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Banning the Bahn: Transport Infrastructure Effects on Austrian Cluster Firms

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Abstract

The adequacy of existing transport infrastructure to four distinct clusters in Austria's key regions is tested by examining the willingness of logistics managers to pay for additional service improvements. Findings show an overall willingness to pay for multiple service improvements; this reveals a general dissatisfaction with current shipping options, regardless of transport mode, where rail mode services (*"Bahn"*) provoke the greatest dissatisfaction. Willingness to pay for improvements generally increases by degrees of regional EU remoteness and relative youth of cluster industries, as hypothesized from Schumpterian assumptions concerning infrastructure innovation.

Key Words: regions, clusters, economic infrastructure, contingent valuation, willingness to pay, transport services, Schumpeterian innovators.

Introduction

Modern firms are said constantly to recalibrate asset portfolios and operations that take advantage of new market and technological possibilities, while also adjusting to changes in their operating and strategic environments, particularly those firms producing traded goods or services or subject to globalizing forces. Michael Porter argues successful globally-active firms adopt strategies to move beyond operational effectiveness of ongoing operations to strategically-position configurations of activities and competencies to span multiple operating environments and gain maximum advantage (1998, pp. 39-49). Evolutionary economists are more likely to see a series of recalibrations, adjustments and redeployments by firms as the normal, ongoing reactions to novelty produced spontaneously by chance or unanticipated strategic actions of others; selection processes shaped by evolving and anticipated market structures compel firms to recognize internal routines that have become defective and action is required to remedy loss of operational effectiveness or to reposition strategically[2].

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[1] Particular thanks are extended to Svend Remoe, Edward Feser, and Ron Boschma for their useful comments and suggestions.

[2] "It is important to note that in a dynamic (evolutionary) context, economic competence refers not so much to the set of maximizing or optimizing skills normally attributed to the firm in static theory as to the qualities which make good performance in the long-run: to generate opportunities, not just react to exogenous changes to make

Either way, firms constantly adjust to external circumstances in efforts to remain successful. In this paper, we focus on one form of immediate external circumstance to which firms must adjust, in this case the supply of infrastructure services—transport services in particular—offered to firms in their region or cluster. At the same time, transport or other externally-sourced infrastructure services can be altered to reflect customer preferences, assuming infrastructure managers are responsive to customer needs. Our principal approach follows Markusen (1994)[3] by seeking to detect how suitably served clusters and regions are by the transport infrastructure services that member firms identify as valuable or in need of improvement.

Two central findings can be mentioned: *first, improved reliability of service is the transport feature most desired in all regions and industrial clusters; second, the option of shifting to rail service from other modes by logistics managers to deliver their firm's average shipment would require substantial price reductions by rail carriers, thereby effectively "banning" its use.* Unlike other related studies, our results convincingly demonstrate the importance of analyzing how industrial clusters value specific transportation alternatives quite differently. Equally important are the findings that reveal key differences between Austria's various regions where clusters concentrate, which might be used to fine-tune or shed more light on regional cluster and infrastructure policies as well.

Transport as Economic Infrastructure

Economic infrastructure refers to the broad range of large-scale, capital-intensive and jointly-used system or network investments that provide a flow of services to many users, "…a kind of social overhead capital, related to fundamental 'enabling' technologies which are basic conditions for production to take place": reduced costs and significance of distance, expanded trade flows, re-division of labor, etc. are among effects familiar to and accepted by those who study the effects of infrastructure on the basic economic performance of firms and industries (Smith, 1997, p. 92-94). Such infrastructure is technically indivisible (very large investment increments), systematic (individual increments cannot be used), unduplicated (multiple versions are unrealistically expensive), and provides resources seen as essential or fundamental to production. Public works such as roads and dams are often as examples, but so too are utilities (power), communications and transport networks, and similar. Because these systems are difficult to adjust or modify extensively after their construction, the *original users* of such infrastructure typically exert strong path-dependent influence over its life-cycle, configuration and operational features. The initial qualities of infrastructure may induce subsequent and unanticipated

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educated guesses and take risks to maintain flexibility, and to learn". B. Carlsson and R Stankiewicz, "On the nature, function and composition of technological systems," *Journal of Evolutionary Economics* (1991), p. 101.
[3] "Studying Regions by Studying Firms". 1994. *The Professional Geographer.* Vol. 46, No. 4: 477-90.

future users to seek advantage in wholly new ways, which in turn may trigger further marginal or even major restructuring of infrastructure services (e.g., disused freight canals have become recreational waterways, airports engulfed by surrounding growth have become industrial complexes and abandoned railways converted to biking and hiking corridors).

The interplay between infrastructure providers and commercial users was seen by Schumpeter as the essential economic dialogue between innovative entrepreneurs that stimulate periods of intense innovation punctuated by lapses of activity, thereby resulting in cycles or waves. Andersen (2002) sees Schumpeter's infrastructure entrepreneurs as "…'true innovators': the implementation of blueprints or visions into economic practice as long as this is not a routine matter to do so" (p. 17). The task of the innovator in Schumpeter's words lies "…in the leadership of groups, in successfully dealing with politicians and local interests, in the solution of problems of management and of development in the regions the roads opened up. It was 'getting things done' and nothing else, a variety of pure entrepreneurship stripped of all accessories" (Schumpeter, p. 327, 1939 as cited by Andersen, 2002). Thus, even though infrastructure projects often evolve into publicly-managed monopolies, the original innovation was truly an innovative act, i.e. produced by a Mark I innovator.[4] It is among alternative infrastructure innovators (e.g., oil v. coal v. nuclear v. solar power infrastructures) that Schumpeter identified the most fundamental form of competition, although competition between firms in the same line of energy business (Mathews, 2002, p. 15) is said to drive the evolutionary development of firms. This paper intends to examine how well the contemporary transport infrastructure serves firms in some of Austria's key regions and industrial clusters.

Austrian and EU Transport: Path Dependencies and Path Creation

Austria provided the empirical and experiential foundation upon which Schumpeter built his "railroadization" hypothesis (summarized and evaluated by Andersen, 2002). Schumpeter illustrated the general developmental tendencies of large-scale innovative infrastructures by examining closely the history and development trajectory of railroads *("Bahn")* and related industries.

The physical elements of skeletal infrastructure networks and facilities are not, of course, directly useful to the proper functioning of an economy. They

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[4] The latter stages of infrastructure expansion and elaboration were carried out by Mark II managers who, in Schumpeter's words, are "New types of men took hold of them (the railroads), very different from the (Mark I) type of earlier railroad entrepreneurs. Some of them were not entrepreneurs at all, but simply efficient administrators…..As far as the new men…were not administrators, they were organizers and financiers…[who created] new production functions, reorganization of large sectors of the system, increase of productive efficiency all around" (Schumpeter, p. 402, 1939 as cited by Andersen, 2002). To the degree that state rather than private ownership characterizes managerial regimes, Schumpeter envisioned few direct improvements from such custody, apart from productivity gains due to improvements in rolling stock, control equipment and other accessories made available from private suppliers and vendors and taken on by the state railways.

are merely the capital embodiment of *latent* capacity, which must be properly designed, maintained and managed to deliver a flow of infrastructure services needed by firms and industries. These capabilities form what Carlsson and Stankiewicz (1991) call an agent's "economic competence," which is necessary to transform latent capital capacities into imaginative new and effective infrastructure services required by industrial clusters and technological systems alike: "…economic competence refers not so much to the set of maximizing or optimizing skills attributed to the firm in static theory as to the qualities which make good performance in the long run: to generate opportunities, not just react to exogenous changes, to make educated guesses and take risks, to maintain flexibility and to learn." (p. 101). These activities place pressure on other firms to take risks and expand dynamic flexibility as the means to survive, and not all are sufficiently competent to survive. The most innovative private suppliers of telecommunications and transportation services now compete in global marketplaces for demanding corporate customers in exactly this manner.

While 150 years have passed since Schumpeter's "railroadization" age began, contemporary firms and industries continue to be served by Austria's accumulated stock of transport services, which reflect heavy path dependencies on vintage infrastructure alignments and original service requirements of the agriculture, quarrying, mining, iron, steel, coal, machine goods, and wood sectors that emerged as industrialization accelerated in the late 19th century (Matis, ed., 1994). Austria's transport infrastructure is further imprinted by the country's singular Alpine topography, its trade corridor between the 1st and 4th largest EU economies, and its wrenching 20th century experiences: collapsed Empire remnant, former 3rd Reich province, 4-power occupied post-WWII territory, 1955 statehood, rapid penetration of roadways, and among the most recent entrants to EU-15 membership that shares borders with four EU-10 entrants[5].

By 2000, total EU-15 railway and waterway length had *shrunk* from a 1991 index of 103 to less than 100 (1995=100). High-speed passenger railways, however, expanded from around 300 km in 1990 to 2,300 km in 2000, none in Austria. At the same time, the EU roadway index increased from 85 in 1990 to 111 in 2000 (EEA, 2003). Even as roadway haulage potential increased and traditional modes decreased, Austrian railways in 2000 still carried the highest freight loads per km of any EU-15 railway line, much of it international. The Austrian Federal Railway is the largest rail-network owner (91% of 6,200 km) and its services account for 99% of total freight carried. This dominance may lessen after Austria's railway market opened for more competition in 2000.

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[5] Included here are establishment of a mature railroad alignment by end of 19th century, alpine barriers to further system elaboration, transition from private to Empire consolidation of railroads, heavy transport infrastructure to support trade between Germany and Italy, temporary integration of the Austrian Federal Railways (ÖBB) into Nazi Germany's rail system (including major industrial service improvements), subsequent re-nationalization of many sectors (including rail) to avoid post-WWII Soviet expropriation, and integrated trade and harmonization requirements of EU membership.

Deregulation, harmonization and competition being introduced via EU reforms within former state rail sectors is now widely accepted, but implementation lags well behind as other privatized transport modes seized EU growth from state-owned rail companies that can't count, whose trains don't run properly, that lack cross-system information, that feature 'ghost trains', single trains with many drivers, etc.: "If nothing is done, rail's share of the freight market, which has already fallen from 11% in 1990 to 8% in 1998, can be expected to slip to 7% by 2010 (Commission of the European Communities, pp. 26, 28). In Pelikan's view (1995, p. 12) "…the quality of management in turn strongly depends upon the competence of the owners: without highly competent owners, it is unlikely that a high quality of management will be obtained and maintained."[6]

One could interpret the growth in freight carried by trucks as a partial market response to firms' dissatisfaction with rail services; more dramatic evolutionary strategies of firms that adjust by relocating previously to more favorably-served locations cannot of course be observed directly, so the empirical findings discussed here are necessarily the product of data drawn from firms that have thus far survived in place. Further degradation or even delay of transport service improvements could threaten the long-term viability of Austria's core rail-dependent industrial regions and clusters and aggravate the environmental distress produced by enormous present and projected growth of trucking through the Austrian Alps, which prompted Austria to investigate with EC support the potential for establishing multi-mode logistic centers in one or more locations to ensure industrial viability and long-term trade with neighboring accession countries. This recent governmental attempt at 'path re-creation' was based in part on the unmet transport needs of several key industrial clusters (metal working, motor vehicles, chemicals/pharmaceuticals, food, wood/paper, electrical/electronic, construction materials), which have varying degrees of dependence on logistical services of several types. The industrial clusters were located in one or more specific regions (Villach/Klagenfurt, Linz/Wels, Graz, and Vienna), consisting of numerous smaller political units as indicated on Figure 1.

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[6] "In the absence of private and tradable ownership of capital, no automatic impersonal feedback from economic results related to the size of capital can exist. Consequently, errors in the owners' decisions do not automatically cause this size to diminish. Instead, all promotions and demotions must be determined by decisions of specific agents in specific positions within a corresponding politico-administrative hierarchy…(who, having)…been selected in politico-administrative ways, their competence for correcting economic errors is also likely low, and their appointment to such positions is itself likely to be an error. Even gross errors may thus remain uncorrected and their authors may not be demoted for a long time, possibly not until they cause the entire economy to fall into a deep crisis" (Pelikan, 1995, p. 10)
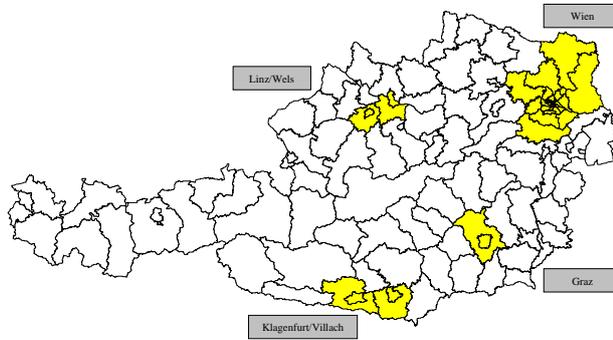
Figure 1: Map of Austrian Regions

Clusters were identified systematically by Bergman and Feser (1995) and Feser and Bergman (2000) in terms of 'value-chain' membership of firms from different industries whose input-output coefficients indicate they are likely to trade heavily with each other, which further research has shown also tend to co-locate in nearby surroundings.[7] The ability of firms to manage supply-chains and organize production inputs and outputs depends heavily upon logistics options available to them and, by extension, permits us to infer how well-endowed key Austrian regions and clusters are with transport infrastructure services.

Research Hypotheses and Design

Basic hypotheses will therefore focus initially upon the degree of satisfaction firms express with their current transport and logistical arrangements. Direct expressions of satisfaction are often misleading, however, because firms do not logically consider alternatives presently unavailable to them. Potential--but presently unavailable-- transport options are the ones that firms might actually prefer and that transport suppliers might provide, if such preferences were known. Therefore, one key assumption behind such hypotheses assumes firms presently enjoy optimally provided transport services *unless they are willing to pay more for additional types and units of transport services*. This assumption and related hypotheses call for a research design that employs contingent valuation methods to extract shadow prices of potential alternatives[8].

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[7] Value-chain clusters are preferred when studying trade and interfirm supply-chain dependencies on transportation of intermediate goods. This approach has figured prominently in OECD (1999, 2001) and other works (Bergman and Feser, 1995; Feser and Bergman, 2000). When detailed postal-code locations of value-chain cluster firms in U.S. agglomerations are compared systematically with the location of all other nearby industrial firms, cluster firms are nearly always grouped more closely together, even though such cluster firms are often drawn from entirely *different industries* (Feser and Sweeney, 2001). Co-location reflects the desire to shorten just-in-time deliveries between supplier and customer, while it enables spillovers and inter-firm collaboration on shared non-trade issues of importance to cluster members. Clustered firms also helps transport-service providers rationalize longer-distance transport and the design of logistic centers to serve co-located cluster firms. Additional definitions and approaches have been used since the early '90s to analyze Austrian clusters for other purposes (Ademetz, et al, 2000; Anlanger, 2002; Bellak and Weiss, 1992; Bergman and Lehner, 1998b; Clement, et al, 1994, 2000; Gassler and Rammer, 1999; Holzschlag, 1997; Hutschenreiter; 1994; Peneder, 1994, 1999; Schröch, 1998; Steiner, et al, 1996, 1997, 1998; Toedtling et al, 2001, 2004; Trippl, 2004; Weiss, 1994).

[8] Contingent valuation, sometimes called "stated preferences", includes extremely diverse literatures of method and application (see Holt, 1999, and UCLA Economics Department, 2001) to derive information about respondent's preferences by asking direct questions concerning trade-offs (Cummings, et al, 1986; Mitchell and

Specific hypotheses of interest revolve around the shadow prices that firms in various regions or industrial clusters would willingly pay to obtain unavailable transport options or, conversely, would pay to avoid undesired options. Focusing first on regions, one would logically expect those located nearest EU-15 borders (or at international links) with the longest recent trading patterns would have the best transport service (i.e., firms there would pay least for potential improvements) and those nearest EU-10 borders with the shortest recent trading patterns would have the worst (i.e., pay most for improvements). In terms of the regions under investigation here, Wels-Linz is the western-most region, nearest Germany (Austria's single largest trading partner), and was the beneficiary of extravagant rail infrastructure and industrial investment during the 3rd Reich, which leads one to expect that its firms enjoy the best freight transport services. Perhaps Vienna qualifies as the second-best served, since the capital requires high transport service levels—at least in terms of passenger transport—as do organizations that are part of its international complex. Villach-Klagenfurt is near the more frequently-transited Slovenian and Italian (EU) borders, while the Graz region essentially borders the Hungarian and Slovenian frontiers. These stylistic factors reflect the more typical calculations of transport accessibility as compiled and mapped by Spiekermann and Neubauer, 2002 (particularly Figures 2, 3, 4, 6 and 8). Therefore, our hypothesized ranking of relative regional transport accessibility *(and satisfaction)* is: Linz-Wels>Vienna>Klagenfurt-Villach>Graz. Their locations relative to border positions discussed above are illustrated in Figure 2.
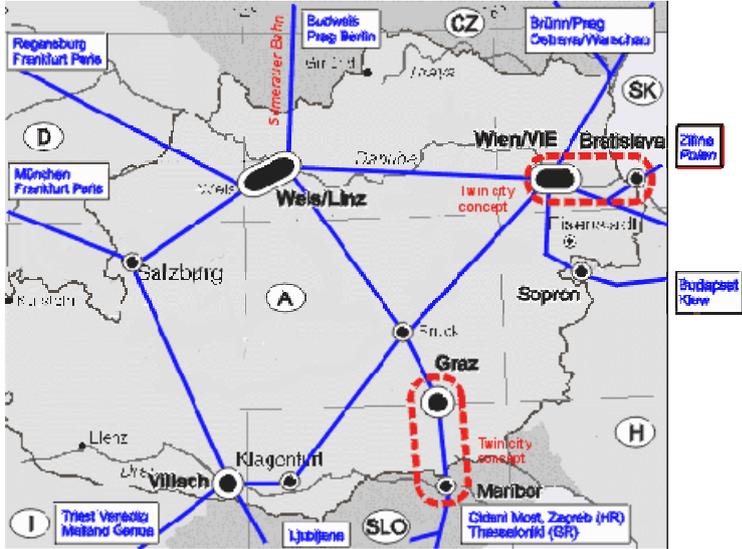
Figure 2. Regional rail connections at Austria's borders

Carson, 1989). Typical methods are questionnaire surveys or, as in our case, experiments with simulated decisions. In this application, our principal comparisons focus on *alternatives within the logistics function of a firm*; opportunity costs of pursuing non-logistic strategies, such as adjusting R&D budgets, retraining workers, relocating assets or outsourcing, etc. are not the direct focus of this research, although all are indirectly dependent upon the commercial viability of firms and upon *prior infrastructure innovations* that permit the allocation of resources for present strategic purposes.

If we redirect our attention to clusters, then firms in clusters that produce products requiring special handling and multi-modal logistics to specific customers located in a variety of distant markets and precisely-timed input deliveries are likely to be served least well by Austria's tradition-heavy transport system (i.e., such firms are willing to pay most for potential improvements). However, firms in clusters that ship traditional bulk goods and heavy or damage-resistant products directly to a few highly concentrated customers are probably reasonably well-served by traditional transport services (i.e., pay least for improvements). Thus, machinery/metal and electronic/electrical clusters fall in the first group, the latter being a somewhat more modern cluster than the former of this group. Accordingly, we would hypothesize electronics/electrical firms are probably least-well served of the two. Of the remaining two clusters, chemicals/pharmaceuticals are often commodity shipments in bulk containers, while motor vehicles require individual care in loading, transport, queuing and storage, and both are shipped in bulk-lots to single or few destinations. We would therefore hypothesize the rank of transport satisfaction from highest to lowest as follows: chemicals/pharmaceuticals>motor vehicles>machinery/metals>electronics/electrical cluster firms. This ranking also tracks the approximate vintage of technological regimes that are thought responsible for the origins of the clusters and constituent sectors under study.

The performance features of transport service that meet current firm needs are arrayed below. From an industrial perspective, some dimensions such as reliability of shipments are more important for JIT or flow-dependent input clusters, while cost or frequency of shipment could affect heavy industry clusters with more traditional production technologies. Rail-mode is likely to appeal mainly to firms producing commodities, large-units, or low-value to weight products for shipment. Because a given industry might choose one mode rather than another due to availability of features and relative costs in specific locations, we also include mode as an "option" to be evaluated. Therefore, these features can be thought of as a menu of transport choice ingredients, depending upon the industrial clusters being supported by economic infrastructure. These are described below in terms of their measurement.

TIME   in hours required for delivery of shipment
RELIABILITY   in percentage point of on-time shipments
FREQUENCY   in hours *between* shipments
FLEXIBILITY   in *minimal notice* time (hours) to request shipment
COST   of a typical shipment
MODE   of transportation used for typical shipment

Contingent-Valuation Model: Implementation and Findings

To detect the shadow prices that firms in various clusters or regions would pay for potentially available transport services, we also adopt the frequently deployed contingent valuation[9] approach that implements a conjoint alternative scenario experiment, which is by now a well-established procedure for systematically collecting stated preference information from respondents. In the context of freight transport, similar methods have been used among others by Bates, 1988, Fowkes and Tweddle, 1997, Bolis and Maggi, 1999, Engel, 1996, Maier and Bergman, 2002, Maier, Bergman and Lehner, 2002. In such studies, a logistics manager serves as the interview partner who is asked to describe a typical transport relationship of the company along a number of transport service dimensions. The features described above were drawn from those most frequently used in revealed preference transport studies, which are also useful from the point of view of transport-related industrial cluster policy.

We implement the contingent-valuation model in a way that sheds light on our principal hypotheses, i.e. we model repeated estimations of transport service trade-offs by sampled firms that comprise the industrial clusters or regions of interest. When value-chain clusters comprise the sampling frame, one must recognize such a cluster may consist of as few as 4 detailed industry components, while others may contain more than 100. Using international concordances and pre-tested procedures developed by Bergman and Lehner (1998a, 1998b), all detailed Austrian industry employment groups were classified into one of seven non-exclusive value-chain clusters in the following relative proportions.

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[9] See expanded discussion in Appendix 1 (further operational details and methodological refinements are evaluated at greater length in Maier and Bergman, 2002 or Maier, Bergman and Lehner, 2002.)

Table 1: Cluster Employment in Austria

CLUSTER	1991 TOTAL EMPLOYMENT [10]	CLUSTER/ TOTAL[11]
Metal Working	289,360 (111,737)	.40
Motor Vehicles	234,560 (54,544)	.32
Chemicals/Pharmaceuticals	187,300 (40,272)	.26
Electronic/Electrical	169,700 (68,484)	.23
Food	100,960 (67,052)	.14
Wood/Paper	100,400 (51,063)	.14
Construction Materials	24,200 (13,680)	.03

The four largest clusters studied here account for approximately 70% of net total manufacturing employment, while the remaining three account for about 30%. The smallest 3 clusters are natural resource-dependent and therefore ship most of their output to other downstream producers. By definition, natural resource clusters receive few, if any, regular *input* shipments of consequence to logistics managers from other producers. The three natural resource-based clusters are also less widely distributed across the regions tested for transport satisfaction. Attention was therefore focused on the transportation needs of firms in the four largest and most spatially-sensitive industrial clusters. Scattered portions of these four industrial clusters are to be found throughout Austria and in neighboring country regions as well, although generally higher concentrations of firms arise in one or more of our study regions. Accordingly, we first examined broad industrial patterns across all the Austrian Laender, then focused on specific border regions most likely to host major expansion and improvement of transportation systems to improve trade and commerce: Vienna (Slovakia), Linz-Wels (Czech Republic/Germany), Graz (Slovenia/Hungary), and Villach-Klagenfurt (Slovenia/Italy)[12]. The joint distribution of employment by Austrian

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[10] Employment in the "Core cluster" (parens) includes those industrial sectors whose inter-industry trade is most highly correlated ($>= 0.6$) with other members of the full cluster. For details on the strength of attachment, see Feser and Bergman, 2000 and Bergman and Feser, 1995.

[11] The seven clusters listed total more than 100% of 1991 employment because certain specific industries are members of *more than one cluster*, thanks to broad inter-industry trading networks, which would lead to multiple-counts if one simply summed nominal cluster employment levels.

[12] Tabular and mapped information permitted the detection of which study regions and transportation corridors host the most highly concentrated clusters. Mapping relative concentrations revealed cluster activity and a unified framework for selecting a stratified sample of firms. The tabular summaries are presented in Appendix 2. As in many industrialized countries, the limitations of officially collected and released data in Austria are quite severe, such that the only type of sectoral data available at all geographic levels is the number of establishments. Employment data are available for larger geographic units, but entries for sectors in specific areas are suppressed if 3 or fewer establishments per sector report their employment levels, which can often be the case. Data suppression was circumvented by a routine but highly complex process of row and column adjustments to the partially suppressed matrix of employment at multiple sectoral and geographical levels of 1995 data supplied by the Austrian Statistical Office.

region and cluster, including recent changes and relative concentrations as revealed by standard "location quotients", is shown in Appendix 2.

Although the results of our modelling efforts can be portrayed and discussed in various ways[13], e.g. as direct coefficients, elasticities, and contingent valuations, we focus almost exclusively on the *monetized contingent valuations* for expository reasons. Contingent valuations describe in the most direct way the value to firms of transport services available in Austrian regions and clusters. At the same time, they embed the most face-valid expression of transport and logistic decisions typically made by firms that struggle to position themselves in global competition. We present here the results for three different estimations: combined firms, regionally-partitioned firms, and cluster-partitioned firms.

General Willingness to Pay for Transport Services

The estimation results for the combined dataset are quite good. The corrected rho-square value is 0.30, the likelihood-ratio-test for the overall model is with 913 (31 variables) highly significant. All the above listed explanatory variables have highly significant parameters (probability of error less than 1%) and all with the expected sign.

These estimation results have been converted to the marginal prices in Austrian shillings (13.76 ATS=1 €) logistics managers were ***willing to pay to obtain one additional unit or type of desired transportation features that differed from their current shipping options***. The usual performance features apply to all transport modes, while "willingness to pay" ATS 2,343 less if rail mode is used reflects: 1. logistics managers currently use non-rail--typically road--very heavily, and 2. the amount these managers would pay for average current shipment *if* rail were substituted for current mode. The most striking overall finding is *the large price that an average Austrian logistics manager is willing to pay to retain existing modes (typically road), i.e. to avoid using rail transport* (or, equally logically, the *reduction* in shipment prices a manager would demand *if* rail service were substituted). Quite vivid reasons were occasionally offered by logistics managers during interviews to justify their distaste for rail service, some of which reflect key transport features (reliability, frequency, flexibility) included in our modeling.

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[13] More typical purposes for which similarly-designed studies have been intended stress the relative size and significance of elasticities and coefficients for alternative transport service features across transport regimes and territories (Bates, 1988, Fowkes and Tweddle, 1997, Bolis and Maggi, 1999, Engel, 1996; Pereira, 1996), which the present authors have also investigated elsewhere using alternative modeling specifications on this dataset (Maier and Bergman, 2002; Maier, Bergman and Lehner, 2002).

Table 2: Willingness to Pay for Features (combined dataset)

General transportation features evaluated by logistics managers	Willingness to pay (ATS) for Associated Transport Feature
TIME (-1 hour total shipment time)	126
RELIABILITY (+1 percentage point)	815
FREQUENCY (-1 hour of interval)	198
FLEXIBILITY (+1 hour less notice)	102
RAIL MODE (avoid rail mode)	2,343

With respect to our most general hypothesis, *the fact that firms would pay for improvements in every performance feature tested means that their current logistics arrangements are not satisfactory and that improvements in transport infrastructure services could benefit their operations.* The prices logistics managers are willing to pay for service improvements implies that room exists for some improved rail and *other* logistics services offered in Austria, else firms would show no willingness to pay for additional levels or qualities of service. There are of course limits on the degree to which rail services could feasibly or quickly be altered in a system built over time for an evolving industrial base that may bear only passing resemblance to Austria's contemporary clusters[14]. Advanced industrial producers and clusters are more likely to have developed during recent periods when well-organized logistical services based on international truck and airline freight service alternatives became available. The main hope for rail service probably depends upon a strategic rationalization of current services and designing new rail services that permit Austria's main industrial clusters to receive and ship goods *reliably* within the projected EU inter-industry trading space. Private, open-alignment transport and logistical services could respond more rapidly and flexibly to improve their offerings.

Reliability of transport service from all modes is without doubt the most highly prized performance feature now lacking and for which firms are willing to pay. JIT and related delivery requirements typical of modern production systems place a very high premium on reliable service to eliminate inventories, enforce input quality standards, optimize returns on capital investment, and expedite continuous-flow product deliveries. By comparison, frequency, total time, and flexibility of transport services are features of relatively lesser value to firms, which means these are among the least severe shortcomings of transport services available.

Regional Willingness to Pay for Transport Services

Stratification of the sample permits further model estimation of contingent valuations by firms in distinct regions. This permits one to detect relative

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[14] Perhaps Austrian rail service is more adequately designed and operated to support the three smallest industrial clusters: food, wood/paper and construction materials (mainly high-weight, low-value commodities). This might explain the reasons for, but not solve, difficulties faced by the larger, more dynamic clusters.

regional variations in satisfaction with existing transportation features, particularly their willingness to gain additional transportation features at contingently valued prices. We can therefore test additional hypotheses concerning *regional* adequacy of such services. The quality of the estimations is robust. The corrected rho-square lies between 0.18 and 0.34, all the likelihood ratio tests are highly significant. CONSTANT, COST, and RELIABILITY are highly significant in all regions. All significant coefficients have the expected signs[15]. Columns for each region are placed in hypothesized descending rank-order concerning adequacy of transport services (or, conversely, willingness to pay for improvements in such services). In general, willingness to pay rises with decreasing regional rank-ordering of hypothesized substitutions of rail mode, while willingness to pay for improvements in transport services are less clearly related to regional location.

Table 3: Willingness to Pay for Features (regionally partitioned)

FEATURE/ REGION	LINZ-WELS	VIENNA	KLAGENFURT-VILLACH	GRAZ
TIME (-)	124	0	109	138
RELIABILITY (+)	872	676	396	834
FREQUENCY (+)	105	112	0	587
FLEXIBILITY (+)	0	232	7	95
RAILMODE (-)	0	1,775	3,312	3,442
RAIL ACCESS (+)	0	0	2,328	na

Linz-Wels is seen to be unique among Austrian regions by its relative indifference to rail vs. road (Railmode=0), which implies the average logistics manager there is sufficiently *satisfied* with services available (no willingness to pay to use or avoid shipment by rail). The indifference among Linz-Wels managers concerning mode contrasts strongly with the substantial *price reductions* logistics managers in the other regions would require to use rail service when arranging shipments: somewhat lower-than-average price reductions would be required in Vienna, which then nearly double for Klagenfurt-Villach or Graz. These variations could reflect the relative overall quality or relevance of rail service for particular clusters that logistics managers face in Graz and Klagenfurt-Villach regions, where substantial price reductions

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[15] Two caveats are necessary: first, '0' entries in the tables imply that an estimate was insignificantly different from 0, and second, data collected in Graz did not include information about direct access of firms to rail lines ('na'), which is an interaction-variable evaluated in these more detailed models. Note that the interactive effects of direct rail access (rail siding at/near firm with rail mode) is evaluated in these estimations to detect regional variations.

per shipment that would be required to attract rail service customers. Only Linz-Wels as a region considers rail transport as adequate. Overall, this pattern strongly supports our initial hypothesis.

Our results reveal further contingencies with respect to direct rail access: while the *average* Klagenfurt-Villach firm wishes pay ATS 3,312 *less* if rail services are used in its average shipments, those Klagenfurt-Villach *firms with direct access to controlled rail sidings ("rail access")* value their direct access as worth ATS 2,328. This compensating valuation implies that direct access helps improve the value of rail mode such that the price penalty that would be assessed by the Klagenfurt-Villach firm with rail sidings drops to ATS 948 (ATS 3,964 - 2,742). Availability of direct rail access was not valued by logistics managers in Vienna or Linz-Wels, thereby implying that the value of rail mode services in these regions is indifferent to direct rail access, although perhaps for different reasons: Vienna is relatively more heavily dominated by industrial clusters for which *rail access* may be less relevant than other available transport modes and therefore existing access has little or no value, while satisfaction with existing rail access in Linz-Wels could reflect that region's historically deep rail infrastructure, which is sufficiently ample that rail sidings *per se* offer little improvement over already high levels of rail service access.

Other transportation qualities show some limited regional ranking effects. Reductions in total length of shipment **time** elicited no willingness on the part of Viennese firms to pay for a *one hour reduction*, thereby implying general satisfaction with overall delivery times. The length of shipment time is of some importance (109 to 138 shillings, or up to €10/shipment) in the other regions. **Frequency** of service appears to be a particularly acute problem in Graz, where logistics managers would pay 587 shillings to *reduce by 1 hour the interval between shipments,* while other regions would pay less than ¼ that amount or nothing at all. These scattered findings lend further support our general hypothesized relationship.

As mentioned earlier, reliability of shipments is by far the most important transport service feature: Graz and Linz-Wels logistics managers are the least satisfied with **reliability** of service, such that 834 to 872 shillings per shipment would be paid to *improve on-time shipments by one percentage point:* as these inadequacies are at opposite ends of our hypothesized rank ordering, this implies a more general problem everywhere. Lesser but still substantial amounts would also be willingly paid by Viennese and Klagenfurt-Villach firms for improvements in reliability. Vienna stands apart from others in the highest **flexibility** premium its logistics managers would pay (232 shillings) to *reduce by one hour the order-to-pickup time* of a shipment; Linz-Wels managers are unwilling to pay for any flexibility improvements, presumably because they are sufficiently satisfied with existing services.

Our regional analytic frame yields findings that support key elements of our hypothesis, particularly concerning railroad services, and somewhat less so

for frequency and flexibility of service. Other findings identify isolated points of weakness or inadequacy of transport service in specific regions, at least from the viewpoint of logistics managers in the region's most important industrial clusters. In a very qualitative sense, we might conclude that Vienna and Linz-Wels together enjoy the best overall regional transport (including rail), Graz has the worst service, and Klagenfurt-Villach lies somewhere between. A willingness to pay for specific improvements in transport service could reflect either the adequacy of overall transport options available or the unique blend of demands placed on the transport system by any region's mix of industrial clusters. To understand the nature of industrial cluster demands, we move next to a consideration of logistic manager responses of firms sorted by industrial cluster partitions.

Cluster Willingness to Pay for Transport Services

Further stratification of the observations permits model estimation of contingent valuations by firms in distinct industrial clusters. Again, the quality of the estimations is good: corrected rho-share values lie between 0.23 and 0.33, and all the likelihood ratio tests are highly significant. With the exception of RAIL ACCESS and FREQUENCY for the electronic-electrical cluster, all the variables yield significant coefficients in all estimations, most of them highly significant.

As Figure 4 shows, industrial cluster firms reveal consistently significant evidence of willingness to pay for *all* types of transport improvements, which indicates a general dissatisfaction with levels and qualities of current transport services. The important question is, do the relative amounts firms are willing to pay tend to confirm our rank-order hypothesis?

Figure 4: Willingness to Pay for Features (cluster partitioned)

FEATURES/ CLUSTERS	CHEMICALS/ PHARMA- CEUTICALS	MOTOR VEHICLES	MACHINERY/ METALWORK	ELECTRONIC/ ELECTRICAL
TIME (-)	81	107	295	111
RELIABILITY (+)	549	775	720	1,033
FREQUENCY (+)	74	145	386	0
FLEXIBILITY (+)	22	103	166	213
RAIL MODE (-)	1,444	1,426	2,742	3,575
RAIL ACCESS (+)	0	0	3,964	0

If we start our discussion by considering again rail service as the alternative transport mode in an average cluster firm's shipment, the *logistics manager in every cluster would demand price reductions to use **rail transport***. The price reductions in fact rise in rank order as hypothesized, where motor vehicles and chemicals-pharmaceuticals demand the smallest price reductions (ATS 1,426 to 1,444), presumably reflecting less dissatisfaction, while machinery-

metalworking and electronic-electrical clearly demand increasingly higher reductions (2,742-3,575) to use rail shipments. There is again an interesting contingency worth exploring. Machinery and metalworking logistic managers differ uniquely in their views. While the average logistics manager in this cluster would be willing to use rail with a price reduction of ATS 2,742/shipment, in those firms with direct rail access, logistics managers would be *willing to pay 1,222 shillings extra for rail transport* of its average shipment. In other words, only firms with direct access find rail to be a valuable transport service and are willing to pay more for it, *not pay to avoid it*[16]. We should not be surprised to learn that the concentration of this cluster is also highest in Linz-Wels (Appendix 2, location quotients), the region that enjoys the best overall rail service. It is probably the case that Austria's Linz-Wels region and its metalworking-machinery cluster grew in national importance at a time when appropriate rail investments gave priority to these groups of firms.

Reliability of on-time shipments is again the single most important feature in terms of unit-prices, and Table 4 shows general rank-order increases in prices cluster managers are willing to pay for higher reliability: bulk-dominated chemicals/pharmaceuticals offering the lowest payment (highest satisfaction) and the electronic/electrical cluster offering the highest payment (least satisfaction). The table clearly indicates a generally increasing willingness of the same clusters to pay for improved reliability or to demand lower costs/shipment of rail service.[17] This tendency is even more strongly evident in the results for **flexibility** as well: logistics managers of electronics-electrical and machinery-metalworking clusters will pay two to ten times (ATS 166 to 213) more per shipment than logistics managers of chemical/pharmaceutical or motor vehicle clusters to reduce time between shipment orders and pickups.

The machinery and metalworking cluster has uniquely exceptional difficulties with two additional service features that help complete this scenario: **time** length and **frequency** of shipments. Total length of shipment **time** was approximately three times as important (*ATS 295/shipment to reduce total time by one hour*) and increased **frequency** of shipments was two to three times as important (*ATS 386 to reduce time interval between shipments by one hour*) than for other clusters. These additional needs are calculated for the average metalworking and machinery firm, not necessarily those firms with direct rail access or those located in Linz-Wels.

As hypothesized, the *four industrial clusters ranked by transport sensitivity reveal progressively greater dissatisfaction with: 1. the value of rail as an alternative transport mode, and 2. reliability of shipment arrival times, or 3. flexibility of available transportation service options.* Systematically less

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[16] Perhaps more direct rail access should be offered to firms in this cluster. The extra ATS 1,222 such firms are willing to pay could also be capitalized in the price of facilities with rail access and made available to firms.

[17] "Reliability" was also determined to be the most significant transportation/shipment problem faced by the metal-working and machinery industry in a recent Chicago transport and cluster study (Pereira, 1996).

satisfaction with transport infrastructure services is evident for firms in clusters than in regions, although there are very few transport service qualities that satisfy logistics managers of Austria's key export firms, regardless of region or cluster identity.

Conclusions

There are several overall conclusions observable in the findings that merit mention. First, Austrian firms in general appear not to be well-served overall by the available transport services and infrastructure, and to be served less well in clusters than regions. Firms express a broad willingness to pay, often generously, for improvements in their average shipment arrangements. This implies un-served markets, potentially vulnerable regions, and transport-dependent clusters that policymakers and transport service providers should recognize. In Schumpterian terms, Austria's transport infrastructure sectors desperately need more Mark II innovators.

Second, as hypothesized, we conclude that regions located furthest from traditional trading partners or other external economic forces are generally less-well served by available transport infrastructure, although there are interesting exceptions that may fade as trade accelerates with EU-10 neighbors and as EU-stimulated infrastructure projects or transport privatizations take hold. At the very least, this would seem to imply that regional policymakers should seek to investigate further which specific services and providers are needed and how best to support them[18]. We have only examined the largest and most significant clusters and only those in key regions, but since we find serious transport deficits in precisely these areas of greatest relative importance, other regions are also likely to warrant further attention.

Third, the striking differences in transportation satisfaction and willingness to pay for improved service that was hypothesized and observed among value-chain clustered firms wholly confirm our research approach to partitioning Austria's manufacturing industries and to sampling firms to detect relative sensitivity to various transportation options. Unlike Bolis and Maggi (1999), who "…found no evidence for difference in valuation among sectors…"(p. 13) in their study of contingent valuations for Swiss transport options, we find the most pronounced and highly systematic differences in transport valuation for firms grouped into distinct value-chain clusters. We also find the largest transport deficits in younger or technically-significant clusters with the greatest export promise, while more traditional clusters are seemingly better served by available transport. While this is understandable in an historic sense, there seems to be a serious lag in providing the essential transport infrastructure to grow and develop Austria's most promising clusters.

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[18] More detailed transport policy implications for specific combinations of regions and clusters can be drawn from further analyses of these data (see Maier, Bergman, 2002; Maier, Bergman, Lehner, 2002), but this analysis focuses primary attention on the hypotheses associated with the relative accessibility of regions versus clusters.

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Appendix 1: Conjoint Experimental Scenario Procedures

Product shipping services are a type of service that typically combines a number of characteristics like cost, speed of delivery, reliability of service, into one product. Logistics managers evaluate those services based on their characteristics. This leads to decisions about whether or not to use a certain service for their product shipment needs. Two problems are evident in this context:

1. Logistics managers' evaluation of characteristics cannot be observed directly but only indirectly through their choice of service.
2. Those decisions are typically made implicitly via observation of the market and negotiations with potential service providers. Therefore, it is difficult to clearly identify alternative services a logistics manager had considered but decided not to use. This form of decision making also dramatically reduces the frequency of observable decisions.

Conjoint analysis is a technique that can overcome those problems. It is frequently used in marketing, typically in the context of the introduction of new products or new product characteristics. We use conjoint analysis for identifying the logistics managers' preferences for the characteristics of shipping services.

In total, 98 interviews were held with logistics managers of sampled firms, following a thorough pre-test of all instruments and the consequent understanding of the respondent's perspective. Every interview involved the following three steps:

1. Collection of basic information about the firm (including whether the firm has direct rail access).
2. Collection of information about current shipping services used for two typical transport relations, one on the input side and one on the output side.
3. Generation of *hypothetical* alternatives based on the responses in step 2 and collection of information how the logistics managers value the hypothetical alternative relative to the one reported in step 2.

The first two steps of each interview took no more than 10-15 minutes and helped establish the rapport necessary to conduct the third step. In a few cases follow-up telephone calls were necessary to clarify information supplied in the first step. All responses were recorded directly on the interviewers' portable computer, whose software also generated the characteristics of the hypothetical alternatives used in step 3.[19]

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[19] Data were collected in 2001 by Vienna University of Economics and Business team members for the Vienna and Linz-Wels regions; data for the Graz and Villach-Klagenfurt regions were collected by the two other research groups, one an independent co-operating research group within the IMONET project and the other under contract control of the Vienna team. Most of the data for Vienna had been collected before that team briefed the Graz and Villach-Klagenfurt teams on how best to administer the computer scenario interviews (CSI). Thorough briefings of how best to consistently deploy our standardised data collection *instrument* permitted all teams to gather remarkably stable and useful information from firms in a variety of clusters from very different regions. In our project, all interviews were handled directly on the interviewer's portable computer, the computer program for which was written by Gunther Maier in Visual Basic.

In step two we used the five continuous characteristics cost, time, reliability, frequency, and flexibility plus the discrete characteristic transport mode to describe the method of current shipment. We asked the respondents to characterize the typical shipping services used for inputs and the services used for output shipments. The results derived from this step form the baseline alternatives for step three of the analysis. In a number of cases, mainly final market producers, respondents had no shipping needs on one side of the market and therefore could characterize only one service. Since the answers in step two were the basis for the conjoint experiments in step three, in these cases, of course, only one of the experiments could be completed. In total 148 conjoint experiments were conducted in the 98 interviews.

In step three of the interview for each conjoint experiment, we generated 20 hypothetical alternatives. For each hypothetical alternative, three of the characteristics were taken directly from the baseline alternative reported in step 2. For two of the continuous characteristics, we use random values that marginally deviate from the baseline[20]. Additionally, in cases where respondents reported to use truck or train as the mode of transportation, the hypothetical alternative may switch to the other mode. Table A1 gives an example. In step 2 of the analysis the respondent reported among others that the respective logistics service has reliability of 60, frequency of 84, and used the truck as mode of transportation (RAIL MODE = 0). Based on this information the software generates one hypothetical alternative in step three with the same cost, time and flexibility as the baseline, but higher reliability (77) and lower frequency (56) of service. Moreover, the alternative service uses the train as mode of transportation.

Table A1: Generation of hypothetical alternatives - example

ALTERNATIVE	COST	TIME	RELIABILITY	FREQUENCY	FLEXIBILITY	RAIL MODE
BASELINE	980	48	60	84	24	0
HYPOTHETICAL	980	48	77	56	24	1

In the conjoint experiment each hypothetical alternative is presented to the respondent alongside with the baseline alternative (the one recorded in step 2). Every time the respondent is asked to decide which one of the two he/she prefers. So, for each hypothetical alternative, a decision from the respondent is directly recorded in the software. Consequently, from each interview we get up to 40 statements from the respondent about the preference of the baseline alternative or the hypothetical one.

These statements (stay with the original transportation service – switch to the hypothetical service) have later been used for estimating a logit model.

Every such statement generates *one observation* in the model estimation. The final model consists of the following variables:

- The generic variables: COST, TIME, RELIABILITY, FREQUENCY, and FLEXIBILITY
- An alternative specific constant α.
- A respondent specific alternative specific constant τ_n for every respondent except the first. As usual in discrete choice modeling (see, e.g., Ben-Akiva and Lerman, 1985, Maier and Weiss, 1990), the parameter of the first respondent must be set to zero exogenously in order to avoid linear dependence with the alternative specific constant.
- A dummy variable RAILMODE, which takes the value one when the respective alternative uses the rail-mode, and zero otherwise,
- A dummy variable RAILACCESS, which takes the value one when the RAILMODE value is one *and* the company reports that it has direct rail access, zero otherwise. This variable takes into account a firm's direct access to rail infrastructure.

Since every respondent produces up to 40 statements about the preferability of the baseline or the hypothetical alternative (i.e., up to 40 observations in the model), the observations of our model are not independent. To capture individual specific effects, the individual specific alternative specific constants had to be introduced. This modelling technique is also known as "fixed effect estimation".

Appendix 2: Basic Cluster and Regional Employment Change and Location Quotients (LQ*)

Cluster	Region Villach/Klagenfurt employment			LQ*		Region Linz/Wels employment			LQ*		Region Graz employment			LQ*		Region Wien employment			LQ*	
	91	95	91-95 (%)	91	95	91	95	91-95 (%)	91	95	91	95	91-95 (%)	91	95	91	95	91-95 (%)	91	95
motor vehicles	7418	5216	-29.7	1.19	0.92	20800	15548	-25.3	0.89	0.83	9494	12045	26.9	1.02	1.26	74171	53354	-28.1	1.32	1.20
chem/pharm	7581	5997	-20.9	1.53	1.38	21274	15358	-27.8	1.14	1.07	8659	6673	-22.9	1.17	0.91	50798	34292	-32.5	1.14	1.01
constr. mat	1361	1608	18.1	2.12	2.75	1548	1595	3.0	0.64	0.83	1083	1041	-3.9	1.13	1.06	3596	2802	-22.1	0.62	0.61
elektronics	6919	5952	-14.0	1.54	1.38	15566	11907	-23.5	0.92	0.83	7792	6354	-18.5	1.16	0.87	54010	50165	-7.1	1.33	1.48
food	2398	2159	-10.0	0.90	0.80	7097	6654	-6.2	0.70	0.74	2498	3579	43.3	0.63	0.78	28306	22408	-20.8	1.17	1.05
metal working	8263	5657	-31.5	1.08	0.83	41559	31687	-23.8	1.44	1.41	12911	13529	4.8	1.13	1.18	63254	44574	-29.5	0.92	0.84
wood, paper	2233	2159	-3.3	0.84	0.76	5727	6216	8.5	0.57	0.66	4572	4045	-11.5	1.15	0.84	10033	8891	-11.4	0.42	0.40
manufact.	19517	18842	-3.5			73569	62224	-15.4			29107	31708	8.9			175616	147646	-15.9		

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