Door-to-door time against in-vehicle time across European corridors

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***Abstract*—Journey planners and timetable feeds report in-vehicle time. Travellers experience door-to-door time, which adds access, egress and the waiting that a filed connection imposes. This paper asks how far the two diverge across European corridors, and whether the divergence is large enough to change which mode is ranked fastest. Using a snapshot of 936 filed itineraries on 493 European corridors, we decompose every itinerary into in-vehicle time, filed interchange time and a parameterised access and egress allowance. In-vehicle time accounts for a median of 77% of door-to-door time, with an interquartile range of 57 to 87.3%. On the 79 corridors where two or more modes are filed, the mode ranked fastest changes on 13 of them, 16.5%, when the clock changes from in-vehicle to door to door. The reversals are produced almost entirely by filed interchange time rather than by the access and egress allowance: every one of the 13 reversals also occurs when the allowance is set to zero, and the reversal rate moves only between 16.5 and 20.3% across the full range of allowances tested. The practical implication is that a planner can correct most of the bias in in-vehicle time using data it already holds, without first resolving the access-time parameter that the literature disagrees about. Data and analysis code are released.**

***Index Terms*—door-to-door travel time, in-vehicle time, access and egress, interchange, mode choice, multimodal journey planning, European corridors, open timetable data**

I. Research question

Every public timetable, and almost every journey planner built on one, reports the time a service spends running. That is not the quantity a traveller spends. The traveller also reaches the station, waits for the connection the timetable happens to offer, and leaves the station at the far end. The gap between the two has been named and measured before: Krygsman, Dijst and Arentze define an interconnectivity ratio, the ratio of access, egress and transfer time to in-vehicle time, and find it large enough to dominate short multimodal trips [1]. Valuation research finds the same asymmetry from the demand side, with waiting and transfer time carried at a multiple of in-vehicle time in revealed and stated preference alike [2], [3], [4], and with the number of stops and the reliability of a connection entering mode choice in their own right [5].

Two questions follow that are not settled, and that matter to anyone building a ranking:

1) Across a corridor network rather than a single city, how much of door-to-door time is actually spent in a vehicle?
2) Is the difference large enough, and unevenly enough distributed across modes, to change which mode a traveller would be shown as fastest? On which corridors?

We hypothesised that reversals would be concentrated on short corridors, where a fixed access penalty is large relative to the journey, following the accessibility literature's usual result [6], [7]. We also expected the reversals to depend heavily on the access and egress assumption, which is the parameter most studies argue over [8], [9]. The first expectation is supported. The second is not, and that is the more useful finding.

II. Related work

Door-to-door measurement is well established in urban accessibility research, where multimodal travel time is computed from schedules and street networks and compared across modes [7], [10], [11], [12]. That literature is mostly intra-urban and mostly concerned with accessibility surfaces rather than with which option a planner ranks first.

The intercity literature asks the ranking question directly, but almost exclusively for the rail against air comparison, where the airport access penalty is large and well studied [13], [14], [15], [16], [17], [18]. The recurring result is a break-even distance beyond which air wins, and the recurring sensitivity is to the airport access assumption.

What is comparatively unexamined is the ground-mode case: rail against coach against ferry, on corridors where the access penalties are similar and so ought to cancel. If access and egress were the only source of divergence, those corridors would show no reversals at all. They do, and the reason is the other term.

Methodologically this paper sits with the work that computes journey time from released feeds rather than from a model [19], [20], [21], and it follows that work's convention of releasing the code that produced the numbers.

III. Data

The analysis reads a timetable snapshot released with this paper. It holds 545 corridors of filed rail, coach, ferry and air itineraries collected from operator feeds, each itinerary carrying real departure and arrival stamps per leg, the calling points, the operator and the number of changes. It was collected on 2026-09-16 for service on 2026-09-28 and 2026-09-30.

Restricting to corridors whose origin and destination are both European leaves 493 corridors, 936 itineraries and 2765 legs, over 166 cities in 25 countries. City coordinates are WGS84 from the released place file. Corridor distance is the great-circle distance between city centroids.

The snapshot also carries a per-leg detour factor. It takes only the four values 1.00, 1.05, 1.10, 1.15 and is assigned by mode rather than by corridor, so it carries no corridor-specific information and route distance is a constant multiple of great-circle distance within each mode. Great-circle distance is therefore used directly and the detour factor is reported here only so that a reader does not assume it did work it did not do.

Two integrity checks run inside the analysis and are asserted by the released test suite: no leg has a negative duration, and the elapsed time computed from the first departure and last arrival equals the snapshot's own stated journey time on every itinerary in scope. Both pass at zero exceptions.

IV. Method

For each itinerary we compute three quantities.

In-vehicle time T_v is the sum over legs of arrival minus departure. It is the quantity a timetable reports.

Interchange time T_i is elapsed time, last arrival minus first departure, minus T_v. This is filed data, not an assumption: it is the gap the operators' own published times leave between one service and the next.

Access and egress T_a is an allowance applied once at each end, by the mode of the first and last leg. The central case uses the allowances the Orlero ranking engine applies in production: 22 minutes at a station for rail and coach, 45 at a port, 95 at an airport. These are allowances, not measurements, and the whole of Section VI is given over to showing how little the result depends on them.

Door-to-door time is $T_d = T_v + T_i + T_a$.

Each itinerary is assigned a *headline mode*, the mode accounting for the largest share of its in-vehicle minutes. A Berlin to London journey that opens with eleven minutes of S-Bahn is a rail journey; classifying it by its first leg would record a fact about leg order rather than about travel.

A corridor is *comparable* when it carries filed itineraries under two or more headline modes. On a comparable corridor each mode is represented by its own fastest itinerary, which is what a search result shows, and crucially the minimising itinerary is allowed to differ between the two clocks. On several corridors the fastest train in the vehicle is not the fastest train out of the door, and forcing one itinerary to stand for both would suppress part of the effect being measured.

A *reversal* is a comparable corridor whose first-ranked mode differs between the T_v ordering and the T_d ordering.

V. Findings

A. How much of a journey is spent in a vehicle

In-vehicle time accounts for a median of 77% of door-to-door time across the 936 itineraries, mean 70.4%, interquartile range 57 to 87.3%. The median itinerary carries 107 minutes that a timetable does not report: 47 minutes of filed interchange and 67 minutes of access and egress. The median interconnectivity ratio in the sense of [1] is 0.299.

The distribution is wide and it differs by mode (Table I, Fig. 1). Ferry itineraries spend the least of their time in a vehicle, because a port allowance is charged at both ends of what is often a short crossing. Coach itineraries spend the most, because the journeys are long enough for a fixed allowance to disappear into them, even though coach carries by far the longest filed interchanges.

TABLE I
SAMPLE COMPOSITION AND THE TIME DECOMPOSITION, BY HEADLINE MODE. MINUTES ARE MEDIANS.

	Count		Median minutes				
Mode	Itin.	Corr.	T_v	T_i	T_a	T_d	% in veh.
Rail	230	145	453	38	44	585	79.7
Coach	211	141	947	117	44	1262	81.8
Ferry	488	280	548	23	90	821	73.5
Air	7	6	74	0	190	245	28.3

TABLE II
TIME DECOMPOSITION BY NUMBER OF CHANGES. MINUTES ARE MEDIANS.

Changes	Itineraries	Median T_i	% in vehicle
0	276	0	73.1
1	228	55	73.2
2	138	72	80.4
3 or more	294	155	80.1

The air row rests on *seven* itineraries and six corridors. It is printed for completeness and no claim in this paper depends on it. The snapshot files air only where an operator feed happened to answer, and a sample that small supports no inference about air at all.

Grouping by the number of changes (Table II) shows the two components trading places. Direct itineraries carry no interchange by construction, yet have a *lower* in-vehicle share than itineraries with two changes, because many of them are short crossings where the fixed allowance dominates. Filed interchange time rises steeply with the number of changes, from zero to a median of 47 minutes overall.

B. Whether the ranking changes

Of the 493 corridors, 79 carry filed itineraries under two or more headline modes. On 13 of those, 16.5%, the mode ranked fastest changes when the clock changes. All 13 order changes are changes of the leading mode rather than reshuffles below it, which follows from most comparable corridors carrying exactly two modes.

Fig. 2 plots, for every comparable corridor, the margin held by the in-vehicle winner under each clock. Points below the zero line are the reversals. They are not marginal cases clustered at the origin: several corridors where one mode leads by ten hours in the vehicle lose by seventeen hours out of the door.

Table III lists them. Ten of the thirteen are under 400 km (Table IV), which supports the hypothesis that reversals concentrate on short corridors. Eight are Mediterranean island or peninsula corridors, where the surface alternative to a sailing

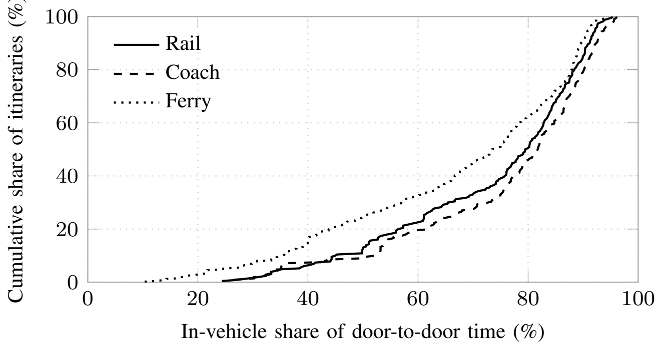

Fig. 1. Empirical cumulative distribution of the in-vehicle share of door-to-door time, by headline mode. Air is omitted: seven itineraries do not make a distribution. A curve further left means more of the journey is spent somewhere other than in the vehicle.

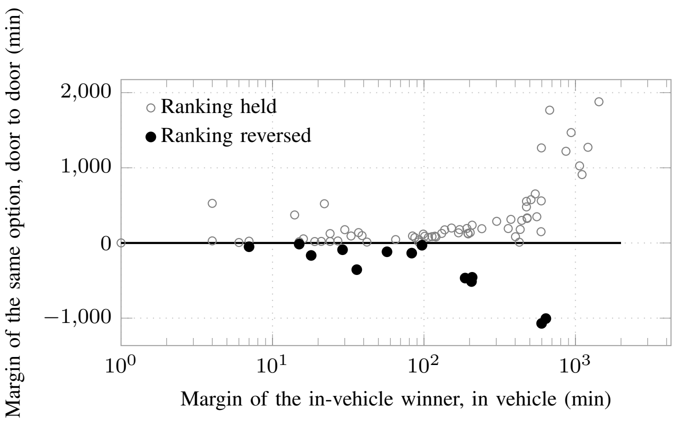

Fig. 2. Each point is one of the 79 comparable corridors. The horizontal axis is how far the fastest mode by in-vehicle time led its nearest rival; the vertical axis is how far that same mode leads, or trails, once access, egress and filed interchange are counted. The horizontal axis is logarithmic. A point below the line is a corridor where the ranking reversed.

is a long land detour with long filed waits, and two are the same city pair in both directions.

The same question asked of itineraries rather than modes gives a consistent answer. Of the 443 corridors carrying more than one filed itinerary, the single fastest itinerary changes on 76, 17.2%.

C. Which term does the work

This is the result we did not expect. Setting the access and egress allowance to zero for every mode leaves filed interchange time as the only difference between the two clocks. Under that setting there are 14 reversals. All 13 of the reversals found in the central case are among them: the allowances create 0 reversals and cancel 1.

In other words, the effect is carried by a quantity that is published in the timetable and needs no assumption at all. The access parameter, which is where the intercity literature concentrates its uncertainty, is close to irrelevant to the ranking question on these corridors, because the corridors where two ground modes compete charge both of them the same allowance and it cancels.

VI. Robustness

Table V sweeps the allowance. The ground allowance was varied from 10 to 45 minutes and the terminal premium, the extra charged at a port over a station, from 0 to 60 minutes, with the airport premium held at three times the port premium: 72 combinations. The reversal rate never leaves the range 16.5 to 20.3%, and it does not respond to the ground allowance at all, because a change applied equally at both ends of two competing ground options cancels exactly.

A second check addresses the long tail. Aegean and Corsican corridors connect through sailings a day or more apart, and an itinerary that asks a traveller to sleep somewhere is arguably not waiting in the sense the interconnectivity literature means. Dropping the 50 itineraries containing any single interchange longer than twelve hours leaves 76 comparable corridors and 11 reversals, 14.5%. The headline result is not an artefact of overnight layovers.

VII. Limitations

These are the reasons not to over-read the result, stated plainly.

Two adjacent service dates. The snapshot covers 2026-09-28 and 2026-09-30. Filed interchange time is a property of the timetable on the day, and two days in late September are not every day. Frequency effects, seasonal sailings and weekend timetables are all outside what this measures. A repeated snapshot is the obvious next step and the released code runs unchanged on one.

493 corridors, not the European network. These are the corridors for which a feed answered, which skews toward corridors somebody asked about. They are not a random sample of European city pairs and nothing here should be read as a population estimate.

Access and egress are allowances. No feed used here records how long a particular traveller takes to reach a particular station. The allowances are the platform's operating constants. Section VI is the honest treatment of that: the conclusion survives the whole range, but the reported minute counts in Table I do move with it.

Detour factors are derived and coarse. The released network assigns one of four detour values by mode. It is not a corridor-level measurement and is not used as one here.

No fares. Ranking in practice weighs price against time. This paper measures only time, so it says which mode is fastest, not which a traveller would choose. The snapshot carries no fares for rail and coach and none are invented here.

Air is not measured. Seven itineraries. The rail against air comparison that most of the related literature is about is exactly the comparison this data cannot support, and it is not attempted.

Headline-mode classification. On a short strait crossing, an itinerary that includes a ferry leg can be classified by the land mode carrying more of its minutes. Reggio Calabria

TABLE III
THE 13 CORRIDORS WHOSE FASTEST MODE CHANGES BETWEEN THE TWO CLOCKS. MINUTES ARE THE BEST FILED OPTION FOR THE NAMED MODE UNDER THE NAMED CLOCK.

		Fastest by in-vehicle time			Fastest door to door		
Corridor	km	Mode	T_v	Rival T_v	Mode	T_d	Rival T_d
Piraeus to Kavála	340	Coach	962	1560	Ferry	1650	2720
Athens to Kavála	334	Coach	942	1580	Ferry	1670	2676
Bastia to Nice	209	Rail	644	850	Ferry	945	1458
Porto Torres to Toulon	327	Coach	572	780	Ferry	870	1327
Nice to Bastia	209	Rail	631	818	Ferry	927	1394
Stavanger to Hirtshals	291	Coach	863	899	Rail	1198	1553
Porto Torres to Savona	386	Coach	285	368	Rail	936	1071
Livorno to Olbia	299	Rail	174	192	Coach	549	715
Budapest to Milan	787	Rail	908	965	Coach	1064	1181
Naples to Cagliari	474	Coach	433	530	Rail	772	802
Civitavecchia to Arbatax	297	Rail	355	384	Coach	622	712
Catania to Milan	1012	Coach	1005	1012	Rail	1106	1156
Reggio Calabria to Messina	13	Coach	66	81	Rail	139	154

TABLE IV
REVERSAL RATE BY GREAT-CIRCLE DISTANCE BAND.

Distance (km)	Comparable	Reversals	%
Under 400	56	10	17.9
400 to 800	7	2	28.6
Over 800	16	1	6.3

TABLE V
REVERSAL RATE ACROSS THE ALLOWANCE SWEEP. EACH ROW SPANS NINE GROUND ALLOWANCES FROM 10 TO 45 MINUTES; WHERE THE ROW PRINTS ONE FIGURE, THE RATE WAS IDENTICAL AT ALL NINE.

Terminal premium (min)	Reversals	Rate (%)
0	14	17.7
6	14	17.7
12	14	17.7
18	13	16.5
23	13	16.5
30	13	16.5
45	13	16.5
60	16	20.3

to Messina in Table III is such a case. The classification is stated, reproducible and applied identically to both clocks, so it cannot by itself manufacture a reversal, but it does mean a mode label there names the dominant leg rather than the whole journey.

VIII. CONCLUSION

Across 493 European corridors, in-vehicle time captures a median of 77% of what a traveller spends, and the shortfall is distributed unevenly enough across modes to reverse the fastest-mode ranking on 16.5% of the corridors where two modes compete. The reversals concentrate below 400 km, as the accessibility literature would predict.

The finding worth acting on is the decomposition. The reversals are produced by filed interchange time, which every timetable already publishes, and not by the access and egress allowance, which nobody can measure without a survey. A journey planner that wants to stop misranking modes does not need to resolve the access-time question first. It needs to stop reporting the sum of the leg durations and start reporting the time between the first departure and the last arrival, which it is already holding.

OPEN SCIENCE

The analysis script, the timetable snapshot, the place file and the network file are released under CC BY 4.0 at https://orlero.com/research/door-to-door-europe. Every number in this paper is generated: `node analysis/analyse.mjs` writes `results.json`, the table bodies and the figure data, and `make` rebuilds this PDF from them. A test suite in the same repository recomputes every published figure from the raw data and fails on drift. Reproducing the paper requires Node 20 or later and `tectonic`, and no network access beyond what `tectonic` needs to fetch its own packages.

COMPETING INTERESTS

The author is the founder of Orlero, which operates the journey planner whose ranking method is the subject of the paper and whose data the paper analyses. The access and egress allowances examined here are that platform's own, and the finding is in part a critique of how such platforms measure time.

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