

HPR RESEARCH REPORT

Ridership

What the corridor will carry — and why the demand case does not separate HPPR from ALTO

Demand-side analysis · reference class and modal-share envelope · 2035–2080

SUMMARY

Ridership is the hinge of the corridor decision. A high-speed project is justified by high ridership, and every cost ratio is downstream of how many people ride. This chapter bounds corridor demand from two directions and shows that the answer does not turn on the choice between HPPR and ALTO.

The outside view — a reference class of twelve operating intercity-rail systems — finds that car dependency, not speed or fare, governs ridership, and places the corridor at the unfavourable extreme: a predicted ≈ 0.29 trips per capita, on the order of 4–5 million annual trips, barely above the 0.23 conventional service reveals today. The inside view — a modal-share envelope built on corridor population, trip generation, and HPPR's capture by fare regime — runs from about 5 to 20 million at maturity, central near 10 million, in line with the independent forecasts (McGill TRAM 2026 survey base 10.9M, the federal Joint Project Office ≈ 13.5 M, C.D. Howe 12–21M).

The two methods bracket a wide band, but ALTO's published 24-million target sits above every point in it. Three findings survive the spread. ALTO's target is the outlier against the entire forecasting record. HPPR and ALTO arrive at ridership in the same range — HPPR within roughly sixteen per cent of ALTO at maturity, and ahead of it through the opening decade — because both sit near the top of a saturating modal-share curve where additional speed buys little. And the ridership question is separable from the cost question: whatever the corridor's true demand, HPPR serves it nearly as well as ALTO at a fraction of the capital and subsidy. The difference between the two systems is on cost, not ridership.

FARE DISCOUNT TO LEAD

11–18%

parity; ~20% leads throughout

HPPR : ALTO, MATURITY

84 : 100

at equal fares; ALTO = 100

TOTAL RIDERS BY 2080

321 : 341M

HPPR : ALTO, 5.7% apart

6.1 Ridership is the hinge

The case for a corridor of this scale rests, ultimately, on a ridership forecast. The number of riders sets the user benefit, drives the farebox, and sits in the denominator of every cost ratio; choose the ridership and the economics are largely determined. This chapter therefore treats demand as the first-order question and tests it with deliberate conservatism.

Two complementary readings are used, and the chapter keeps both in view rather than collapsing them into a single point estimate. The first is an outside view in the manner of reference-class forecasting: rather than re-running a project-specific demand model, it asks what comparable systems actually achieve, and locates the corridor within that distribution. The method follows Flyvbjerg — replace the inside view with the observed distribution of outcomes from a class of completed projects — and it is the same method underlying the Initiative’s cost work. The second is an inside view: a transparent modal-share envelope that multiplies corridor population by per-capita trip generation by HPPR’s share of those trips under a fare regime, with an explicit ramp. The outside view supplies a conservative floor anchored in revealed behaviour; the inside view supplies a mechanism-based central case. Where they disagree is itself informative, and the disagreement is resolved in Section 6.8.

6.2 The demand reference class

The unit of analysis is annual intercity rail trips divided by the population the network serves — trips per capita of served population. It is a deliberately simple measure of how intensively a society actually uses its intercity railway, comparable across countries of very different size. The reference class comprises twelve operating systems spanning every major high-speed and fast-intercity geography, with China held out as a separate check.

Two structural tiers emerge. National networks — systems that serve an entire country — cluster between 1.0 and 3.4 trips per capita. Single corridors — one dominant city-pair or a cross-border link — sit on a floor near 0.3, regardless of technology. The corridor, though physically long, is functionally a corridor: a single chain of cities, served today by conventional service at 0.23 trips per capita, squarely in the lower tier.

System	Type	Max speed (km/h)	Trips / capita	Year
Taiwan HSR	National	300	3.4	2024
Sweden (long-distance)	National	200	2.9	2024
Japan Tōkaidō Shinkansen	National	285	2.4	2024
Korea KTX + SRT	National	305	2.4	2024
France TGV	National	320	1.9	2024
Germany Fernverkehr	National	300	1.6	2024
Italy Freccie + Italo	National	300	1.1	2024
Spain AVE	National	310	1.0	2024
<i>China HSR (held out, reference)</i>	<i>National</i>	<i>350</i>	<i>2.3</i>	<i>2024</i>
HS1 / Eurostar	Corridor	300	0.35	2024
Brightline (Florida)	Corridor	200	0.31	2024
Amtrak Northeast Corridor	Corridor	240	0.30	2024
VIA Corridor (Canada, today)	Corridor	160	0.23	2024

Table 6.1. Annual intercity rail trips per capita of served population. National networks occupy a higher tier; single corridors sit near a 0.3 floor. China is shown for reference but excluded from the statistical fit. The year column gives the reporting year of each ridership figure. Served population is the population each system actually serves: the national population where the network is country-wide, and the catchment of the line itself otherwise — for the Tōkaidō Shinkansen, the Tokyo–Osaka belt of roughly 70 million rather than all of Japan.

6.3 The Car Dependency Index

Why do Taiwan and Sweden carry ten times the per-capita ridership of the Northeast Corridor? The dominant factor is not how fast or how cheap the trains are, but how committed the surrounding population is to the private car. The Car Dependency Index (CDI) captures this on a 0–100 scale as the equal-weight mean of four components, each mapped onto fixed absolute anchors so that the index is stable as systems are added: motorization (vehicles per 1,000 people), fuel price (inverted — cheap fuel raises the score), toll and road-pricing coverage (inverted — free roads raise the score), and destination transit quality (inverted — weak last-mile transit raises the score). Higher CDI means a more car-committed society.

Regressed against ridership across the twelve fitted systems, the index produces a strong, significant negative relationship.

Model	Pearson r	R^2	p	Spearman ρ	n
trips per capita ~ CDI	–0.71	0.50	0.010	–0.71	12

Table 6.2. The single-variable Car Dependency model. Motorization alone is the strongest individual predictor ($r = -0.84$); the composite is preferred because it does not rest on a single input vintage.

The corridor scores 71, in the company of conventional VIA service (71), the Northeast Corridor (64), and Brightline (73). The fitted line places its expected ridership at about 0.29 trips per capita — roughly 4–5 million annual trips against a corridor population of order 14–18 million, and only marginally above the 0.23 that conventional service reveals today. Two denominators run through this chapter, and it is worth separating them once. The reference class is scored on the full Québec City–Windsor corridor of about 18 million residents — the basis on which VIA’s 4.2 million corridor passengers give 0.23 — while the modal-share model from Section 6.5 onward works from the served census-metropolitan population of about 15.1 million. The roughly three-million difference is corridor population living outside the directly served CMAs, not a disagreement between the two methods.

One honest qualification belongs in plain sight.

The relationship is anchored by its extremes. In the middle of the index the scatter is wide — Taiwan and Sweden sit well above the line while Spain and Italy sit well below it, at essentially the same car-dependency score. The CDI predicts the ends of the spectrum well and the middle poorly. That matters less here than it might, because the corridor is not in the ambiguous middle: it is at the high-dependency end, where the relationship is tight and uniformly unfavourable.

6.4 Speed, fare, and density are not the levers

The case for the project leans on three properties — it is fast, it can be made cheap to ride, and it threads a populous corridor. Tested against the reference class, none of the three is the lever proponents assume.

Speed. Maximum speed on its own explains almost nothing ($R^2 = 0.11$, $p = 0.29$, not significant). At roughly 300 km/h, ridership ranges from 0.35 (Eurostar) to 3.4 (Taiwan); at 200 km/h, Sweden carries

2.9 while Brightline carries 0.31. Added alongside the CDI, speed stays insignificant ($p = 0.25$) while car dependency remains significant ($p = 0.013$). The two are strongly collinear ($r = -0.73$) — the world's fast systems are mostly its least car-dependent — so speed adds no distinguishable effect once car dependency is accounted for. Crediting the corridor with full high-speed running produces no ridership uplift at all: its combination of high car dependency and high speed lies outside the entire reference class, so there is nothing to extrapolate from. The corridor cannot speed its way out of its car culture.

Fare. The clean upstream variable is the fare itself — average yield per passenger-kilometre — because operating subsidy is endogenous to ridership. Tested this way, fare carries slightly more signal than speed but still falls short of significance on its own ($R^2 = 0.18$, $p = 0.17$); Japan is the standing exception, among the most expensive systems per kilometre yet among the most heavily used. Added to the CDI, fare is insignificant ($p = 0.82$). Ridership is nonetheless partly buyable through subsidy, and the magnitude of that lever is worth seeing explicitly.

Fare policy	Yield (US\$/pax-km)	Predicted trips / capita	Approx. annual trips
Market fare (VIA-like)	~0.28	0.26	~4.7M
Moderate subsidy	~0.18	0.36	~6.5M
Deep subsidy (Spain-like)	~0.10	0.43	~7.7M

Table 6.3. Corridor ridership under alternative fare policies, holding car dependency at CDI 71 (provisional yields), converted at the 18-million served population of the reference class. Even the deepest subsidy stays below the viability floor of Section 6.8 — and the subsidy is itself a recurring cost.

Density. National population density behaves just like speed and fare: a weaker predictor than the CDI ($R^2 = 0.40$ against 0.50), collinear with it, and insignificant once the CDI is in the model ($p = 0.71$). The fairer question is corridor density, and the reference class contains a natural experiment for it.

Corridor	Pop (M)	Length (km)	Pop/route-km	CDI	Trips/cap
Amtrak NEC (Boston–Washington)	~50	735	~68,000	64	0.30
HS1 / Eurostar (London–Paris/Brussels)	~22	490	~45,000	48	0.35
Brightline (Miami–Orlando)	~9	380	~24,000	73	0.31
VIA Corridor (today)	~18	800	~22,500	71	0.23
Corridor (predicted)	~18	800	~22,500	71	0.29

Table 6.4. Corridor-tier systems — the closest comparators — ranked by corridor population density. The Northeast Corridor's threefold density advantage over the corridor buys only about 0.07 more trips per capita: the difference between 0.23 and 0.30, not the two- to three-fold gain a high-speed business case requires.

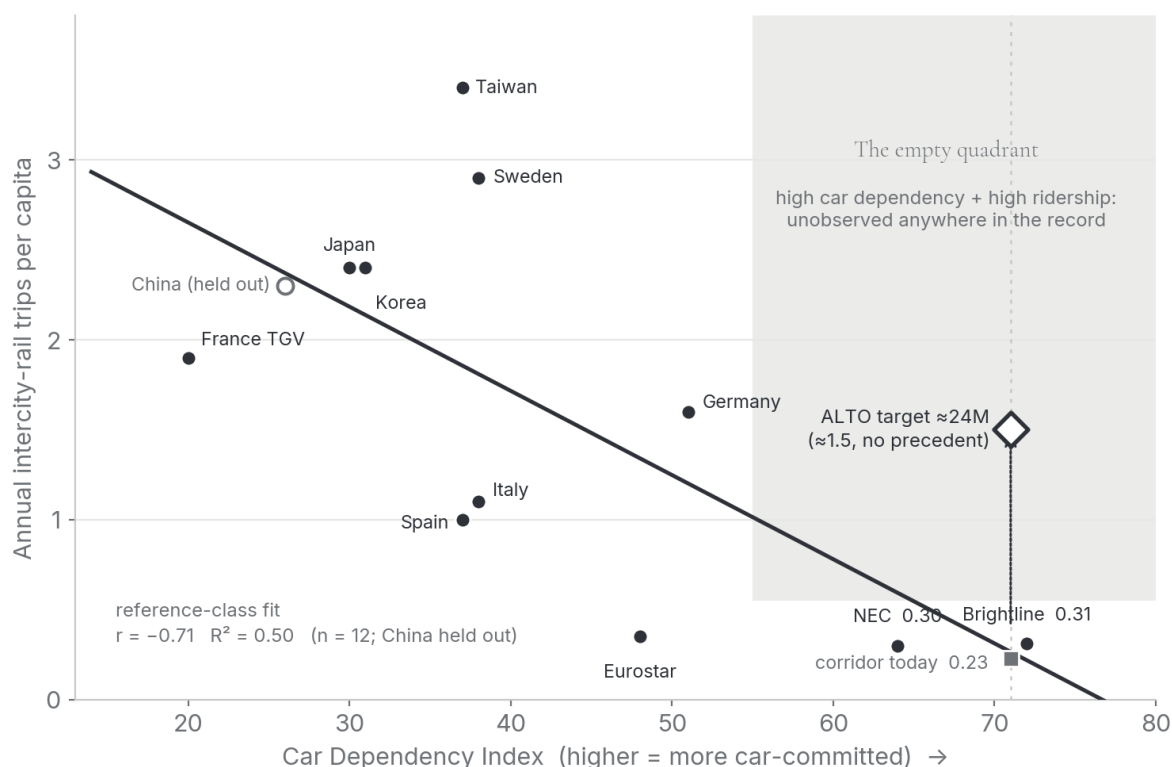


Figure 6.1. The reference class plotted against car dependency. Annual intercity-rail trips per capita fall as car dependency rises (reference-class fit $r = -0.71$, $R^2 = 0.50$; $n = 12$, with China held out and falling on the line). Above a CDI of about 55 every observed system is lightly used, and the upper-right — high car dependency together with high ridership — is empty. The corridor sits at CDI ≈ 71 , where the fit predicts ≈ 0.29 trips per capita (roughly 4–5 million trips) against 0.23 today; ALTO's 24-million target implies ≈ 1.5 , a point with no precedent anywhere in the record.

The empty quadrant.

Sort the reference class by car dependency and look at the high end, where the corridor sits. Above a CDI of roughly 55, every system is lightly used: the Northeast Corridor (0.30), VIA (0.23), Brightline (0.31). There is not a single high-car-dependency country anywhere running a high-ridership intercity railway. Car-dependent societies either declined to build fast intercity rail or built it and saw it underperform. The upper-right of the chart — high car dependency and high ridership together — is empty. ALTO's projection, in effect, places a marker in that empty quadrant. Nothing in the global record has ever occupied it; that absence is more probative than any single additional data point.

6.5 The corridor population denominator

The inside view begins with the population the railway serves. The directly-served CMAs — Toronto, Ottawa–Gatineau, Montréal, Québec City, and the intermediate centres — had a 2025 population of about 15.1 million. HPR serves the Toronto–Ottawa–Montréal triangle, which carries roughly 90 per cent of corridor demand.

The 2024–25 federal Immigration Levels Plan, which for the first time capped non-permanent residents, produced a structural inflection that older corridor forecasts did not anticipate. Toronto's CMA shrank

slightly in 2024–25 after gaining 269,000 the prior year, and Greater Golden Horseshoe growth collapsed from roughly 313,000 per year to about 40,000. This invalidates the linear extrapolation of pre-2024 growth that the federal Joint Project Office, the Munk School GEPL, and McGill TRAM all used as their baseline. The central trajectory now reaches about 19.8 million by 2055 against the 26.1 million a pre-2024 extrapolation implied — a 6.3-million gap that removes roughly 17 million annual trips from the addressable pool at central trip generation.

Trajectory	Average annual growth	2050	2080	Driver
Lower (LG)	0.5%	16.9M	20.0M	NPR cap structural; ageing
Central (M1)	1.0%	18.8M	25.7M	cap one-off; immigration normalises
Upper (HG)	1.6%	21.3M	34.7M	pre-2024 pace partly resumes

Table 6.5. Three corridor population trajectories, anchored on the 2025 baseline of ~15.1 million and on Statistics Canada's January 2026 projections with a corridor-CMA premium. The three rows are Statistics Canada's own low-growth (LG), medium-growth baseline (M1) and high-growth (HG) scenarios, which vary fertility, mortality, immigration and non-permanent residents over the horizon; the growth column is therefore an implied average rather than a constant rate applied to the baseline. Statistics Canada's provincial projections run to 2050, so the 2080 column extrapolates beyond their published horizon. These are full-corridor figures; HPPR serves the triangle (~90 per cent of corridor demand). The central trajectory is the working assumption.

Corridor population: the 2024–25 demographic inflection

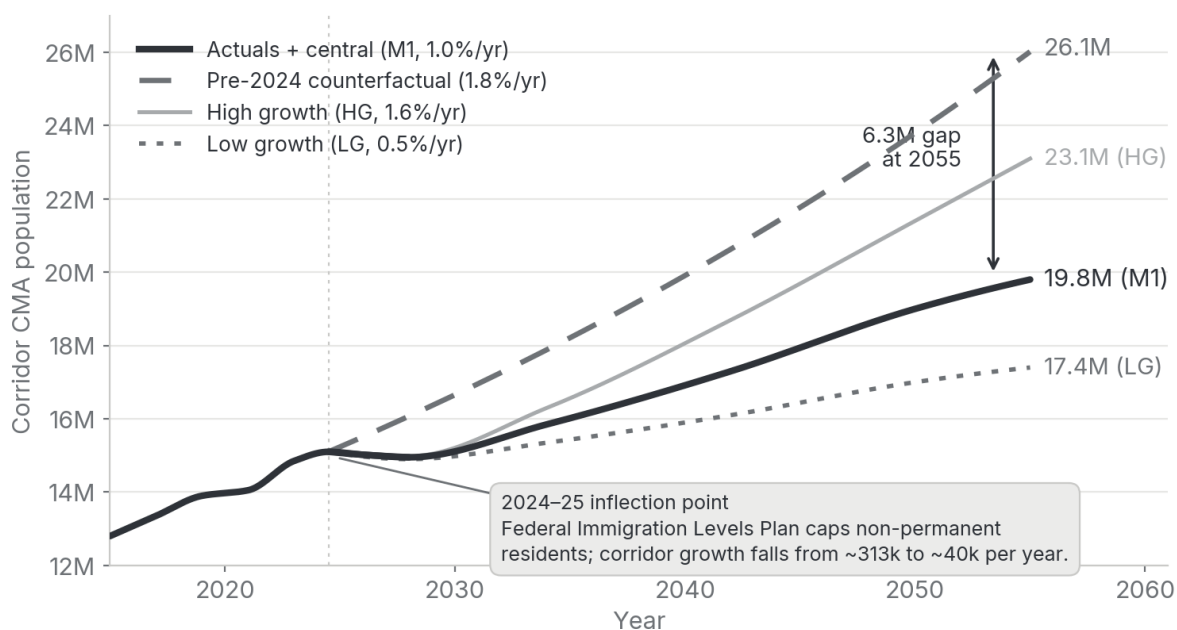


Figure 6.2. Corridor population: actuals and projections to 2055. The 2024–25 federal Immigration Levels Plan broke the surge trajectory — the pre-2024 counterfactual (1.8%/yr) reaches 26.1 million by 2055 against the post-cap central trajectory (1.0%/yr) at 19.8 million, a 6.3-million gap. HPPR serves the triangle, about 90 per cent of this corridor population. Statistics Canada actuals; January 2026 projections.

Against the 2025 population and roughly 25 million addressable annual person-trips, per-capita generation is about 1.7 trips per resident per year. That pool is wider than the triangle's three principal pairs, which the Initiative's roadside work measures at about 12.7 million end-to-end person-trips a year across all modes — a rate near 1.0 against the three census metropolitan areas. The gap between the two is the intermediate-station, Québec City and secondary pairs that an end-to-end measurement

does not count, and the distinction matters, because the two rates are easily quoted against each other as though they measured the same thing. The wider figure is corroborated independently of this model by the three-market build-up in the companion demand brief, which counts car diversion, air diversion and retained conventional rail directly, reaches 7 to 9 million riders at maturity, and back-solves to a trip-generation rate near 1.7 rather than near 1.0. Over the 45-year horizon the rate is roughly stable to mildly declining — hybrid work and AI-mediated meetings suppress business travel while urbanisation supports leisure travel — so the analysis uses 1.6–1.8 trips per capita with a central case near 1.7 and assumes no structural shift in the trip-generation function. The measured end-to-end rate of 1.0 is carried throughout as an explicit low case, and is reported as such in Section 6.8.

One further distinction matters for the comparison that follows: ALTO and HPPR do not serve the same population. ALTO runs the full corridor — the Toronto–Ottawa–Montréal triangle and onward through Trois-Rivières to Québec City — while HPPR serves the triangle together with the Lake Ontario shore communities (Cobourg, Belleville, Kingston, Brockville, Cornwall) but terminates at Montréal. The two exclusive segments are markedly unequal. HPPR's lakeshore catchment totals about 0.40 million residents; ALTO's Québec City extension — the Québec City and Trois-Rivières census metropolitan areas — totals about 1.0 million, roughly two and a half times as large, with Québec City alone (~0.84 million) outweighing the entire lakeshore by more than two to one. HPPR therefore works off a population base of about 14 million against ALTO's roughly 15 million — a population factor of about 0.93 — applied to HPPR's ridership throughout, on top of its modestly lower modal share. The combined effect places HPPR's central trajectory about sixteen per cent below ALTO's at maturity, even as HPPR's faster single-stage opening carries it ahead through the early 2050s while ALTO's Québec City phase is still ramping.

6.6 Travel times

The modal-share curves that follow read off one number for each city pair: the time a traveller actually spends getting from one downtown to the other. That city-centre-to-city-centre time — not the line-haul speed quoted in headlines — is what decides the market, because it is what the traveller compares. The three triangle pairs are set out below for every mode, together with Kingston — the principal intermediate stop on the spine — reached directly from each.

City pair	Car (401/A20)	Air (door-to-door)	Conventional rail	HPPR	ALTO
Toronto–Ottawa	~4h30	~3h30	~4h15	2h55	2h00
Toronto–Montréal	~5h30	~3h45	5h13	3h32	3h07
Ottawa–Montréal	~2h00	~2h45	~1h55	1h30	1h00
Toronto–Kingston	~2h45	—	~2h10	1h36	—
Ottawa–Kingston	~2h00	—	~2h00	1h19	—
Montréal–Kingston	~3h00	—	~2h40	1h53	—

Table 6.6. City-centre-to-city-centre travel time by mode on the three triangle pairs and the Kingston pairs — total elapsed time between downtowns, including access, processing, and egress, not vehicle line-haul alone. Rail and car endpoints are central; air carries a fixed airport-access and processing penalty. HPPR times are the Chapter 4 §4.8 Express figures, quoted platform-to-platform there and read as city-centre times because the principal stations are downtown; ALTO is its published figure (3h07, Chapter 4 §4.8); conventional times are from current VIA timetables; car times are typical free-flowing 401/A20 driving. Chapter 4 builds up no Ottawa–Montréal time and no ALTO time outside Toronto–Montréal; ALTO's Toronto–Ottawa figure is the two hours

C.D. Howe (2025) reports for the high-speed scenario, and the two Ottawa–Montréal cells are the Initiative’s own timings, against which the Joint Project Office’s 2021 business case gives an hour and forty minutes on that pair for high-frequency operation. The lower three rows give Kingston, the principal intermediate stop on the spine, served directly by HPPR from all three triangle cities; Kingston has no scheduled intercity air, and ALTO publishes no Kingston times — its station there is unresolved (Chapter 4). The Toronto–Kingston Express time includes the Union–Pickering GTA-East approach — the corridor’s most constrained zone, run on the shared GO/Metrolinx Lakeshore tracks — the Kingston–Montréal leg is Chapter 4’s own express figure, and the Kingston–Ottawa leg is taken by difference from the Express triangle times, so that shared approach is counted once.

The quoted times are city-centre to city-centre — the full elapsed time between the two downtowns, not the vehicle line-haul alone. This is the basis on which the modal-share curves are read, and it is the basis on which the modes actually compete, because their endpoints differ. Rail and car start and finish in the core: the principal stations — Toronto Union and Montréal Central — are downtown, and Ottawa’s station sits about ten minutes from it, so the rail figures are taken as city-centre to city-centre with only a nominal station allowance, and driving is door-to-door by construction, so its line-haul time is its city-centre time. The rail times are the Express patterns established in Chapter 4 — HPPR in the 177–240 km/h band, conventional service from current VIA timetables, and ALTO from its published 300+ km/h targets.

Air is built up from its components, because its endpoints sit outside the core: downtown-to-airport access (30–40 minutes); check-in, security, and a boarding buffer (about 75 minutes for a domestic, carry-on trip); gate-to-gate block time (about 1h05 Toronto–Ottawa, 1h15 Toronto–Montréal, 0h55 Ottawa–Montréal); deplaning (about 15 minutes); and airport-to-downtown egress at the destination (20–25 minutes). These assume no checked baggage and no irregular operations, so they if anything understate air’s real elapsed time in winter and at peak. That fixed access-and-dwell penalty — roughly two-and-a-half hours of overhead wrapped around a one-hour flight — is what places the short flight outside the competitive zone once rail reaches the two-to-four-hour band.

City-centre to city-centre, HPPR already beats the plane.

On Toronto–Ottawa it is faster door-to-door than flying — 2h55 against roughly 3h30 — and faster on Ottawa–Montréal; on Toronto–Montréal it is faster than the plane, 3h32 against about 3h45, while leaving from and arriving in the city centre. This is the fact the modal-share curves encode: in the competitive zone the market is decided by the time the traveller actually spends, not by line-haul speed, and HPPR already clears the threshold that matters.

6.7 Speed, price, and the balance between them

HPPR’s annual ridership is the product of four quantities — the served population, intercity trips per capita, HPPR’s share of those trips, and a ramp factor. On the Toronto–Ottawa–Montréal triangle both systems share the first two, so on that contested market the durable difference lives in modal share; the two part company on geography, since ALTO additionally serves the Québec City extension and HPPR the lakeshore (Section 6.5). Modal share answers to two levers, each a saturating S-curve: journey time, the speed lever, and fare, the price lever. The central design insight is that the optimum is the balance between them, not the maximum of either — enough speed to climb onto the steep, high-capture part of the curve, then price to convert the rest. HPPR is engineered to that balance; ALTO buys speed past the point where the curve has flattened. This section takes the two levers in turn, then assembles the ridership envelope.

6.7.1 Speed

Rail's share of the air-competitive market is a logistic in absolute journey time — shallow below two hours and above five, steep through the competitive two-to-four-hour band where infrastructure decisively moves share. The decisive gain on every pair is the move off conventional times onto HPPR's, the steep middle of the curve; ALTO's further speed is a residual on the flattening top.

City pair	Air-competitive market	Road market (rail + car)
Toronto–Ottawa	75%	34%
Toronto–Montréal	58%	34%
Ottawa–Montréal	94%	27%
Triangle (aggregate)	~70%	~31%

Table 6.7. HPPR modal share by corridor pair at the canonical fare (Regime B, $r \approx 0.7$). The air-competitive market is rail's share of the air-divertible market; the road market is rail's share of the rail-plus-car market for a solo traveller. Against conventional air shares of 14, 10, and 89 per cent, the speed-and-price gain is largest on the two Toronto pairs; Ottawa–Montréal is already rail-dominant on air but hardest to win on the road, where its short two-hour drive competes. The triangle-aggregate air capture (~70 per cent) and the resulting ~27 per cent corridor share — the volume-weighted blend across air, road, and retained rail — are the moderate-subsidy regime (Regime B) of Table 6.8. Group travel pushes every road share lower. The Toronto–Montréal shares are recomputed on the Chapter 4 Express time of 3h32 (air capture 55→58 per cent, road 33–34); the other two pairs are unchanged because their times are. The retiming lifts the triangle air capture by about one point and the aggregate corridor share by under half a point, and both aggregates are held at their published values as the conservative reading.

The pattern is the same on every pair, and it is the core of the speed argument: a traveller is converted only once, so beyond the time-sensitive majority additional speed competes for a shrinking pool. On Toronto–Ottawa and Ottawa–Montréal both HPPR and ALTO sit in the high-capture zone where the curve has flattened, so the vertical distance between them is a band of points, not a multiple; on Toronto–Montréal, at a capture near 58 per cent, HPPR is still on the steep middle of the curve, which is why the six minutes recovered there move share at all. HPPR's modelled Express times — 2h55 Toronto–Ottawa and 3h32 Toronto–Montréal — are chosen precisely to reach that flattening top: the point past which additional speed, and the capital required to buy it, stops paying for itself in ridership. Were HPPR to slip back toward conventional performance it would slide down the steep part of the curve and the gap to ALTO would widen materially; the 177–240 km/h band exists to prevent exactly that.

6.7.2 Price sensitivity

The second lever is fare. The same logistic, extended with a price term, gives rail's share as a function of the rail-to-air fare ratio r ; a lower fare lifts share along the very same curve. Three fare-and-subsidy regimes span the realistic policy space. They reach modal captures close to ALTO's per regime — HPPR's price advantage offsets its lower line-haul speed — but at far lower subsidy, because HPPR's capital service and operating cost are a fraction of ALTO's.

Regime	Fare structure	Annual subsidy	Air capture	Aggregate share
A. Heavy subsidy	VIA-equivalent; $r_{\text{air}} \approx 0.5$	\$0.8–1.2B/yr	~80%	~36%
B. Moderate (canonical)	modest premium; $r_{\text{air}} \approx 0.7$	\$0.4–0.8B/yr	~70%	~27%
C. Minimal (yield mgmt)	above VIA; $r_{\text{air}} \approx 0.9$	~break-even	~55%	~19%

Table 6.8. Three fare and subsidy regimes for HPPR, with implied air capture and aggregate share of corridor person-trips. The aggregate shares are within a few points of ALTO's 40/30/22 per cent, which net ALTO's larger per-pair capture on the triangle against the intermediate-station market it does not serve (Appendix); the subsidy column is the order-of-magnitude difference. Unlike ALTO, HPPR's minimal regime is near operating break-even.

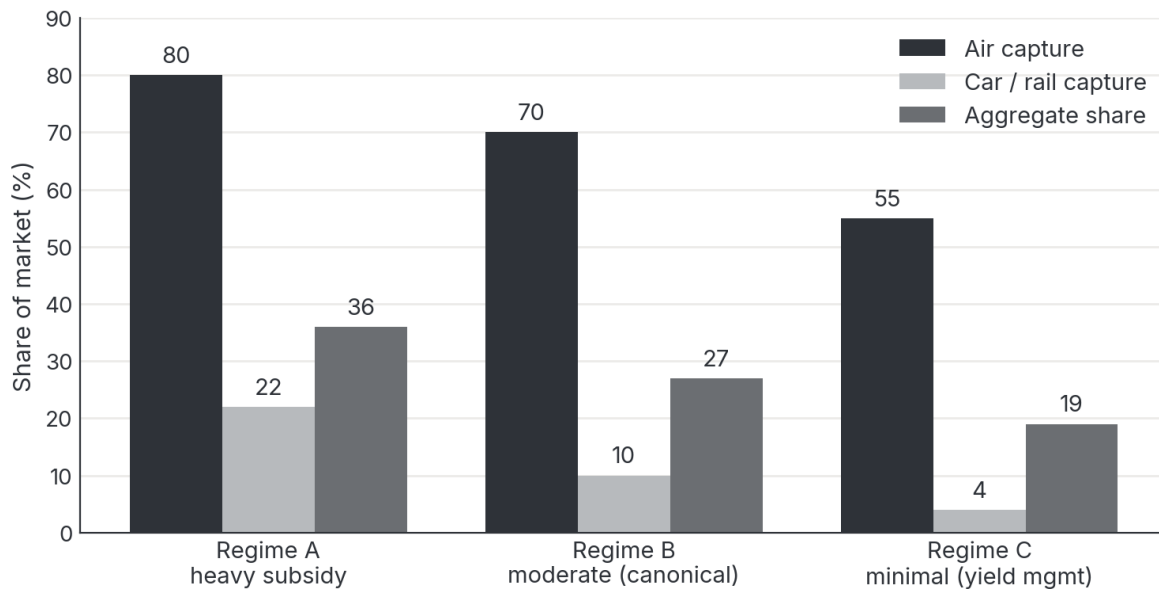


Figure 6.3. HPPR modal capture by regime. Under heavy subsidy (A) HPPR takes ~80 per cent of the air market; under the canonical moderate regime (B) ~70 per cent; under minimal (C) ~55 per cent. The aggregate share — a group-weighted blend across air, rail, and car — runs 36 / 27 / 19 per cent across the three regimes.

Read against the fare ratio, each pair's share slides down its logistic as the ticket dearens. The lever does most of its work in the contested middle — Toronto–Montréal — and almost none where rail already saturates — Ottawa–Montréal. The road market sits lower and steeper still: the car competes at every distance, and the price coefficient against it is larger, so a given fare cut moves more share than on the air market.

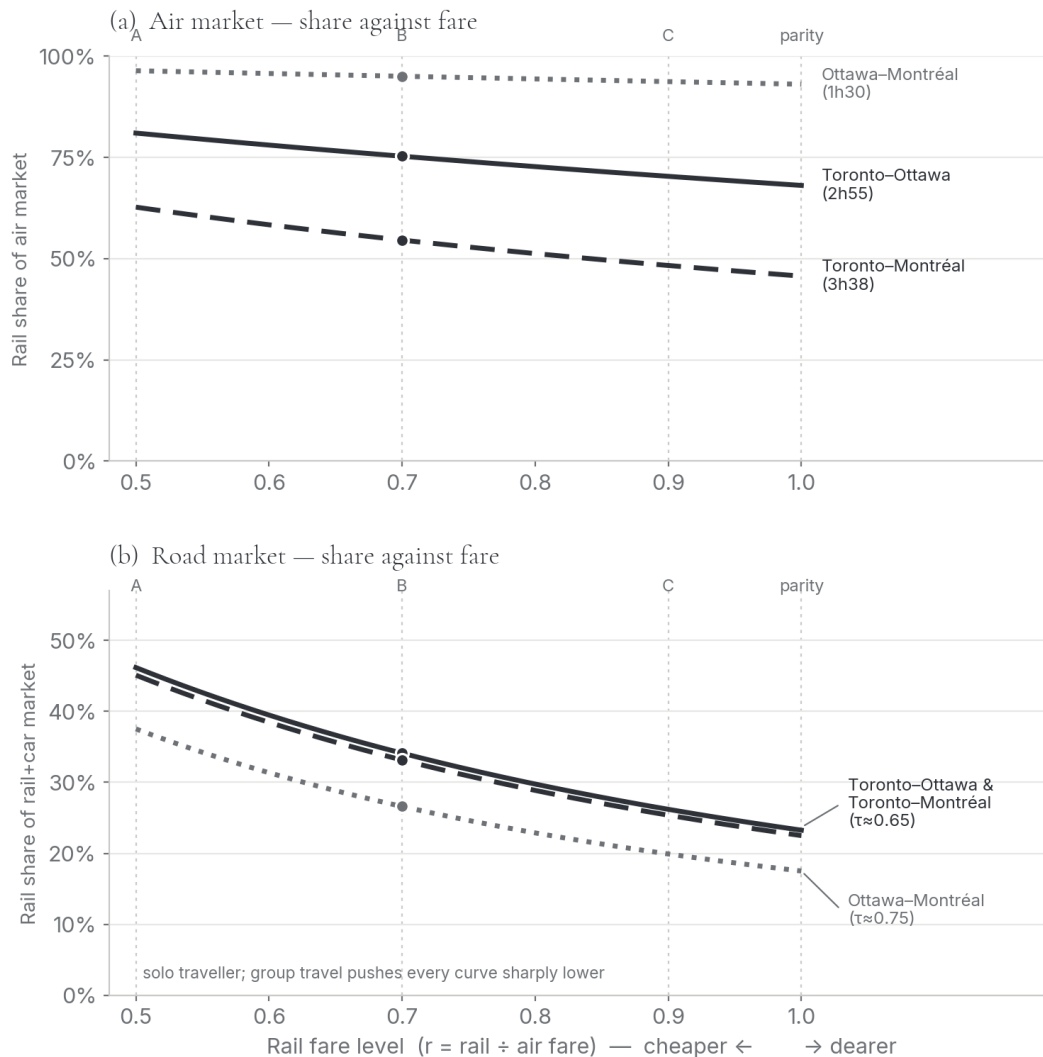


Figure 6.4. HPPR's modal share against the rail fare ratio (rail ÷ air fare), by corridor pair, with the canonical Regime B ($r \approx 0.7$) marked on each curve. (a) Air market — rail's share of the air-competitive market: the fare lever does most of its work on Toronto–Montréal, on the steep middle of the curve, and almost none on Ottawa–Montréal, already saturated near the top. (b) Road market — rail's share of the rail-plus-car market for a solo traveller: shares are lower and more fare-sensitive than on air because the price coefficient is larger; the two Toronto pairs nearly coincide because the road curve turns on the rail-to-drive time ratio rather than distance; and Ottawa–Montréal is weakest because its short two-hour drive is hard to beat. Each additional car occupant multiplies the price ratio and pushes every road curve sharply lower.

Blended across air, road, and retained rail and scaled to passengers, the fare decision alone moves 2055 ridership by about 5.7 million — roughly the span of the entire demographic band. This is the price half of the balance, and it runs toward HPPR: it can spend on fares what ALTO must spend on speed, because its costs leave room to. The canonical Regime B ($r \approx 0.7$) is the working point carried forward.

That headroom invites a sharper question: how much cheaper would HPPR have to be to carry the same total ridership as ALTO? At equal fares ALTO sits about twelve per cent ahead in 2055 — roughly 9.2 against 8.2 million — drawing on both its faster service and the Québec City extension HPPR does not serve. Lifting HPPR's blended ridership to that level takes a fare about eleven per cent below ALTO's, a ratio near 0.62 against 0.70. Tracing the same condition across every fare pair gives an equal-ridership locus that lies below equal fares: HPPR must price under ALTO to match its total, by a margin that

narrows toward five per cent as ALTO nears air parity and widens as ALTO discounts. The discount also grows over time — toward roughly eighteen per cent by 2080, as ALTO's Québec City phase matures — but the decisive fact is not the discount but who can afford it: HPPR stays inside its subsidy envelope at every point on the curve, while each point asks ALTO to forgo revenue it can far less afford.

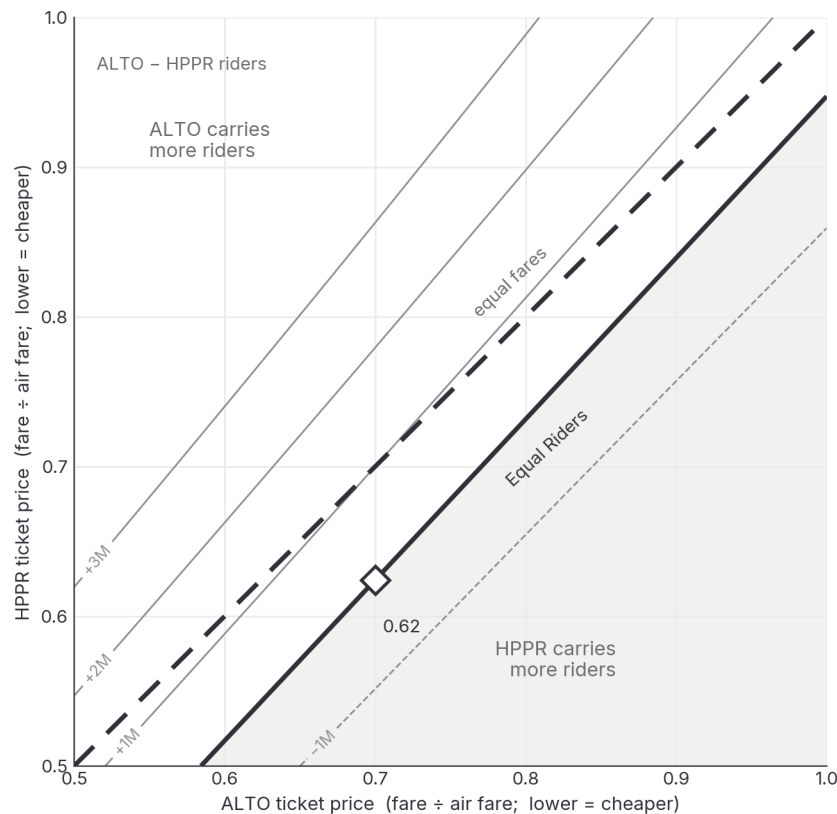


Figure 6.5. The equal-ridership locus and the ridership-gap field, on a total-system 2055 basis with Québec City riders kept in ALTO's total. The bold curve marks every (ALTO fare, HPPR fare) pair at which the two systems carry the same number of riders, each fare expressed as a fraction of the competing air fare; the diamond is the canonical case, where ALTO at 0.70 is matched by HPPR at about 0.62, roughly eleven per cent cheaper. The thin contours show where the gap — ALTO riders minus HPPR riders — holds at plus one, plus two, plus three, and minus one million. The locus lies below equal fares — the heavy dashed diagonal, where ALTO leads by about twelve per cent (9.2 against 8.2 million) — so HPPR must undercut ALTO to match its total, by a margin that narrows toward about five per cent as ALTO approaches air parity and widens as ALTO discounts — until, below an ALTO fare of about 0.58, HPPR cannot match even at its deepest costed fare. The field assumes ALTO's ridership responds to its own fare with the same sensitivity as HPPR's, scaled to that equal-fare gap, and holds the central 2055 population fixed.

6.7.3 50-year ridership growth profile

Two further inputs turn modal share into a ridership number: the phasing ramp and the population denominator.

HPPR's phasing is faster than ALTO's three-phase sequence: because it upgrades and uses existing corridors rather than building roughly 1,000 km of new dedicated track, the triangle can be reached by 2040, on the ten-year build Chapter 5 assumes. The North American ramp is meaningfully slower than European comparators — Madrid-Barcelona took about four years to overtake the air bridge, and Brightline Miami-Orlando remains in financial ramp-up several years after opening — so the lower and central cases use a Brightline-anchored profile and the upper case a Madrid-Barcelona profile.

Combining the favourable and unfavourable ends of both levers — the population trajectory and the fare regime — produces the full envelope: roughly 5 to 20 million annual passengers at maturity, central near 10 million; roughly 5.5 to 12 million by 2055, central ~8.2 million. Holding demographics fixed at the central trajectory, the fare and subsidy decision alone swings 2055 ridership by roughly 1.9 times — from about 5.8 to 10.9 million. The regime choice is a policy lever, not an engineering one; the canonical Regime B central case (~8.2 million by 2055) is the working figure carried forward.

HPPR ridership at the central population, by regime

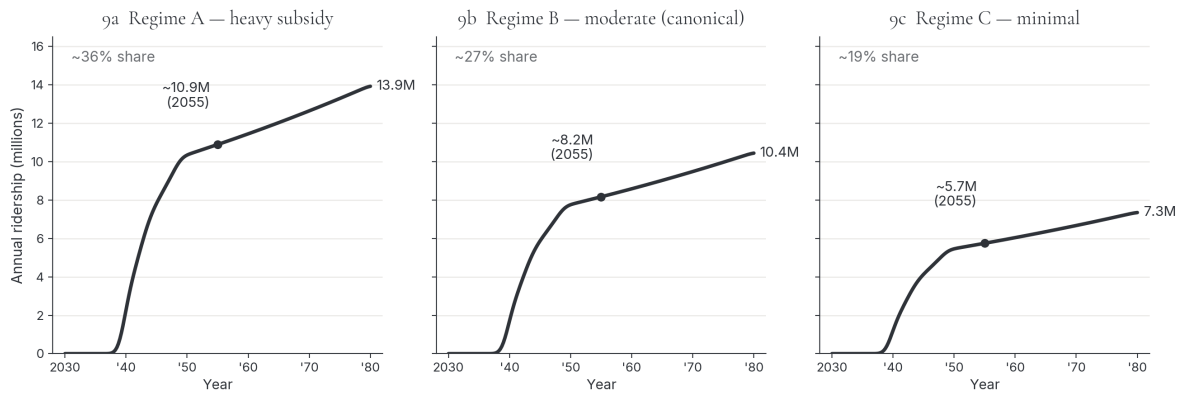
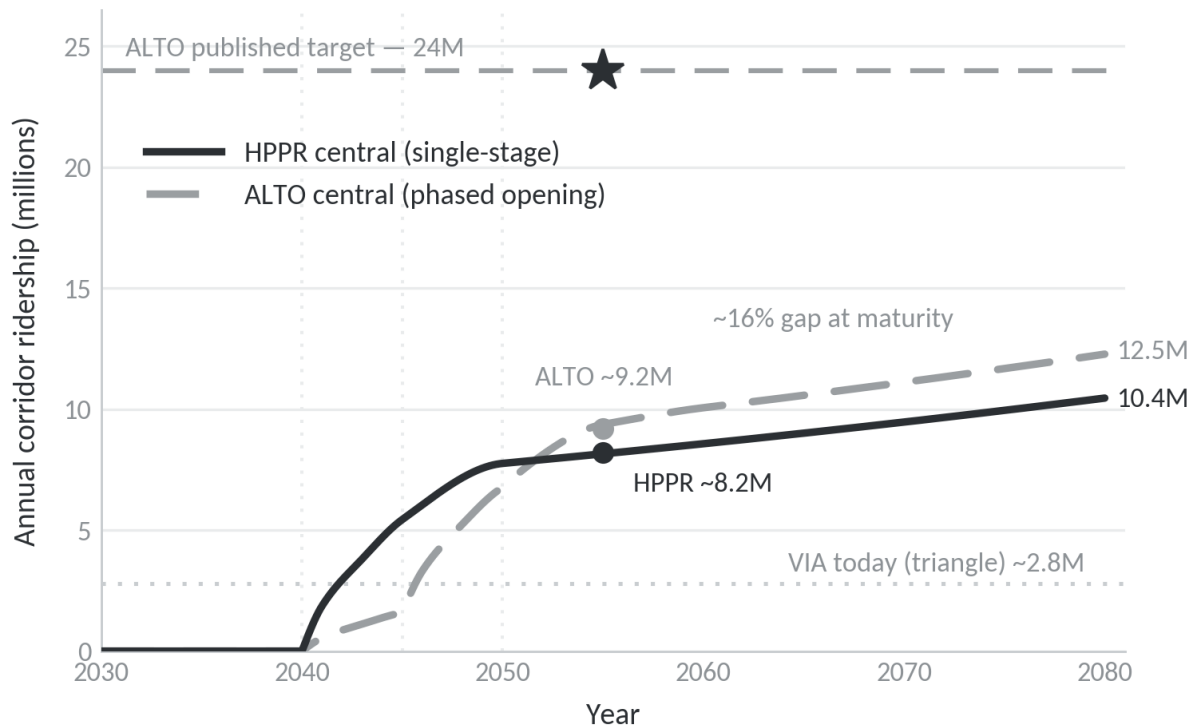


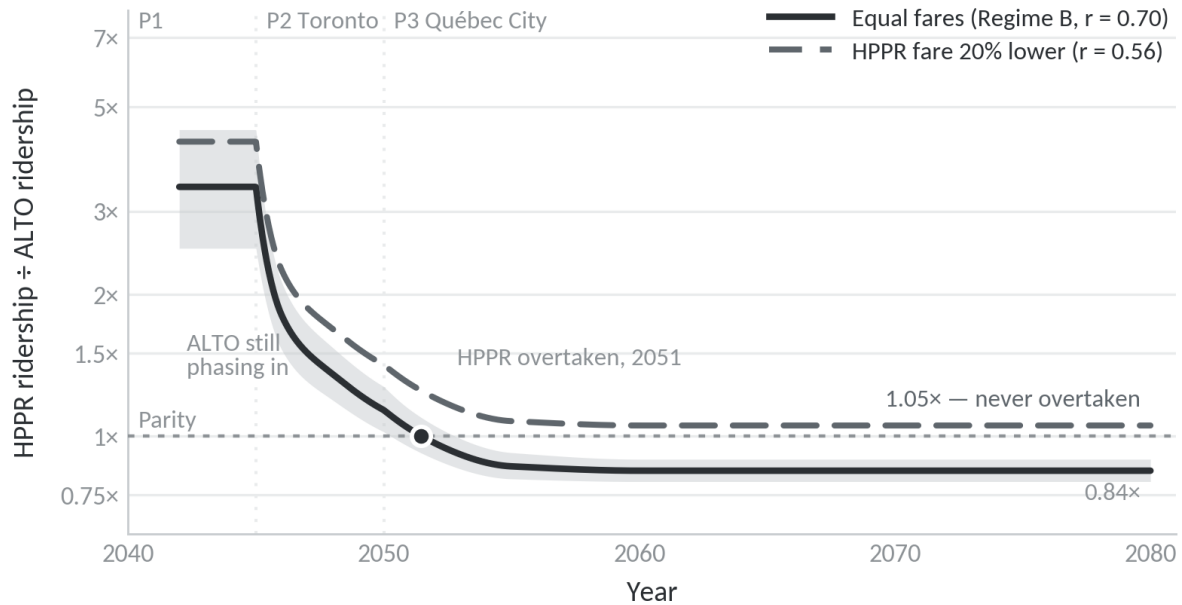
Figure 6.6. HPPR ridership at the central population trajectory, by subsidy regime. Holding demographics fixed at the central population, the fare and subsidy decision alone swings 2055 ridership from ~5.8 to ~10.9 million (Regime C to A), and 2080 ridership from ~7.3 to ~13.9 million.

Carried out to 2080 and set against ALTO's own phased opening, the central case traces the corridor's fifty-year ridership path for both systems.



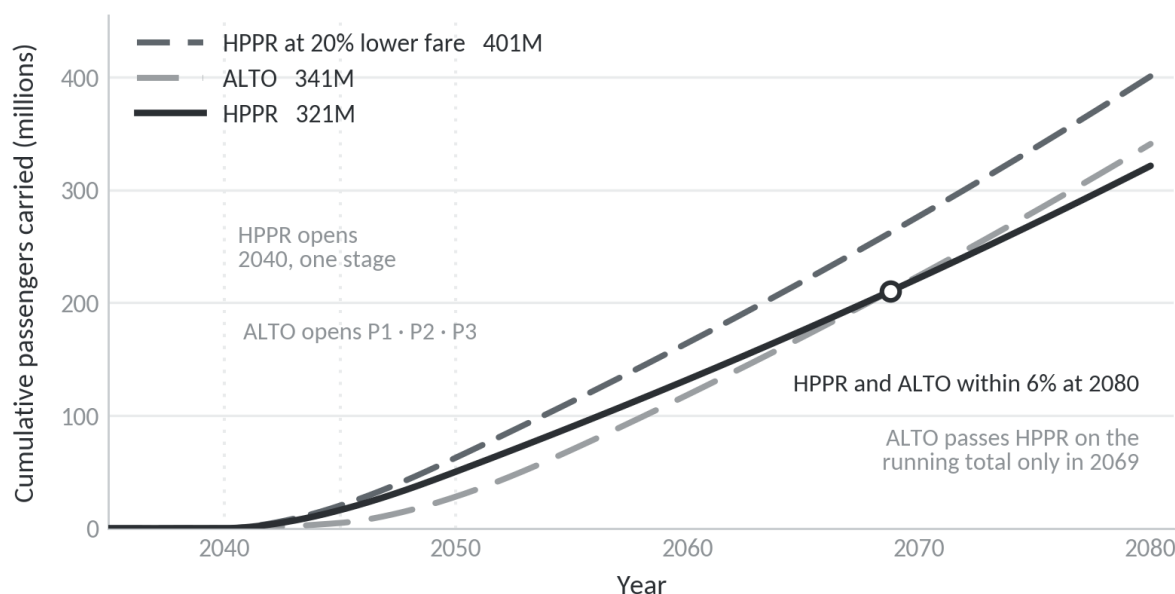
ALTO construction phases • P1 2040 • P2 2045 • P3 2050

Figure 6.7a. Central ridership trajectories, 2030–2080. HPPR (single-stage, opening 2040) and ALTO (phased: P1 2040, P2 2045, P3 2050) climb toward maturity across the build-out. HPPR's faster opening carries it ahead through the early 2050s, while ALTO's Québec City phase is still ramping; thereafter ALTO — which also serves the Québec City extension that HPPR does not — settles about sixteen per cent above it: 9.2 against 8.2 million by 2055, and 12.5 against 10.4 million by 2080. The VIA triangle carries about 2.8 million today — the triangle's estimated two-thirds share of VIA's 4.2-million Québec City–Windsor corridor total for 2024, itself about 95 per cent of the 4.4 million VIA carried system-wide; the 2.1-million figure sometimes quoted is the 2022 count. Both run far below ALTO's published 24-million target across the entire horizon.



Trip generation μ and the population trajectory cancel between the two systems, so the ratio does not depend on the size of the corridor market. It turns only on catchment, mature modal share, and the difference in opening ramps. A fare change scales HPPR uniformly, so on a log axis it is a vertical shift. Band (equal-fare case): ALTO phase weights, catchment 0.91–0.95, share ratio 0.88–0.94.

Figure 6.7b. The ratio of HPPR to ALTO ridership, 2042–2080, at equal fares and with HPPR priced twenty per cent below. Trip generation and the population trajectory are common to both systems, so they cancel in the ratio: what remains turns only on the two catchments, the mature modal-share ratio, and the difference between a single-stage opening and a three-phase one. The ratio is therefore knowable to a far narrower tolerance than either ridership figure on its own — which matters, because the size of the corridor market is the least settled quantity in this chapter. At equal fares (solid) HPPR carries several times ALTO's ridership through the 2040s, while ALTO's Toronto phase is not yet open; ALTO overtakes it in 2051 as that phase ramps; and from the mid-2050s the ratio settles at about 0.84, the sixteen per cent maturity gap of Figure 6.7a. Priced twenty per cent below ALTO (dashed) — a discount Section 6.7.2 shows to sit inside HPPR's subsidy envelope — the whole trajectory lifts by about a quarter and never returns to parity: the ratio bottoms out at 1.05, so HPPR carries more riders than ALTO at every point in the horizon. The fare response is fitted to the Regime A, B and C figures of Section 6.7.3, and because a fare change scales HPPR uniformly it appears on a log axis as a vertical shift. The shaded band, shown for the equal-fare case, spans ALTO's phase weights, a catchment factor of 0.91–0.95 and a mature share ratio of 0.88–0.94; the vertical rules mark ALTO's three phase openings.



Annual trajectories of Figures 6.7a and 6.7b, integrated. Both railways open in 2040, but ALTO phases in to 2050, so its running total climbs more slowly through the 2040s. Single-stage delivery is worth most of what ALTO's higher mature ridership is worth: the two totals differ by under six per cent, and ALTO overtakes on the running total only in 2069.

Figure 6.7c. Cumulative passengers carried to 2080 — the annual trajectories of Figures 6.7a and 6.7b, integrated from opening. Both railways open in 2040, so HPPR is credited with no head start; but HPPR opens as a single stage and is fully ramped by about 2050, while ALTO phases in to 2050, so its running total climbs more slowly through the 2040s. Single-stage delivery alone is worth most of what ALTO's higher mature ridership is worth. HPPR carries about 321 million passengers to 2080 against ALTO's 341 million — a difference of 5.7 per cent, against sixteen per cent at maturity — and ALTO passes it on the running total only in 2069; HPPR's cumulative lead peaks at about 23 million in 2052. Priced twenty per cent below ALTO, HPPR carries about 401 million, some 18 per cent more than ALTO over the same period, and is never overtaken. The totals are integrated from the calibrated central trajectories and inherit their assumptions, but the comparison between them is firmer than any of the three levels, because the population path and the trip-generation rate are common to all three.

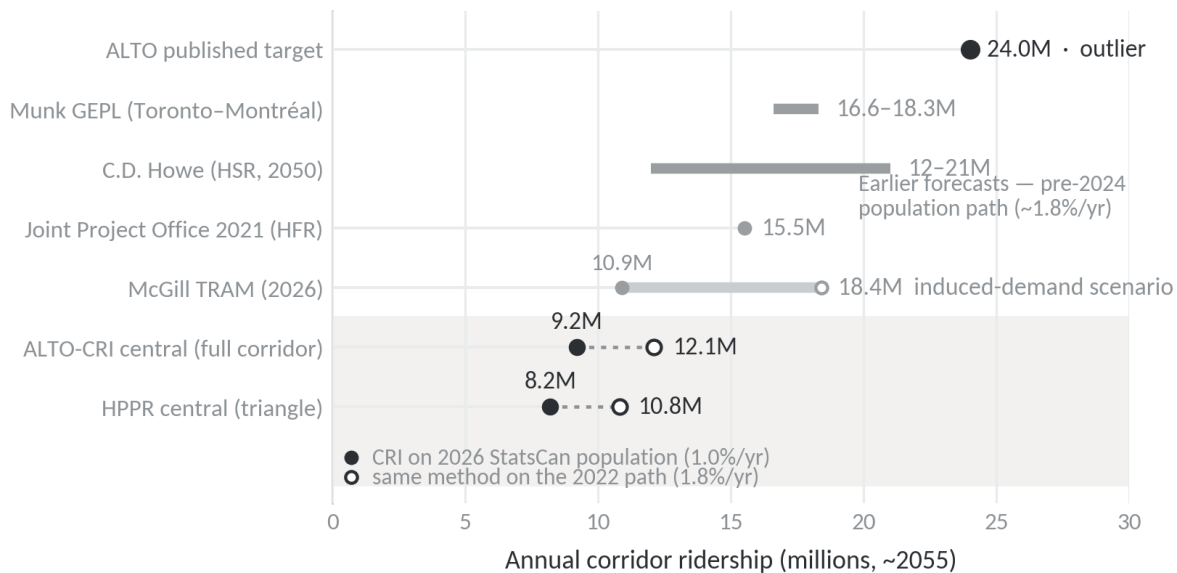
6.8 Triangulation: bracketing the answer

The outside and inside views can now be set side by side. Four independent methods bracket the corridor's realistic ridership, and they agree on the order of magnitude even as they span a wide band.

Method	Basis	Trips / capita	Annual trips
Revealed demand today	Conventional service on the corridor	0.23	~4M
Car-dependency reference class	CDI regression (Section 6.3)	0.29	~4–5M
Modal-share envelope (central)	Population × trips × capture (Section 6.7)	~0.5	~8–10M
Modal-share envelope (low μ)	Same model at the measured end-to-end rate $\mu = 1.0$	~0.3	~4.8–6.1M
Gravity model (Europe-calibrated)	Population-and-distance, European coefficients	0.7–0.9	~10–13M
de Rus viability floor	Minimum traffic to justify HSR, ~500–800 km	—	8–10M

Table 6.9. Independent estimates of corridor ridership. The realistic baseline (revealed and CDI, ~4–5M) sits below the de Rus floor that high-speed rail needs to be economically justified; the modal-share and gravity estimates (~10–13M) reach it only if the corridor behaves like a fast-rail market rather than its car-dependent reference class.

The reconciliation is straightforward once the two views are read for what they are. The reference class is the risk-adjusted floor — what comparable car-dependent corridors actually achieve — and it is the strongest single argument that ALTO's 24-million target is unreachable. The modal-share and gravity estimates are mechanism-based ceilings that materialise only if the corridor sheds its car culture; the CDI is precisely the evidence that, on every measured component, it has not. One reading deserves separating out. Run at the measured end-to-end rate of 1.0 rather than the addressable 1.7, the same modal-share model returns about 4.8 million by 2055 and 6.1 million at maturity for HPPR — which is to say it lands on the reference class rather than above it. On that reading the two methods do not bracket the answer at all; they converge on it, and the case against ALTO's target becomes correspondingly harder to answer. It is reported as a low case rather than the central one because the demand brief's three-market build-up, which does not use a trip-generation rate at all, independently supports the wider pool. The honest position, at 2055, is a wide band between roughly 4–5 million and 12–13 million, with the independent forecasts (TRAM 2026 survey base 10.9M, the Joint Project Office ≈13.5M, C.D. Howe 12–21M) clustering in the upper half. The most recent of these deserves reading closely, because it is the one usually cited as raising the corridor's expected demand. McGill TRAM's 2026 report puts corridor ridership at 10.48 million by 2050 on its survey evidence — a figure interpolating to about 10.9 million at 2055, close to the CRI central and inside the band above. Its higher figure, 17.53 million by 2050, is not a second estimate of demand but the same survey base with an induced-demand layer applied on top, at annual rates the report attributes to “past experience” without citation or derivation. The layer adds two-thirds to the base. The report is also explicit about what it rests on: its results “rely on ALTO's announced information, survey data, and stated assumptions”, and it prices the line at C\$79.8 billion, near ALTO's own published midpoint rather than the reference-class figure of Chapter 4. It is therefore best read not as an independent test of ALTO's case but as ALTO's assumptions carried through a survey model — which is why its survey base belongs in the band and its induced-demand scenario belongs beside ALTO's target rather than among the independent estimates. The same caution applies more widely than to TRAM alone. Two of the four published comparators are not independent of the promoter: TRAM states that its results rely on ALTO's announced information and stated assumptions, and C.D. Howe describes its own work as an economic analysis largely building on VIA-HFR passenger forecasts rather than a full bottom-up transport modelling exercise. Neither is a separate test of the demand case; both carry the promoter's forecast through a benefits model, and the band is correspondingly narrower evidence than four independent estimates would be. The fourth comparator makes the point from the other direction. The Joint Project Office's 2021 business case — produced by the organisation that has since become ALTO — put corridor ridership at 11.0 million by 2034 and 16.8 million by 2059, which interpolates to about 15.5 million at 2055. The 24-million target now advanced for the same corridor is roughly half as much again, and that difference arrived with the change from high-frequency to high-speed rather than with any new measurement. ALTO's published target sits above the entire band. That band and the five-to-twenty-million envelope of Section 6.7.3 are the same finding at two horizons rather than two answers. The envelope's own 2055 corner is 5.1 to 12.7 million — the band stated here — and carrying its upper corner forward on the high population trajectory reaches about nineteen million by 2080. The envelope is a maturity figure; the band is a 2055 figure, matched to the horizon of the published forecasts it is set against. Neither is a wider claim than the other.



TRAM (2026) is interpolated to 2055 on the report's own growth rates: its survey base of 10.9M sits close to the CRI central, and the higher figure is an induced-demand layer applied on top. Munk GEPL studied Toronto-Montréal only; its year-20 and year-30 figures are grossed to the corridor at its own 57 per cent share. The Joint Project Office figure is interpolated to 2055 and forecasts high-frequency, not high-speed, operation. TRAM and C.D. Howe both build on the promoter's own passenger forecasts rather than independent models.

Figure 6.8. Central case against published corridor forecasts, around 2055. The filled markers — the ALTO-CRI central (~9.2 million) and HPPR's central case (~8.2 million) — sit just below the independent band (McGill TRAM, the federal Joint Project Office, C.D. Howe, and the Munk School GEPL), with ALTO's published 24-million target far above. Most of that distance is population basis, not method: the earlier forecasts predate the 2024–25 immigration cap, and Figure 6.2 puts the resulting corridor population deficit at 6.3 million by 2055 (26.1 against 19.8 million). The open markers run the same CRI method on that pre-cap 2022 population path — about 12.1 (ALTO) and 10.8 (HPPR) million — landing inside the lower band. So on a common population basis the CRI is no more conservative than the lower published forecasts; only the higher estimates additionally assume stronger demand. The filled figures are shown at 2055 to match the forecasts' horizon, and climb to about 12.5 and 10.4 million at maturity. C.D. Howe's range is its 2050 figure, the only horizon it reports. McGill TRAM (2026) is shown as a span rather than a point because it reports two: a survey base of 10.9 million and an induced-demand scenario of 18.4 million, both interpolated to 2055 on the report's own growth rates. The Munk GEPL study covers Toronto-Montréal only; its year-20 and year-30 figures are grossed to the corridor at its own 57 per cent share. The Joint Project Office figure is interpolated to 2055 from its 2034 and 2059 readings, and forecasts high-frequency rather than high-speed operation.

The uncertainty is asymmetric — and that is the decisive point.

The ridership question is genuinely uncertain, but the consequences of that uncertainty fall on the two systems very differently. If the corridor behaves like its car-dependent reference class (~4–5 million), ALTO is a fiscal catastrophe and HPPR is merely a modest railway operating near the bottom of its envelope. If the corridor behaves like the European gravity model (~10–13 million), both systems do well — but HPPR does so at a fraction of the capital and subsidy. There is no ridership scenario in which the corridor reaches ALTO's 24-million target, and none in which ALTO's several-fold cost premium is repaid by its ridership edge. Downside demand risk threatens ALTO; it does not threaten the case for HPPR.

6.9 Implications

- **ALTO's published target is the outlier.** At 24 million it sits above every independent forecast for the corridor and above the entire reference-class band; reaching it would require upper-case demographics, heavy-subsidy modal share, and full mature operation simultaneously.
- **HPPR's ridership is in the same range as ALTO's, and closer still over the horizon.** Measured on total riders carried to 2080 rather than at a single year, the two are 5.7 per cent apart —

321 million against 341 million — because HPPR opens as one stage while ALTO phases in to 2050. ALTO captures a higher modal share and also serves the Québec City extension, sitting about sixteen per cent above HPPR at maturity — though HPPR's faster opening leads through the early 2050s — and both track within the credible band, central near 10 million for HPPR, far below ALTO's target.

- **The fare regime, not speed, is the real ridership lever.** The same physical asset produces a 36 per cent or a 19 per cent aggregate share depending on the fare and subsidy decision — nearly a twofold swing in share, and a 1.9-fold swing in 2055 ridership, set by policy rather than engineering.
- **Ridership uncertainty is asymmetric.** The wide band between the car-dependency floor and the gravity ceiling is a downside risk that falls on ALTO far harder than on HPPR, whose case does not depend on the corridor reaching the top of its envelope.
- **Ridership parity is a discount HPPR can afford and ALTO cannot.** HPPR carries the same total ridership as ALTO — Québec City riders and all — whenever it prices about eleven per cent below it at 2055, widening toward eighteen per cent by maturity as ALTO's Québec City phase fills in, and a narrower margin as fares rise toward air parity. That discount sits inside HPPR's subsidy envelope across the pricing range, whereas matching it would oblige ALTO to forgo revenue several times more costly to give up. ALTO's extra speed and reach, bought with several times the capital, are worth in ridership terms only a fare gap HPPR can concede at will.
- **The difference from ALTO is on cost, not ridership.** HPPR reaches this envelope at roughly a third of the operating subsidy and a fraction of the capital. The demand case and the cost case converge on the same conclusion, developed in the cost chapter.

6.10 Guarding Against Optimism Bias

Chapter 1 sets the standard this report asks of ALTO: that a forecast be tested against what comparable completed projects actually achieved, rather than defended from inside its own assumptions. A standard applied only to an opponent is not a standard, and reference-class discipline is easy to apply to another party's numbers and uncomfortable to apply to one's own. Figure 6.8 is where that is tested here. Its open markers run the Initiative's own method on the pre-2024 population path the earlier forecasts assumed, and land inside the published band — so on a common population basis this method is no more conservative than the lower published estimates, and the distance between them is a Statistics Canada input rather than a modelling choice. The same discipline shows in results that do not help this report's argument. HPPR does not win on ridership: ALTO carries more riders at maturity, 84 to 100, and HPPR ends 5.7 per cent below it on cumulative passengers carried to 2080. The low trip-generation case of Section 6.5 takes both railways below the traffic de Rus finds necessary to justify high-speed construction at all. Both appear here because the method produced them.

The estimate is bounded rather than precise, and the bounds are wide. The reference class is twelve systems, and predicts its extremes far better than its middle. Trip generation is the least settled input, and ridership scales linearly with it. Only the Toronto–Montréal car market is measured at a roadside

cordon, the Ottawa legs being sized from travel demand. The modal-share curves are planning-level logistics rather than a discrete-choice model, and neither railway's journey times have been simulated — ALTO's published figures are estimates of the same kind, as Chapter 4 establishes from the released record. ALTO's own demand model is unpublished, so this chapter can measure the size of the disagreement but not locate its cause, which is why the Initiative's first recommendation is that the model be released for audit. Every input used here is public, and a reader who rejects a conclusion can find the number that produces it and substitute their own.

What would overturn the argument is stated deliberately, because a claim no evidence could touch is not a finding. The empty quadrant of Figure 6.1 rests on an absence, and one counterexample — a single car-committed society carrying intercity rail ridership well above one trip per capita — would remove the chapter's strongest argument at a stroke. Origin-destination data from the National Travel Survey showing corridor trip generation materially above 1.7 would raise every figure here in proportion, though not the ratio between the two railways. None of the three findings in the summary depends on a single contested input, and none was reached by assuming its answer. A critique that can never produce a result against its own preferred option is advocacy with a bibliography.

Appendix. Ridership methodology

The inside-view ridership estimate rests on a single, deliberately transparent identity: annual ridership is the product of how many people the railway serves, how often they travel between corridor cities, the share of those trips it captures, and how far it has climbed its opening ramp.

$$R(t) = P(t) \times \mu \times s \times \varphi(t)$$

Here $R(t)$ is annual corridor ridership in year t , $P(t)$ the served population, μ the intercity trips generated per resident per year, s the railway's aggregate modal share of those trips, and $\varphi(t)$ the ramp factor — the fraction of mature ridership reached by year t . The four terms are estimated independently; the envelope reported in the chapter comes from varying them across plausible ranges rather than from a single point estimate. Each is taken in turn.

Base population, $P(t)$. is the population of the census metropolitan areas the line serves — about 15.1 million across the full corridor in 2025, growing at a central 1.0 per cent per year (0.5 and 1.6 per cent at the low and high ends), the slower trajectories reflecting the structural break in the 2024–25 federal Immigration Levels Plan that older corridor forecasts did not anticipate. The two systems do not share this denominator. ALTO serves the whole corridor; HPPR serves the Toronto–Ottawa–Montréal triangle and the Lake Ontario shore but not the Québec City and Trois-Rivières metropolitan areas (about one million residents), so it works off roughly 14 million — a population factor of about 0.93, applied to HPPR throughout (Section 6.5).

Trip generation, μ . is intercity trips per resident per year, about 1.7 — the roughly 25 million addressable annual person-trips across the corridor's principal and secondary city pairs divided by the served population. The rate is held between 1.6 and 1.8 over the horizon with a central 1.7, with the measured end-to-end triangle rate of 1.0 carried as a low case (Section 6.8): hybrid work and AI-mediated meetings suppress business travel while urbanisation and an ageing population modestly support leisure travel, and no structural shift in the trip-generation function is assumed.

Modal shift, s . is the share of those trips the railway draws from the competing modes — air and car — together with the conventional rail it retains. It is the analytical heart of the estimate, and it is built from the bottom up. For each city pair and each market the share follows a saturating logistic: in the air-competitive market it rises with journey-time savings and falls as the rail-to-air fare ratio r rises; in the road (rail-plus-car) market it turns on the rail-to-drive time ratio and is more fare-sensitive still, because the price coefficient against the car is larger and every additional car occupant multiplies the effective fare. The per-pair, per-market shares are then volume-weighted — by the size of each pair's air, rail, and car markets — into one aggregate. For HPPR under the canonical moderate-fare regime (Regime B, $r \approx 0.7$) that aggregate is about 0.27; across the policy regimes it spans roughly 0.19 to 0.36 (minimal to heavy subsidy, Table 6.8). ALTO's aggregate sits about three points higher, near 0.30 — but not because its per-pair capture is close to HPPR's. On the three triangle pairs ALTO is faster on every line-haul and takes markedly more of both markets: some three to fifteen points more of the air-competitive market, and six to eighteen more of the road market. Almost all of that advantage is given back on the pairs it does not serve. The intermediate-station market — Cobourg, Belleville, Kingston, Brockville and Cornwall, to the three triangle cities and to each other — is substantial, and measured rather than assumed: the Initiative's Highway 401 screenline work puts the eastern-Ontario pairs facing

Montréal alone at roughly 2.2 million car person-trips a year, before the larger Toronto-facing flows from Cobourg, Belleville and Kingston are counted at all. The full intermediate market is the balance that reconciles ALTO's aggregate share with its much higher per-pair capture. ALTO passes those towns without stopping, so it captures none of that market, while HPPR captures it at close to its triangle rate. A large advantage on three pairs, netted against the whole of the rest, is what leaves the three-point aggregate margin. It is this aggregate, not line-haul speed itself, that enters the identity: speed and fare act on ridership through the logistic, and geography acts on it through which pairs each system can carry at all. The fitted curves are stated here so that they can be checked: in the air-competitive market the logit of rail's share is $4.548 - 1.192 \times \text{journey time in hours}$; in the road market it is $1.431 - 3.235 \times \text{the rail-to-car time ratio}$; and the fare term shifts the air logit by -2.96 per unit of rail-to-air fare ratio. One hour of journey time is therefore worth about 0.40 of fare ratio.

Ramp, $\phi(t)$. is the fraction of mature ridership reached by year t , since no fast-rail service fills its trains at opening. The central case uses a Brightline-anchored profile — about a quarter of mature ridership in the first year, half by year three, seventy per cent by year five, and a ceiling of 0.95 from year ten — with the faster Madrid–Barcelona profile reserved for the optimistic case. The two systems ramp on different schedules. HPPR opens as a single stage in 2040 — the same year as ALTO's first phase, so it is credited with no head start at opening — because it upgrades existing corridors rather than building new dedicated track. Its advantage is single-stage delivery rather than an earlier start, and it carries it ahead through the early 2050s. ALTO opens in three phases — Montréal–Ottawa around 2040, the Toronto extension around 2045, the Québec City extension around 2050 — each climbing its own ramp, so the full network matures later even though its mature share is higher.

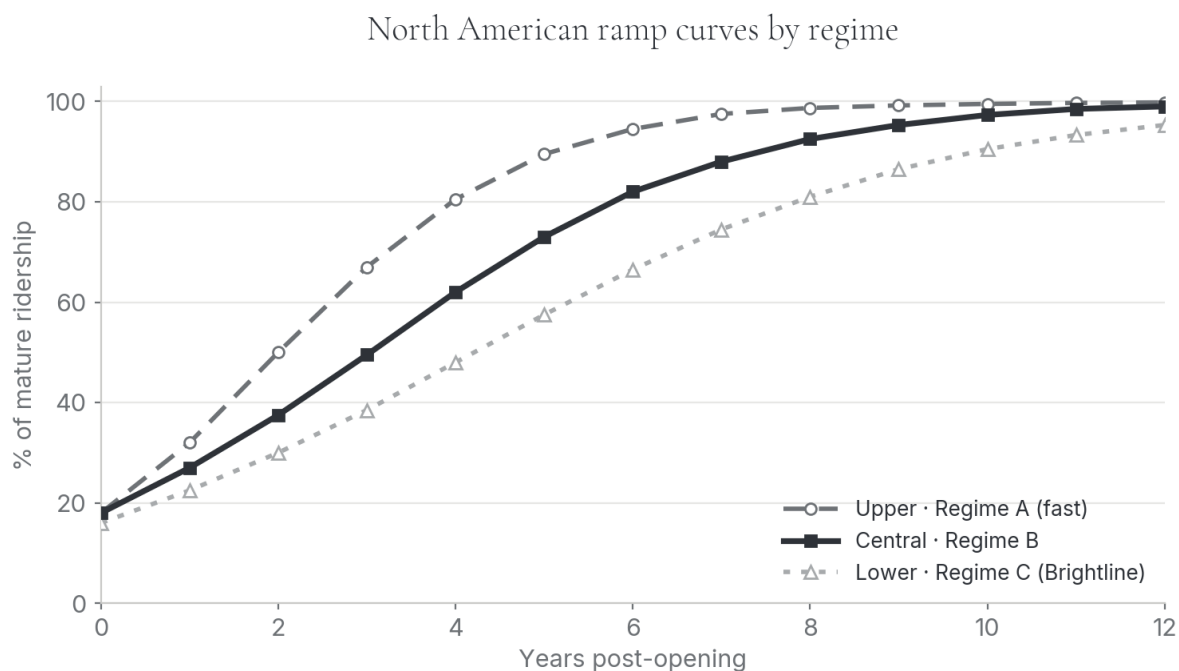


Figure 6.9. North American ramp curves by regime, as a fraction of mature ridership against years post-opening. The lower and central cases use a Brightline-anchored profile; the upper case a Madrid–Barcelona profile. Even the fast ramp takes the better part of a decade to mature.

Multiplied together at the central values, the four terms trace the trajectories carried through the chapter — HPPR reaching about 8.2 million by 2055 and 10.4 million by 2080, against ALTO's 9.2 and

12.5 million. Because the identity is multiplicative, modest uncertainty in each term compounds: varying population and fare regime across their ranges opens the full envelope of roughly 5 to 20 million at maturity, within which the central case is the working figure.

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Companion chapters

- HPR Research Report: Chapter 3, the HPR concept and the freight dividend; Chapter 4, route alignment and capital cost; Chapter 5, environmental and community impact; Chapter 7, operating economics; Chapter 8, financial case and benefit-cost analysis.