

High-speed systems and external rate of return appraisal: the case of Swissmetro and the Basle-Zurich connection, milestones for a blueprint

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The external rate of return or ERR: a concept to be substantiated¹

The notion of external rate of return belongs to economics still to come, or rather said, socio-economics as it mingles knowledge and observable reality seen through several disciplinary approaches. It clearly stems from the more established concept of “Internal rate of return” and suggests, by homology, some similar processing and relations between an objective and expected forms of return through time, yet at the same time, some basic difference as the term “external” precisely stresses. External, in most cases indicates that an identifiable influence or even a benefit of some form (it can be the contrary too: a negative aspect to avoid), takes place outside of the envisaged market relationship. We would like to emphasise, in the case of a major infrastructure development such as a high-speed system, how the external rate of return can complement the internal rate of return, what it is made of, and above all, what decisive role it can play in public decision-making and stakeholders’ governance.

The internal rate of return is a relationship between a planned new system, its level of necessary investment, its regime of exploitation given its various service and customer parametering and its expected revenue through time. In any innovation project, it constitutes, at its right time and right place, the backbone of seduction between the innovation promoter and its socio-economic partners, financiers, public sector and consumers. It focuses on the main service which the proposed innovation intends to deliver and a main yield which can be documented with classical economic appraisal tools (NPV/IRR). It should be related to the boosting effort for the innovation’s promoters to make their objective becomes seductive and supported by key partners. It can attract other objectives to complement the attractiveness of the project, but only on a subsidiary mode, not as possible substitutes, not as a sum of fragmented attributes. Getting aligned R&D, financiers, public policy makers, and other socio-economic stakeholders is a difficult task (marathon) and supposes determination, convergence and focus through various possible destabilising stages. The service constituted by the accomplishment of the innovation project has to suggest, indicate, force the attention to all these stakeholders by itself, profiling the Internal return on investment script in a non ambiguous and highly convincing manner.

¹ Of course, a lot of studies have explored and documented external aspects of a given innovation or risk (see for instance Jaccard and Perret 1995, in the synthesis of the Swiss National research programme 25, presenting clues on this issue out of several researches of the NRP 25, like Jeanrenaud et alii 1993 and Ecoplan 1993). All of them attempted to measure, quantify and bring up convincing results which could be incorporated in a general accounting, and more problems than solutions have emerged out of these various attempts, as disputes typically arise on the calculation mode, scope, content, comparability of data, etc. As for ourselves, we only want to suggest that this needs to be pursued, as clear socio-economic advantages are within access provided we can document external factors and normalise somehow the way to do it.

Having said that it is beyond doubt that some innovative systems embed “external” advantages. The questions are raised therefore of what this external dimension is made of, what leveraging capacity can be associated to it and what kind of relation can be identified between this external side of the innovative project and the internal Here we start having difficulties as most of the external attributes are complex to detect, measure and price, furthermore to sum among themselves as they cover a quite heterogeneous range of factors. Still, some aspects can be measured and suggested as potential external revenue (quantitative attributes), while other can make a difference as they might trigger a social clause or local interests which may be necessary for the integration of specific stakeholders or overall social acceptability of the project (qualitative attributes) (giving global access to a region may be such an attribute, difficult to measure completely. Quantifying the gains and losses of travellers transiting by Cointrin after Swissair decided to leave aside long-haul air tips from this airport can give us a rough idea,, but which will stay incomplete and remain basically as a qualitative signal.

Swissmetro and its “external” potential

High speed systems have externalities worth considering and positioning into a combined socio-economic appraisal. Swissmetro is a good candidate for such an approach. In order to understand this claim, let us stress some interesting characteristics of Swissmetro, beyond its five basic features² and the speedy mobility service that is generated. Let us suggest a few of them.

“Internally”, promising technological characteristics, leading mainly to a interesting ration between passenger transportation (number x speed) and energy consumption

- light vehicle structure (pass./t/km/h)
- Highly efficient energy transfer technology
- Highly efficient aerodynamic configuration

“Externally”, other characteristics should lead to a diversity of advantages as regarding to either competition or complementation with other transport means

- Full-speed access to city centres as well as airports
- Very low noise emission
- Low pollution emission
- Very low ground surface consumption
- Capability to decrease directly and indirectly air traffic congestion
- Because of the underground one-way per tube configuration: low risk means as far as interference (man-made, weather) and error are concerned
- Carefully planned, important gains in inter-modal combinations and economic complementation within a twin-city configuration

² As a reminder : 1) an entirely underground structure, 2) partial vacuum inside, 3) propulsion by linear electric motor, 4) electromagnetic forces for levitation and guidance and 5) energy transfer by induction.

We make the hypothesis that several of these dimensions could be quantified, even in money terms (for instance the noise dimension) and that others could function as decisive trigger to motivate specific actors or even large segments of society in terms of interest or acceptability.

We have suggested this peculiarity already in the past (see Rossel, Bosset, Glassey and Mantilleri 1999) and we suggest now that it could become a critical comparative advantage of Swissmetro in an integrated vision of this technology's implementation (document this idea from already written text)

This determination of integrating direct and indirect technological features to infer external competitive advantages is to be located in a specific context to progress towards concrete measurement and quantification. In our case, it would be the Basle-Zurich link, a significant opportunity corresponding to the leveraging of the above-mentioned features. Its 86 km stretch, with dual option of connecting not only city centres but in addition, airports, in a current situation marked by high air traffic congestion but lagging railway status

Public policy approach will make the difference

We suggested here only the basic reasons why public policy, as well as private economic players, should be interested in developing a Swissmetro service. But the philosophy and then the decisions and accompanying measures, which could make this interest consistent with most territorial issues will finally make the difference between potential success or on the contrary announced failure. In order to make this dilemma more explicit, we have to frame our external effect sensitivity within a clear-cut policy argument.

We made the hypothesis that major players may detect for Swissmetro an interesting potential and, as a logical consequence, would not match it against other means (the competing option), but on the contrary *integrate* it into a larger mobility strategy in which the following issues could be addressed:

- exploring in depth the role which a Swissmetro technology could play in a wide hubbing scheme (multi-airportwise), air traffic having been identified directly (air traffic relief) or indirectly (inter-modalwise complementary to air traffic) as the primary market for Swissmetro³;
- a deep reflection should be made as to advantages as well as inconveniences of building synergies between two urban agglomerations, with specific issues to be documented in a variety of sub-domains (not only air traffic, but also job market and industrial division of labour; major infrastructure sharing, common higher education institution scheme, cultural event pooling, etc.);

³ Let us recall that hubbing can be defined as making effective an air connection platform organised in such a manner as to harmonise short-, medium- and long-haul flights and produce interesting effects of simultaneity (as opposed to accordion effects). In order to reach that goal, critical size of traffic and service, strategic commercial alliances and risk-taking in (for not immediately profitable) intercontinental flights (and in diversity of lines) are necessary.

- a sensitivity study should be made on the optimal phasing, for price, nuisance (noise, ground consumption) and pollution motives, of a division of labour between various types of fast trains in which, if better environmental performance is proven in due time for Swissmetro, a complementation scheme could be devised. For instance the expansion of rail-supported freight intensity due to the modal transfer of track to rail suggests a multi-dimensional, optimised and however robust scheme for inter-city connections.

Typical accompanying measures within an integrated perspective of Swissmetro implementation and servicing could be (let us insist: “provided that the civil society, the elected bodies and policy makers have identified strong societal interest in Swissmetro thanks to good score on the environmental impact and land-use planning levels”):

- Policy makers and public bodies should promote **synergies and coordination** between actors, activities, regional clusters, with clear incitation and support to projects and users
- Policy makers and public bodies should support projects and users related to **enhanced land-use planning and environmental options**

Such a supportive strategy can have both a **direct** expression, partially subsidising a system like Swissmetro, alone or within inter-modal combinations or **indirect** one, e.g. awarding privileges to specific categories of users. This type of policy-level influence can be, much like the one generated by other transport projects accompanying measures (in Switzerland we have for instance the case of and Alptransit and the associated RPLP truck-taxing system), but tuned with technological and organisational improvements to produce maximal effect.

In order to legitimise further calculation, let us summarise the basic divergence in forecasting approaches on the basis of “instrumenting” either a competitive or integrated service in the case of Swissmetro:

The « concurrent/competitive » scenario approach:

One way of approaching the problem of guessing Swissmetro’s impact is to imagine the system as it stands now, i.e. in today’s **competitive** company with car and railway alternatives, updated in 2020 traffic terms on the basis of, roughly, a 1.1 yearly increase (see EBP report). The consumer will then be able to choose between various redundant and **concurrent** services (a little bit like Alptransit evoked earlier, but without accompanying the ad hoc policy to influence modal transfer).

The « integrated » scenario approach:

As a key hypothesis, we suggest that Swissmetro is an expensive infrastructure that no one will build or let build without making modal choices and public policy incitation **coherent** with this new feature on the mobility scene, thanks to targeted accompanying measures; there should be no unnecessary redundant means: a new technology has to play a **complementary** role in addition to leveraging complementary roles for existing transport means. Any increase in traffic should be verified to be compatible with land-use planning policy and desired relief in other modal increase considered as environmentally more damaging. This important point is a condition for envisaging traffic induction as acceptable. Let us also say that a full-fledged

integrated policy towards the introduction of a new transport means such as Swissmetro should already make its effect be felt a few years before the opening of the new Swissmetro service, making this policy a consistent concept.

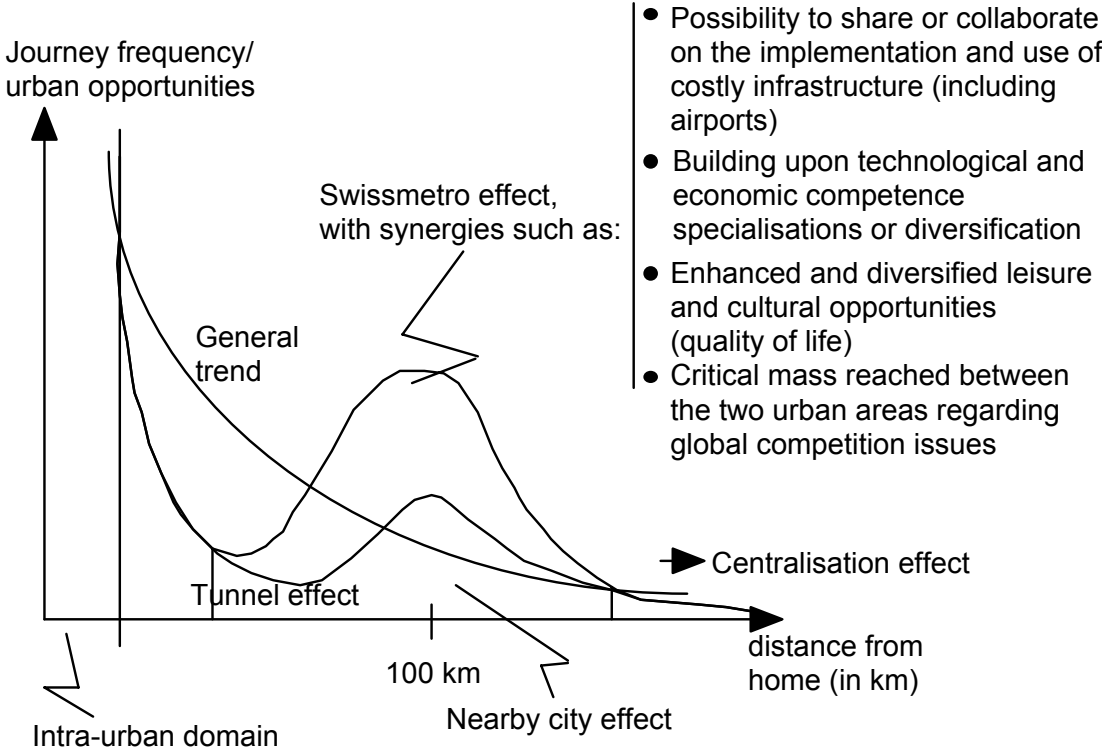
Modal transfers, critical times and twin-city synergies

In order to consider in a dynamic way the influence of an integrated mobility policy making room for a Swissmetro system, it is necessary to add to the supposed modal transfer (see below, the examination of basic hypotheses involved), different possible traffic, each one corresponding to hypotheses and specific scenarios with variations:

1. Hubbing effects and inter-airport optimising services; we will however distinguish two situations, 1) without and 2) with an additional and partly shared airport to airport linkage, this first part being dedicated to the consequences of point 1), some aspects of air traffic complementation (wide hubbing) being nevertheless already at stake.
2. Synergies between two cities which may have more to share with a Swissmetro connection than under existing geographical and transport regime.

The following graph illustrates this idea.

Synergies generated within a bi- (extendable to multi-) urban configuration



Again here, the induced traffic authorisation could be granted only if a provision for relief of existing or potential increase of another kind of expense, consumption or nuisance can be documented. As mentioned earlier, there are several key domains in which such synergies can exert an interesting effect: (air traffic, but also the job market and the industrial division of labour; major infrastructure sharing, common higher education institution scheme, cultural event pooling, with, in this latter process, the young and the retired segments of the population very much concerned, etc.);

All these suggestions of course imply by all means the “integrated mobility policy approach” already evoked and legitimised.

3. Intermodal optimisation between Intercity, international rail links, regional trains, freight on rail, cars and even planes for short-distance up to 500-700 km connections⁴.

Time is indeed a critical element for potential transfers, either in the effective door-to-door gain Swissmetro can really allow for most travelling patterns (some twenty key configurations to be examined in real comparison terms)⁵, the airline traffic optimising it may leverage or the twin-city configuration it may boost. However, this should be analysed carefully, in comparison with Swiss culture statistics for acceptable commuting time patterns⁶ or for equivalence in foreign modal changes.

In summary, there is in the bi-urban synergy hypothesis an important potential for Swissmetro, provided that this new means of transport gets implemented within an integrated policy scheme (and not a competitive one, very unlikely in case Swissmetro is actually built). We have designed the result of such an activity for the Basle-Zurich area, with percentages of the expected total external return of Swissmetro allocated to the different activities (which are in their turn, depending upon other hypotheses which will have to be explored more/supported/made robust). This gives us a preliminary proposal, which goes as such:

⁴ An interesting study of CEMT (1992) shows that for TGV trains, the breakdown of attractiveness in relation with distance is the following one: 3 % for 70 km-type of journey, 45 % for 150-type of journey and 65 % for the 450 km-type of journey. Basle-Zurich, including the air link option, is somewhere between the first and the second figure: not the most attractive target for de-routing people from taking planes, for instance, but already within the range of attractive modal transfer schemes.

⁵ Let us discuss the specific point of station-related time-loss generated by Swissmetro. It is true that Swissmetro means a loss of time to be accessible and left behind, but so do other means of transportation, some typical origins and destinations being more severed by this comparison. But there is for sure not a single mean time loss which would affect only Swissmetro. In addition, the psychological aspect may interfere and should lead to the introduction of coefficients as some journeys, involving several means of transportation may look less attractive than others,, depending upon complex chains of factors relatively regardless of time spent. Extensions of variety and quantity of services offered in stations may play a role in the organisation of people’s day, in a densification scheme. Finally,, there is the frequency factor (the metro effect, by increasing the number of convoys accessible within a certain period of time), compensating losses to a great extent, as compared with means which have only an intermodal connection of the half-hour level or above. For all these problems see Rossel, Bosset, Glassey and Mantilleri 1999 and Kaufmann, Gemelin and Joye 1998).

⁶ There seems to be a strange attractor effect in Switzerland around the hour of duration for such commuting trips, but this kind of study has to be explored much more in depth, the mean result of existing commuting habits being only to a certain extent relevant for such an extrapolation. Many subtle factors should get in the picture when refining this problem’s outline and accessible knowledge.

- New free time mobility, with ex: fairs, concerts, exhibits, special events (10-15%).
- Shared or coordinated major infrastructure and service scheme, which is ideally profiled in a situation like the Basel-Zurich combination (fairs, concert, opera, hospital, higher education institutions and with the reserve mentioned earlier, airports) (50-60 %).
- Co-ordinated economic sector specialisation and high-end job market policy (10-15 %).
- Co-ordinated mi-distance transit scheme (10 %) taking rather the Lausanne-Bern example, here).

The main problem is of course to avoid counting people several times!

Measuring, quantifying, evaluating return as to design a ERR script.

The following paragraphs indicate but a few of the possibilities which are within our reach (provided we have the means in time, multi-competence and money to carry out such evaluation).

- Low pollution and energy consumption

The capacity to match favourably Swissmetro performance in this domain, against or in intermodal complement with other transport means (including transport tightly associated with telecom services), thanks to ecobalance standard practises, is within our reach as to suggest a decisive element for policy makers: quality of life and territorial consistency is at stake and long-term durability belongs to the land-use planning philosophy of the areas which Swissmetro could service. Calculations capable of substantiating this advantage imply different scenarios with intermodal options (with or without airports, integrated car-sharing connections, modal transfer of relieved road and rail capacity to regional train systems, etc.). These scenarios could be categorised according to the level of mobility scheme integration and public investment to support it. Each scenario could lead to a financial estimate, which could further be incorporated into the total external rate of return figure. Needles to insist on the fact that if eco-taxes are voted and enforced, then this dimension is likely to become a critical advantage in favour of Swissmetro as it would constitute an even better match against competing high-speed services.

- Noise

Noise is maybe the most accessible external benefit of Swissmetro as hypotheses on its productivity as compared with other means, like car or trains, but also high-speed like TGV, other maglevs or planes, can be carved out of existing situations to provide figures which could then be combined with acknowledged costs of noise pollution either in medical terms or in anti-noise infrastructure investments (walls on the side of roads and railtracks, silent windows near and limitation of the number of authorised flights near airports). We have figures for window improvement costs near airports, anti-noise wall costs for airports, highways, railways (middle- and high-speed), tunnel which are partly motivated by noise fears, we also have figures for cost of noise at medical level, a portion of which is to be

assumed by transport noise effects. Either all transport means are evaluated and given a noise coefficient which should be taken into account in investment calculation or political decision-making, or a means such as Swissmetro, a very low noise producer, should be credited with different sorts of savings to be evaluated, combined and eventually expressed as a component of an ERR. Such a calculation is underway as a test, and some results should be already available during the Maglev 2002 conference.

- Land-use

This is also a quite interesting-to-value domain of advantages for Swissmetro, involving the price of land, the access to city centres and the expropriation regimes for land a similar infrastructure construction as to produce a global calculation, again, with several possible scenarios.

- Twin-city synergies,

Things here are more diverse and complex to value. The analogy we have suggested of the Lausanne-Geneva case, type of proximity (in terms of time to get from one place to the other) which Swissmetro would generate in a case like the Basle-Zurich link, is nevertheless likely to provide us with figures for distinctive gains and little by little to suggest an overall picture.

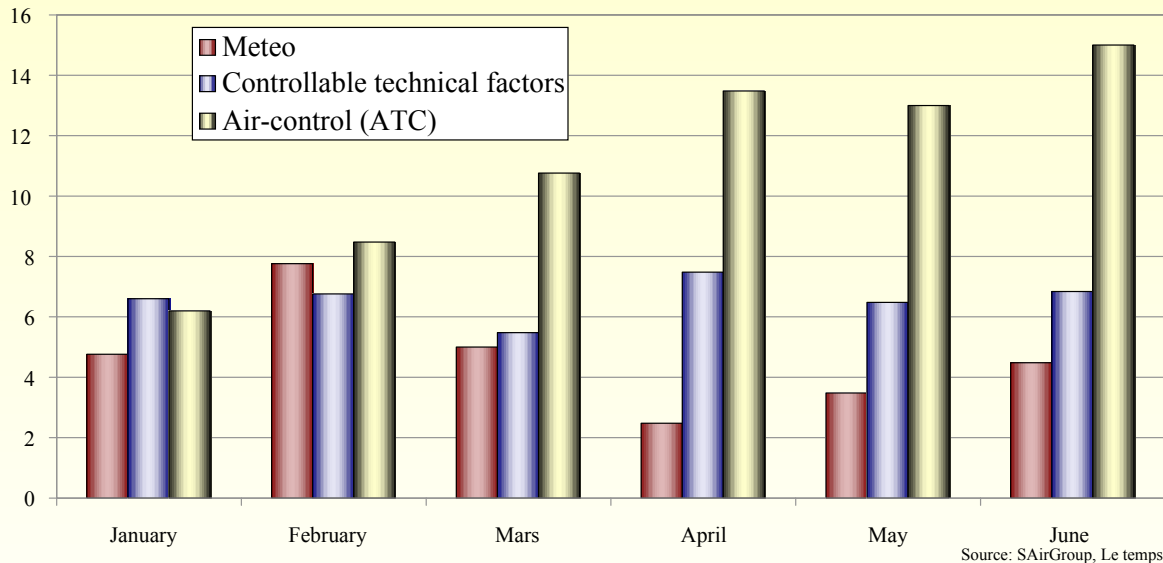
- Others (time gains, favourable risk balance, expandability, etc.)

Time is also a dimension which can be valued. Swissmetro is a time gaining generator and time has an economic value. For instance, in the insurance business, when somebody is incapable of working, insurance has to pay for time loss. The rules then is to distinguish waged persons (the price of time corresponding in this case to the salary to be compensated) and independent workers, calculation of the price of time being then either done through the enterprise' turnover or profit or the economic loss which can be documented (the absence of the boss generating different sorts of negative consequences). Another business area where time has to be valued is the airline traffic monitoring, as flight delays can have penalising results of many kinds, with either individual time valuation problems (the sum of which gives a real cost figure) or collective time appraisal attributes (for insurance). Altogether, even with a lot of precautions as to avoid the naïve approach of making of the overall time gains leveraged by Swissmetro an economic equivalent, time gain here can be sustained as having a driving value for certain categories of persons.

Estimation of the flight delay costs for Swissair in 1999

in millions of CHF

Computation: 50.- CHF per delay hour and per passenger



Among the other external dimensions worth mentioning in this preliminary exploration, is the expansion phase (what the original Swissmetro link, in further stages of implementation, can lead to) and the new accessibility it can provide⁷. For instance, in case of a Lausanne-Geneva Airport-Lyon Airport-Lyon connection, the whole of Lausanne-Geneva area plus the Fribourg-Bern, the Neuchâtel and the Valais areas would be considerably closer to Paris, Marseilles and in general to the North-South TGV axis meaning Bruxelles, London northward and Barcelona and Torino southward, for instance). This is a side value of the main goal (the airport-to-airport link between Geneva and Lyon and its intrinsic potential) which should be assessed. In the Basle-Zurich case, different extensions can enhance the original offer, either with Swissmetro (expansion of the original section) or other high-speed means (combinations has an external value, too)⁸, in direction of the North or the South, but above all as being part of an innovative East-West high-speed linkage which would boost Central European exchanges. This “global” and strategic external dimension is the kind of feature which should be given an estimate as it is today and for the next 40 years a major political issue for our continent. A good example of this “global” level of Swissmetro potential externalities was given recently with the decision by Novartis to develop its research in the United States, betting therefore on a new Basle-Boston axis for its excellence, making de facto the Basle nexus of this configuration a “global” factor.

Risk (environmental, technological, at the level of security for passengers and surrounding neighbourhood) is also a major source of valuation for Swissmetro. Of course, before that, R&D must place this issue high in the agenda and Swissmetro must become a leading actor in the safety-security arena. However, provided ad hoc developments are made, Swissmetro,

⁷ In French, this can be expressed as “l’évolutivité potentielle du système”, in English: the system’s potential for further development.

⁸ See for that the interesting work of Morellet and Marchal (1997) on the cross-influence of TGV and air traffic.

given its entirely underground structure (out of reach, of interference with falling objects or animals, not subject to climate nor weather influence, one tube per direction and therefore less subject to man-made or technological deficiency), its black-box control operation system, highly monitorable, its robotics approach to maintenance and its multi-independent security-checking philosophy, is a good candidate for lower risk figures in the transportation scene of the future. Given the cost of accidents, casualties and insurance primes, this means an interesting combined economic risk appraisal perspective, already suggested by Perret (1999).

Finally, one the most promising factor which can be valued in terms of external gains is the relief-generating effect for various types of traffic increase, reaching their saturation level): some train lines at peak hours of course, but more obvious and dramatic, air traffic congestion and road traffic congestion. As an example, a Swissmetro service between Basle and Zurich would certainly allow public spending to be avoided in the construction of a third track on the highway connecting the two cities. Congestion relief can be direct, as in this case, or indirect as in a coordinated arbitration of air traffic involving two or more airports. Altogether, a “integrated hubbing economics” should arise, with the objective of make the best combined use of all the available transport and information technology resources as well as the intra-or near-urban intermodal infrastructures which can make travelling more effective, in normal conditions, but also in case of general problem or local deficiency.

Peculiarities of the External Rate of Return concept

Given the amount of conditions and alternatives which might make external features of Swissmetro actual advantages or on the contrary dormant possibilities, the is fair to consider the External Rate of Return as a virtual value, a potential series o gains associated with attributes and clauses. Let us not forget what we have said in the beginning: the External Rate of Return can only be subsidiary to the main objective, the return value of the principal service achieved thanks to the proposed innovation: the Internal Rate of Return. Considering the External rate of Return as virtual is not a negative approach. Much the opposite, it constitutes a flexible reservoir of deliverables and policy-supportive arguments. One of the most interesting s of this virtual status is the multi-facet nature of its design and use. In other terms, what is the currency of the External Rate of Return? One would think that money is the obvious answer and it is the case to a certain extent. But even money, given the important variability of the calculations and scenarios at stake, should be expressed not in absolute terms, but in terms of range (between x and y), or even formulated in its complex effectiveness (if clause A is achieved, ERR is likely to be within the x to y range, if clause B... etc.). But money is not the only interesting expression of the ERR. It can also be valued:

- 1) in relative weight of the Internal Rate of return;
- 2) as a qualitative threshold for public policy manifestation of interest (“if a leveraging value of external return of between x to y can be obtained after z years, then, public support should ...”) or comparative advantage with other transport means (“if Swissmetro does 30 % better than ..., them...”);
- 3) when more studies will have make some standards possible, specific mean ERR units capable of showing the combined value of heterogeneous benefits, much like what is being done with ecobalance practises when dealing with completely different

problems (for instance any combination of noise, pollution, energy and land-consumption impacts).

Project management and governance perspective

As a final comment, it is quite clear that the project management style of the external/internal value of the Swissmetro technology will make a huge difference. The Swissmetro concept has still to demonstrate its reliability, if not its feasibility and therefore undergo several step of R&D before being capable of delivering the claimed transport service. This is on the immediate agenda of the Swissmetro project management. The most important clue the external rate of return approach suggests is that its full-fledged “external” potential should be envisaged and integrated as much as possible very early in the step-by-step project monitoring of this R&D phase as to produce its maximal influence all along the way. The danger, otherwise, would be to reduce Swissmetro to a technologically narrow competing object, within a geographically limited perspective, therefore losing much of its originality and attractiveness. This dilemma is reflected, in terms of project management, between the early approach “we would like to build a network” (beware the high penalty constituted by the low profitability connecting lines) and the philosophy “let us have an attractive market first, which can be replicated and expanded in further stages”.

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