 enterprises (7% of the sample) and 53 enterprises (11% of the sample). Regarding the above-mentioned 'recent introduction into the market' criterion, 82% of JIT users first started using the services after 1995, while the comparable figures for bar coding/tracking and packaging/labeling are 70% and 67% respectively.

One of the key use-of-logistics variables collected that could potentially be associated with significant cost efficiencies is whether enterprises made use of logistics consulting services in designing and implementing their logistics strategy, as such consulting services if appropriate would presumably be geared to making cost effective use of all elements of the enterprise's supply chain management including basic road haulage and multi-modal transport decisions, storage and warehousing, inventory control and management, purchase and vendor management, freight insurance, customs clearance and brokerage services, as well as own versus joint investments in IT and databases. The proportion of enterprises making use of such logistics consulting services ranged from 6% in Poland to 14% in Czech Republic.

Upstream provision of innovative services and intensity of competition. Table 3 reports similar logistics innovation variables as were analyzed from the perspective of user enterprises, but now from the perspective of providers: JIT, bar coding/tracking and packaging/labeling services. The main difference is that these variables reflect the number of customers to which providers offer the services. These variables are appropriate measures of innovative service provision as they capture both the act of innovation (whether the provider chooses to offer these new services) as well as the ability to provide an innovative service to a wide number of users (the number of customers actually supplied with these services). The regression analysis only makes use of the JIT variable, as the other variables have an insufficient number of non-zero observations (5 in the case of bar coding/tracking and 18 in the case of packaging/labeling) for robust results.

Table 3 also reports data on the best available measure of intensity of product-level competition in the road haulage provider market, namely the response by providers to the question 'How many direct competitors who could take away significant amounts of business from you did you face at the end of 1997 when providing road haulage services?' The original variable from the questionnaire has been transformed into a qualitative variable

ranging from 0 (zero competitors) to 5 (more than 10 competitors), under the assumption that the difference in the level of competition provided by 15 or 50 direct competitors is not economically meaningful. On the other hand, a distinction was made between 2 direct competitors and 3-5 direct competitors on the assumption that a market with 3 firms that interact strategically provides significantly more scope for collusion and market power than a market with 4 to 6 firms.

4. Empirical results

Downstream benefits. A useful starting point for exploring the impact of innovative upstream services on downstream enterprises is via direct feedback from the user enterprise managers themselves. Towards the end of the user questionnaire—after all pertinent quantitative questions had been asked in order not to bias results by providing respondents with leading questions up-front—enterprise managers were asked the following 2 questions: (1) 'By what percentage do you think that costs for your most important product groups were lowered over the past 3 years *as a result of use of road freight logistics* (such as faster delivery times and less breakage/spoilage)?' and (2) 'What percentage of your extra sales of your most important product groups over the past 3 years do you estimate *as a result of use of road freight logistics* (such as faster delivery times and better quality of service)?' The median firm manager per country responded that costs were lowered as a result of the use of road freight logistics by between 5 and 10% (a median of 5% and a mean of 8.8% for the Czech Republic, 8 and 8.8% for Hungary, and 10 and 10.7% for Poland). With respect to extra sales revenues, the median manager responded that sales increased by between 10 and 15% (a median of 10% and a mean of 22.6% for Hungary, 15 and 23.8% for Poland, and 15 and 37.0% for the Czech Republic). Although half or less of user enterprises per country responded to these questions (140 enterprises or 28% of the full user sample regarding impact on costs, 203 enterprises or 41% regarding impact on revenues), the responses represent a

benchmark: based on a more rigorous analysis of available separate responses on a range of relevant variables, to what extent are these figures over- or under-estimates?

In Table 4, regression results are presented on the association between usage of upstream logistics services (as captured by use of logistics consulting) and the most relevant cost-based performance measure. Column 1 reports results on the basic negative correlation between use of logistics services and cost increases, suggesting that use of such services allows enterprises to dampen cost increases through realizable cost efficiencies. Column 2 reports that this relationship becomes more statistically significant as changes in other components of a standard cost function are controlled for, with changes in employment serving as proxy for changes in the wage bill, and changes in IT/telecoms investments acting as proxy for changes in IT-related costs. Column 3 provides evidence that the basic negative association between logistics services and cost changes is robust to the inclusion of country and sectoral controls. Enterprise age is not highly significant (the positive association suggesting that recent entrants have incurred larger proportional increases in costs over the past 3 years), and loses its statistical significance when country and sectoral controls are introduced in column 3. The initial regression results are based on a truncated dependent variable, since examination of other data for the 8 outlier observations where cost changes were reported as more than doubling over the 1997-99 period suggested that these numbers may be over-estimates. However, comparable results based on including the originally-reported values for these outliers (including a more than quintupling of costs for the maximum observation) reported in column 4 provide confidence that truncation has not altered the underlying relationships in the data.

Table 5 presents regression results concerning the other key downstream enterprise performance variable, namely on the association between usage of upstream logistics services (in this case best captured by use of JIT services) and changes in revenues. Column 1 reports

a significant positive correlation between use of logistics services and sales increases, suggesting that use of these services allows enterprises to raise revenues by either lowering prices on existing products (with a more than proportionate increase in quantities) or by offering new products or existing products at new locations through faster or lower cost delivery times. Column 2 reports that this relationship remains robust to the addition of controls for size, age and state ownership. Higher sales growth is statistically significantly associated with larger enterprises, younger and privately-owned firms. Column 3 reports that the positive association between logistics usage and sales growth is robust to country and sectoral controls, and that the relationship becomes statistically more significant when Hungary's faster overall economic growth during those years is appropriately controlled for. Column 4 reports that the basic relationship between logistics usage and revenue-based performance remains relatively robust to the inclusion of originally-reported values for outlier observations. The decision to view the results with the truncated dependent variable as the main findings is based on the inconsistency of other enterprise-specific magnitudes with the reported several-fold increases in sales revenues for the 5 outlier enterprises.

Upstream impact of competition. Given the finding that economically meaningful downstream performance improvements are significantly associated with logistics innovations, it is natural to inquire what some important factors may be that stimulate such innovations by upstream providers. Table 6 presents results that address the hypothesis that competition-related pressures are significantly associated with the provision of upstream logistics innovations.

Columns 1 to 3 present OLS regression results. The quantitative provision of JIT services measure is used as an appropriate dependent variable to capture innovative service provision since, as previously argued, this variable captures both the act of innovation as well as the ability to provide an innovative service to a more or less large number of customers.

Column 1 reports a positive association between innovative logistics offerings and intensity of competition, where intensity of competition is captured by the number of direct competitors faced by each provider in its main business line of road haulage. The level of intensity of competition faced by providers in 1997 is used under the assumption that a time lag is required between competitive pressure being exerted on a given enterprise and the selection and implementation of its most appropriate response strategy, here including the provision of logistics services as measured at end-1999. Column 2 reports the robustness of the initial positive association to size, foreign ownership and state ownership controls. The results suggest that larger, internationally-connected, private service providers are better able to offer these innovative services than smaller, locally-based providers and the few remaining state-owned providers. Column 3 reports the robustness of these results to the inclusion of country controls.

Columns 4 to 6 present a complementary set of logit regression results where the dependent variable has been transformed to a qualitative variable merely indicating whether or not a particular provider offers the innovative logistics service. The positive even more statistically significant association between intensity of competition and provision of logistics services, with or without other controls, confirms that the results based on the quantitative dependent variable are not driven by a small number of larger enterprises with many customers but rather that there exists a strong and robust positive relationship between upstream competition and the provision of key upstream innovative services. In columns 5 and 6, 'State ownership' was dropped while running the regressions as it predicts the absence of JIT service provision perfectly.

5. Policy implications and conclusions

This paper contributes to the sparse empirical evidence that exists concerning the impact of, and benefits from, competition in business activities such as road freight logistics

services. The findings are based on a new and purpose-specific set of detailed enterprise-level surveys of both upstream logistics service providers and downstream intensive users of these business services, designed to allow econometric analysis of upstream-downstream linkage issues. In particular, the empirical analysis explores a particular but significant element of the debate of whether infrastructure services have a strong impact on economic development: what is the impact of innovative road freight services on downstream business users. The analysis then explores the extent to which the beneficial provision of innovative road freight services is associated with competition-related pressure.

The paper's main findings are: (1) there are substantial downstream benefits from innovations in road freight services, both dampening cost increases and raising sales revenues of business users, and (2) increased intensity of competition in road freight services is significantly associated with the provision of innovative road freight services. Direct feedback from user enterprise managers indicates that costs for the median user were lowered by between 5 and 10% as a result of road freight logistics and sales were increased by between 10 and 15%. Regression results support the thrust of these direct survey responses by managers: there is a statistically significant negative association in the data between the use of logistics consultant services and cost increases, and a significant positive association between the use of JIT logistics services and sales revenue increases. Finally, there is a statistically significant positive association between increased competition in road freight services and the provision of innovative JIT logistics services.

The paper's findings support both the claim that infrastructure services have a strong positive effect on economic development, and the policy claim that easing any remaining barriers to competition in upstream business services should be a priority. The paper's findings, coupled with further research results along similar lines emphasizing linkages between infrastructure provision and downstream business users, would provide a strong case

for devoting additional policy resources to creating an investment climate that stimulates increased and responsive infrastructure provision, of a type that is as responsive as possible to user needs. One element of such an investment climate may well be a broader and more activist role for competition agencies in support of more effective regulatory reform and supply-side entrepreneurship stimulus. In addition, more systematic documentation of the benefits of increased competition in infrastructure provision on downstream business users would help create stronger political support for further regulatory reforms, especially as new business users are typically not yet present as forceful reform advocates at the time of the initial policy decisions.

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Table 1
Number of firms by size, age and ownership

	Czech Rep	Hungary	Poland	TOTAL
TOTAL	200	203	255	658
USERS	150	151	192	493
Food processors	50	50	60	160
Food retailers	39	37	40	116
Food wholesaler	11	14	32	57
Auto parts	45	37	59	141
Vehicle assembly	5	13	1	19
Micro (0-9 workers)	44	46	87	177
Small (10-49 wkrs)	38	37	49	124
Medium (50-249)	31	42	35	108
Large (250+ wkrs)	37	26	21	84
Median age (years)	8	7	10	
Start-ups (LE 5 yrs)	35	56	36	127
50%+ foreign-owned (of which 100% f.o.)	30 (25)	37 (23)	13 (9)	80 (57)
Previously (& still) 50%+ state-owned	48 (1)	28 (4)	20 (3)	96 (8)
PROVIDERS	50	52	63	165
Micro (0-9 workers)	27	26	25	78
Small (10-49 wkrs)	10	15	21	46
Medium (50-249)	11	7	14	32
Large (250+ wkrs)	2	4	3	9
Median age (years)	7.5	8	9	
Start-ups (LE 5 yrs)	12	7	11	30
50%+ foreign-owned (of which 100% f.o.)	3 (3)	8 (0)	8 (4)	19 (7)
Previously (& still) 50%+ state-owned	5 (0)	3 (0)	12 (6)	20 (6)

Table 2
Downstream users: Performance and logistics use variables

	Czech Rep			Hungary			Poland		
	n	mean	Med	n	mean	med	n	mean	med
% change in total costs, 1999-97	125	17.5	10	105	31.8	12	135	25.9	20
% logistics in total costs, 1999	121	9.9	6	119	9.6	6	141	17.2	10
% change in employment, 1999-97	136	12.1	0	134	15.8	0	175	12.9	0
% change in IT-related costs, 1999-97	117	12.7	0	116	25.2	0	95	22.1	5
% change in main product sales revenue, 1999-97	108	12.9	7	107	39.6	20	125	8.9	10
Use of logistics consulting services (no. of 1=yes)	21			17			11		
Use of JIT consolidation & sequencing (# non-zero)	150 (13)	0.28	0	151 (10)	0.10	0	192 (20)	0.37	0
Use of bar coding & tracking (# non-zero)	150 (15)	0.32	0	151 (11)	0.28	0	192 (7)	0.14	0
Use of packaging & labelling (# non-zero)	150 (24)	0.49	0	151 (21)	0.42	0	192 (8)	0.14	0

Notes:

‘Use of logistics consulting services’ is a qualitative variable that takes the value 1 if the enterprise has used outside consulting services in designing and implementing its logistics strategy.

‘Use of Just-in-Time consolidation and sequencing services’, ‘Use of bar coding and tracking services’ and ‘Use of packaging and labelling services’ are qualitative variables with 5 discrete values ranging from 0 to 10, in response to the question ‘How many third-party logistics providers currently supply you with these specific logistics services’. The possible values of the variables are: 0 representing ‘none’, 1 representing ‘one provider’, 2.5 representing ‘2-3 providers’, 5 representing ‘4-6 providers’ and 10 representing ‘more than 6 providers’.

Table 3
Upstream providers: Logistics offerings and competition variables

	Czech Rep			Hungary			Poland		
	n	mean	Med	n	mean	med	n	mean	med
Provision of JIT consolidation & sequencing (# non-zero)	48 (14)	8.4	0	52 (10)	2.7	0	63 (15)	7.7	0
Provision of bar coding & tracking (# non-zero)	48 (1)	1.5	0	52 (0)	0	0	63 (4)	1.8	0
Provision of packaging & labelling (# non-zero)	48 (2)	1.6	0	52 (9)	1.6	0	62 (7)	2.9	0
No of direct competitors in road haulage services, 1997	48	3.5	4	46	3.8	5	48	3.6	4

Notes:

'Provision of Just-in-Time consolidation and sequencing services', 'Provision of bar coding and tracking services' and 'Provision of packaging and labelling services' are quantitative variables in response to the question 'To how many customers do you provide the following services?' Although the number of customers being supplied with these innovative logistics offerings by provider in the dataset ranges from 1 to 100, it reaches this maximum value for only 6 observations for JIT, 1 observation for bar coding/tracking, and 1 observation for packaging/labelling services. The figures in parentheses denote the number of positive (non-zero) responses in each category.

'Number of competitors' is in response to the question "How many direct competitors who could take away significant amounts of business from you did you face at the end of 1997 when providing road haulage services?", and has been transformed into a qualitative variable ranging from 0 (zero competitors), through 1 (1 competitor), 2 (2 competitors), 3 (3-5 competitors), 4 (6-10 competitors) to 5 (more than 10 competitors).

Table 4
The impact of innovative logistics provision on costs of user enterprises

Dependent variable: Changes in total costs of user enterprises over the past 3 years (%)
Pooled sample, OLS estimation

	1	2	3	4
Use of consulting services in Designing/implementing logistics strategy	-13.921* [8.318]	-18.516** [8.396]	-18.226** [8.427]	-21.188** [9.626]
Change in employment over past 3 years (%)		0.362*** [0.058]	0.343*** [0.058]	0.403*** [0.066]
Change in IT/telecoms-related investment over past 3 years (%)		0.194*** [0.054]	0.172*** [0.054]	0.221*** [0.062]
Age (start-ups = 1, older firms = 0)		10.904* [6.285]	8.872 [6.475]	6.683 [7.397]
Country dummies (Cze, Hun)			X	X
Sectoral dummies (food processing, Food wholesale, food retail distribution)			X	X
R^2	.0077	.2118	.2440	.2561
Adj.R^2	.0049	.1996	.2171	.2297
Observations	365	263	263	263

Notes:

Standard errors in brackets; *** indicates significance at 1% level, ** at 5%, * at 10%.

'Use of logistics consulting' is a 0-1 qualitative variable.

Results in columns 1-3 are based on a truncated dependent variable, where 8 outlier observations (% change greater than 200%) were truncated to 200% (the maximum observation was a reported increase in costs of 447%). Column 4 reports comparable results including the originally-reported values for these outliers (corresponding to the summary statistics reported in Table 2).

Table 5
The impact of innovative logistics provision on revenues of user enterprises

Dependent variable: Changes in sales of most important product of user enterprises over the past 3 years (%)
Pooled sample, OLS estimation

	1	2	3	4
Use of Just-In-Time consolidation & sequencing services	3.392** [1.598]	3.237** [1.560]	4.115*** [1.559]	4.136* [2.335]
Size (from LT 10 employees=1 to GT 250 employees=4)		5.127** [2.056]	3.889* [2.287]	2.590 [3.426]
Age (2000 – year enterprise began Operations in country)		-0.483*** [0.117]	-0.452*** [0.115]	-0.527*** [0.173]
State ownership (% of enterprise owned by central or local government)		-0.359** [0.165]	-0.390** [0.164]	-0.414* [0.245]
Country dummies (Cze, Hun)			X	X
Sectoral dummies (food processing, food wholesale, food retail distribution)			X	X
R^2	.0131	.0799	.1318	.0986
Adj.R^2	.0102	.0689	.1081	.0739
Observations	340	339	339	339

Notes:

Standard errors in brackets; *** indicates significance at 1% level, ** at 5%, * at 10%.

'JIT consolidation & sequencing' is a qualitative variable (with 5 values ranging from 0 to 10) that captures the number of 3rd-party logistics suppliers providing this service to each enterprise.

Results in columns 1-3 are based on a truncated dependent variable, where 5 outlier observations (% change greater than 200%) were truncated to 200% (the maximum observation was a reported increase in sales of 600%). Column 4 reports comparable results including the originally-reported values for these outliers (corresponding to the summary statistics reported in Table 2).

Table 6
The impact of competition on innovative logistics provision

Dependent variable: Number of customers of road freight enterprises to whom providing Just-in-Time consolidation & sequencing services at end 1999 (columns 1-3); Road freight enterprises providing JIT logistics services at end 1999 (columns 4-6)
Pooled sample, OLS (columns 1-3) and logit (columns 4-6) estimations

	1	2	3	4	5	6
Intensity of competition: No of direct competitors, 97	1.107* [0.663]	1.159* [0.641]	1.288** [0.636]	0.320** [0.152]	0.383** [0.160]	0.444*** [0.173]
Size (from LT 10 workers=1 to GT 250 employees=4)		3.294*** [1.056]	3.291*** [1.044]		0.785*** [0.226]	0.804*** [0.235]
Foreign ownership (=1 if GE 50%)		5.003* [2.826]	5.572** [2.818]		0.375 [0.562]	0.419 [0.593]
State ownership (=1 if GE 50%)		-8.130* [4.920]	-8.494* [4.967]			
Country dummies (Cze, Hun)			X			X
R^2 (Pseudo R^2 for col.4-6)	.0198	.1162	.1497	.0322	.1228	.1528
Adj.R^2	.0127	.0900	.1113			
Observations	140	140	140	140	140	140

Notes:

Standard errors in brackets; *** indicates significance at 1% level, ** at 5%, * at 10%.

'Number of competitors' is a qualitative variable (with 6 values ranging from 0 to 5) that captures the number of direct competitors who could take away significant amounts of business that each provider faced at the end of 1997 when providing road haulage services.

OLS results are based on a truncated dependent variable, where 8 outlier observations (with number of customers exceeding 50) were truncated to 50. Comparable results (not reported) were derived where the number of customers ranged to 100 (corresponding to the summary statistics reported in Table 3). Columns 4-6 report results for a separate set of logit regressions where the dependent variable has been transformed to a qualitative variable (0 if no JIT services provided, 1 if service provided to one or more customers).