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Forecasting the Demand for Privatized Transport

What Economic Regulators Should Know, and Why

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This overview of issues that regulators should be aware of in demand forecasting discusses challenges that come with the decision to privatize transport, the perverse incentives introduced when privatization teams use strategic demand forecasts to evaluate assets, the most common problems with demand forecasting, the reasons that demand forecasting matters, and how to think about demand forecasting in the context of regulation.

Summary findings

Forecasting has long been a challenge and will remain so for the foreseeable future. But the analytical instruments and data processing capabilities available through the latest technology and software should allow much better forecasting than transport ministries or regulatory agencies typically observe.

Privatization brings new needs for demand forecasting. More attention is paid to risk under privatization than when investments are publicly financed. And regulators must be able to judge traffic studies done by operators and to learn what strategic behavior influenced these studies.

Many governments and regulators avoid good demand modeling out of lack of conviction that theory and models can do better than the "old hands" of the sector. This is dangerous when privatization changes the nature of business.

For projects amounting to investments of $100–200 million, a cost of $100,000–200,000 is not a reason to reject a reasonable modeling effort. And some private forecasting firms are willing to sell guarantees or insurance with their forecasts to cover significant gaps between forecasts and reality.

Forecasting the Demand for Privatized Transport: what economic regulators should know and why.

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1. Introduction:

While public-private partnerships in the delivery of transport infrastructures and services is expanding, there is also growing evidence of the lack of appreciation of the importance of demand forecasting in preparing and monitoring these partnerships. This often gives an opportunity to the private operators of transport services to complain, soon after taking over a business, about overestimates or underestimates of demand based on the initial information provided by governments. It tends to result in an excuse for the private operators to try to renegotiate the contract to improve its terms.[1] The most common case finds a concessionaire arguing that the "overselling" of the potential business by a government eager to maximize fiscal gains, generated unjustified high expectations. And nevertheless it is quite common that both regulators and concessionaires or bidders devote much more money to the construction costs studies than to the demand analysis--the average ratio quoted among expetrs is one to five.

The lack of focus on good demand forecasting in the context of an increased role of private operators and investors in the transport sector may be somewhat counterintuitive. Transport planners have a long tradition of concern for demand. The analysis of demand has been at the core of the assessment of national or sectoral policy options, including the introduction of new transport modes. But these concerns have generally been addressed through more "macro" oriented modeling exercises focusing on identifying broad support for , or rejection of, policy alternatives.

In the context of more specific evaluations of projects--such as high speed trains, subways or new airports—or in the context of important policy decision regarding modal choices--, many planners have also developed disaggregated demand models capable of generating the kind of information much closer to what is needed to meet the forecasting requirements of a project financier, a privatization commission or a transport economic regulator. There are a few very good recent surveys of these models (see for instance Small and Winston (1999) in English, Quinet (1998) in French) and several comprehensive textbooks on the subject (Ortuzar and Willumsen in (1994) in English or Ortuzar (2000) in Spanish). They reveal impressive improvements over the years to model demand and increased accuracy in identifying and assessing the relative importance of the various factors explaining demand, including modal shifts resulting from policy changes. Although there is a lot we still don't know, many countries can now count on useful results on the value of time and the willingness to pay for various types of transport service users. These are relevant indications when pricing new services to be provided by private operators.[2] It makes sense to compare the tolls or tariffs calculated from the cost side with these rough estimates of the willingness to pay for some services or with the value of time revealed by the post-mortem analysis of comparable projects increasingly found in the literature (see Quinet on Marseille (1998), Small and Winston (1999) on the Dutch data base).

Unfortunately, this improved knowledge does not seem to be spreading to the toolkits used by transport planners or privatization teams in developing countries--and for that matter...in many developed countries—because few are willing to invest in the data needed to make the

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[1] This "overselling" and the common resulting renegotiation of the terms of the contract typically allows th eprivate operator's to obtain extensions of contract duration, new or larger subsidies and/or lower investment requirements. All these changes alter the fundamental financial terms of the contracts which often end up being significantly less attractive than anticipated from the viewpoint of the government--and often also from the view point of the users. On the other hand, new fact sometime do arise and renegotitiation is not necessarily a bad thing, as long as it follows fair and transparent rules.

[2] For a useful overview of how to value time and to relate this to willingness to pay, see Jara-Diaz, S.R. (2000) or Galvez, T.E. and S.R. Jara-Diaz (1998)

most of these new tools. In many cases, "privatization" has a tight time table which does not allow enough time to get the data and sufficiently work the model.[3] In fact, many academics would argue that few transport planners have effectively used the most recent developments in demand modeling techniques. In France, for instance, one of the top transport research centers, recently published a book taking stock of developments in the field outside of France, arguing explicitly that it is intended to meet the need for France to catch-up in the area of demand modeling by urban transport planners.[4]

Luckily for regulators or project financiers, things are changing. The best evidence of recent progress is that demand forecasting is a profitable business and that many of the firms offering these forecasting services are willing to stand by their forecast offering guarantees or insurances to their clients. The US has some good experience but so do Mexico and Brazil who are relying on serious modeling to assess the future demand for its commuter rail and assess the government financial support requirements for various levels of tariffs.[5] This market is likely to grow and there is already a plethora of software to pick from, just like there is a plethora of methodologies to pick from. The increased availability of private firm willing to offer advise on demand forecasting will however not address well the second main type of error a regulator needs to be concerned with: the traffic modelers often are not referees, but advocates for the initial actors' interests as discussed later.

The main purpose of this paper is to guide regulators though this very technical and somewhat foggy field to allow them to make the most of new opportunities to collaborate effectively with specialists. The goal is not to provide a detailed technical introduction but rather to provide a "light" overview of the main issues a regulator needs to be aware in demand forecasting. To achieve this objective the paper is organized as follows. First, it discusses the changes and challenges brought about by the privatization decision. Privatization introduces a number of perverse incentives in the process that leads to strategic demand forecast used in the evaluation of assets by privatization teams. Next it provides a checklist of the most common problems with demand forecasting, highlighting the main reasons why demand forecasting matters in practice. Section 4 then provides a brief overview of the main techniques. Section 5 provides some sector specific illustrations. Section 6 provides some practical tips as how to start thinking about demand in the context of regulation. Section 7 concludes.

2. The changes brought by the privatization context

This section reviews the main changes resulting from public sector restructuring brought along privatization. The increased role granted to the private sector does not mean that the public sector disappears from the sector. In many ways this role is strengthened by the recognition of the importance of an independent regulator. But the implementation of a restructuring that recognizes the importance of independent regulation requires an increase in the number of players since the policy and regulatory functions typically enforced by an integrated public sector are now assigned to an unbundled public sector. The regulatory dimension of this unbundling is quite complex since it provides a set options which influence the relative importance of demand forecasting in the context of privatization. A particularly important aspect

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[3] Privatization is here defined as any type of public-private partnership in which the private sector takes on the main responsibility for the operation and the investment in the sector. It includes sales/divestitures, concessions/franchises, management contracts and greefield projects. In developing countries, roughly 66% of the public private partnerships are done through concessions/franchises. For more details see Estache (2000)

[4] Dossier du Centre d'Etude sur les Reseaux, les Transports, l'Urbanisme et les Constructions Publiques (1998), "Comportement de deplacement en milieu urbain: les modeles de choix discret"

[5] This is that it is not cheap. Depending on the specifics of a projects at good demand study can cost as much as $250,000 dollars.

of this choice is the trade-off between the incentives given to the operator to perform well and the risks that this operator is expected to take on. The specific assignment of responsibility and of the choice of regulatory instruments are the main reasons for the strategic use of demand forecasting by the key players involved in the privatization process as discussed next.

2.1. The diversity of objectives across actors

In practice, at least four groups of actors are involved: consumers, operators (in a large sense, that is including sponsors and financiers), the government (which represents the taxpayers and the voters) and the regulator and it is important to understand how their concerns differ. Users will worry about prices, service quality and reliability. All influence demand. The operators typically worry about profits, risks and market power.[6] All are influenced by demand. Governments, who are often the dominating players in the context of the reform of the sectors covered here, are generally interested in reducing the fiscal burden imposed by the public enterprises of the sector and often also try to generate a flow of resources through the reform process. They generally want to please tax payers by cuttting taxes and respond to some of the constituants with environmental and distributional concerns.[7] These concerns can both influence demand and be influenced by demand. In discussing demand forecast key actors are often more advocates of their agenda than scientifics. Regulators which happen to be the Government officials or political appointees in many cases, want to balance everybody's concerns fairly accounting for many aspects of demand typically ignored in the privatization process, including a reasonable comparison of willingness and ability to pay to avoid, in particular in the case of passenger transport, an unfair exclusion of some segments of the population.

2.2. The regulatory regime and the balancing of risks and incentive

Regulatory regimes come in multiple sizes and shapes (rate of return, price cap, hybrids,...) and have very different effects on the behavior of operators in terms of pricing strategies, quality or investment decisions. The real importance of demand forecasting in the context of privatization of local monopolies cannot be appreciated without a proper recognition of its relevance for the effectiveness the regulatory regime chosen. In turn, it is almost impossible to understand the desirable design of the regulatory regime without recognizing that it depends on the ranking of the various objectives (cost minimization, investment level and speed, social concerns, fiscal goals) reflecting the many concerns of the various actors influenced by the privatization decision.[8].

From a regulatory viewpoint, the regulator must chose who bears the technical and commercial risks. This means balancing essentially between "fixed price" (e.g. toll price caps based and lumpsum construction cost contracts which pushes the operators to minimize costs and contracts, in which both risk types are passed on to the operator) and "cost-plus" type contracts (which guarantees that the operator recovers at least cost and make a minimum rate of return on the business). If the concern for efficiency dominates and business risks are minor, fixed price type contracts would dominate all other forms of regulation. Under this regime, demand would mostly be the operator's problem since it is supposed to decide autonomously the risks it is willing to take. It turns out that fixed price contracts are most likely to attract efficient private operators

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[6] Most regulators would argue that the concerns of the financial advisors and of the operators do not always coincide The operators mostly care about getting the deal signed and this requires very good demand prospects . The operator wants to have a longer term view and is typically more cautious about the prospects.

[7] They are sometimes as well concerned with the need to deal with unions as the restructuring of these sectors often result in labor redundancies.

[8] For a longer discussion of this point, see Crampes and Estache (1998)

when risk levels are low. This means that the more precise demand is, the lower the risk, and thus the easier it is to rely on fixed price contracts. In addition, the reliability of demand forecast allows the regulator to better assess the actual efforts of the operator to improve efficiency and to lower the information rent potentially available to the operator (i.e. the pure profit that the operator can obtain from its superior knowledge of costs and traffic type when compared to what the regulator knows) and the incentive rent (i.e. the gains that may be obtained from saving on the cost of the efforts needed to meet the efficiency requirements built in the concession contracts).

An alternative strategy for the regulator is to come up with a regime that requires a minimum of information on demand. For toll roads and airports runways, Engel et alt (1997a & b, 1998) suggest a new type of auction which consists in selling the toll or fare and the investment obligations and to allow for variable duration so that the effects of demand uncertainty are eliminated. The contract ends when to the operator has recovered its investment at the set toll level. It protects against over and underestimates of demand. The mechanism is quite creative and useful although it faces its own share of problems and should reduce the need assess demand from the view point of a regulator. (see Tirole, DeRus and Nombela). In practice, it is very unlikely that a regulator will ever have to ignore the interactions between its regulatory choices, the economic environment of a project, including the determinants of costs and demand and the outcomes. [9]

The problem is the most acute when risks are significant and there is a problem in attracting potential bidders. In this context, some type of cost-plus form of regulation which allows better risk sharing should generally be preferred. The main concern under this regulatory regime is that operators will cheerfully endorse the overshooting of actual demand since it justifies investments to be included in their asset base. If tariffs are set and demand is overshot, operators are simply likely to get more time to recover the costs. This last problem is compounded in cases in which the government structures the privatization around some payment to the public sector by the operator and is thus concerned with maximizing the fiscal payoffs of this privatization. In this context, the payment to the government will be highest when the potential value of the business is highest. This is why the calculation of the minimum price a government is willing to accept for a "privatized" asset is such a strategic variable. For a given asset value, the valuation of the business is essentially driven by a demand forecast which both the operator and the government have an incentive to overestimate. The better the demand prospect, the highest the minimum price the government can hope for.

2.3 The relevance of the actor's strategic behavior

Whatever the regulatory regime selected, many of the players have a strong incentive to play strategically. Politicians will want to look good during their tenure and support policies that maximize short run fiscal payoffs and/or minimizes tariffs. They can do so quite consciously and knowing perfectly well that requiring high payments and expenses from the operators while imposing low tariffs are generally not consistent and sustainable policies. Willingness or ability to pay and hence the real potential value of a business are seldom analyzed very analytically in this context. The political gain for them to announce a new infrastructure is much higher than the political loss of having to increase taxes; furthermore these concerns and the eventual renegotiation of the deal is left to their successors since they generally imply political costs. But it is clear that private operators happily play in this game. For many of the best deals, their main concern is to get

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[9] The regulator can be a little bit less concerned with the risk that the operator undershoots demand and that users do not get what they want initially. If willingness to pay is demonstrated, operators are quite likely to make the additional investment requirements ad regulators will simply have to ensure that there is no abuse in the pricing of the new service.

the contract signed by the government, knowing quite well that there is generally significant room for renegotiation. Patience in this field is often rewarded once the contract is won.

In sum, there are enough reasons and there is enough evidence to argue that in the context of privatization, it is not easy to achieve convergence on the views of what a good demand forecast should be because both firms and government have some interest in playing strategically with the demand forecast. This should make a convincing case to ensure that regulators do their best to come up quite early on in their tenure with independent assessments of demand. This assessment will be useful at almost every stage of a regulator's activity. Demand is important in most types of conflicts that have to be resolved through tariffs or quality adjustments. Demand is important when assessing financial support requirements for projects requiring subsidies. Demand is also important in understanding the distributional consequences of any regulatory decision. Demand is finally important every time there is a renegotiation and this means it will often matter because most contracts end up being subject to some degree of renegotiation.

3. How to deal with a wrong demand forecast?

As most policymakers will acknowledge, there are always many ways of getting any policy decision wrong. In the case of demand forecasting, there are some clear patterns. It may be useful to briefly review them since a better understanding of these recurring mistakes may be a good place to start improving demand forecast. One way of approaching the problem and to track the reasons for the importance of demand forecasting is to assess the consequences from the viewpoint of the main characteristics of a transport system and in particular the changes in this system to meet the expected demand.

Investment for significant infrastructures are quite slow and costly and at some point it is necessary to try to take bets on growth prospects in demand. If these bets are unfounded, it can be quite costly. Forecast can either be too optimistic or too conservative. Figure 1 summarizes the main problems resulting from the mismatches between demand and supply for capacity and the main suggestions discussed in this section.

3.1. How to deal with an overoptimistic demand forecast

Before getting into demand overestimation, it may be worth to point out that many casual observers may easily be misled into seeing an overoptimistic forecast where there is nothing but prudent long term planning! Consider the case of airports, roads or ports. The investments needed to achieve the right medium to long run capacity are huge but mostly slow and bulky (indivisibilities result in lumpy investments!). It will generally be impossible for most of these types of infrastructures to design a flexible piecemeal investment strategy to adjust quickly to increases in demand for capacity)—justifying the presence of a single operator. In many instances, beltways or urban access roads have been build with assumptions underestimating growth patterns. Because of the nature of the investment process, most of these projects require some short run excess capacity to be able to absorb the longer run demand. These are not mistakes. The main policy question here is whether to allow the tariff today to cover the needs of tomorrow or to have the government pre-finance these future capacity needs through subsidies. This is not a demand forecasting problem—since it is foreseen-- but it is a pricing problem very similar, although different from the one resulting from a sheer forecasting

mistake in the context of a fixed duration contract build around specific demand and related return assumptions.[10]

Figure 1: Problems with demand forecasting
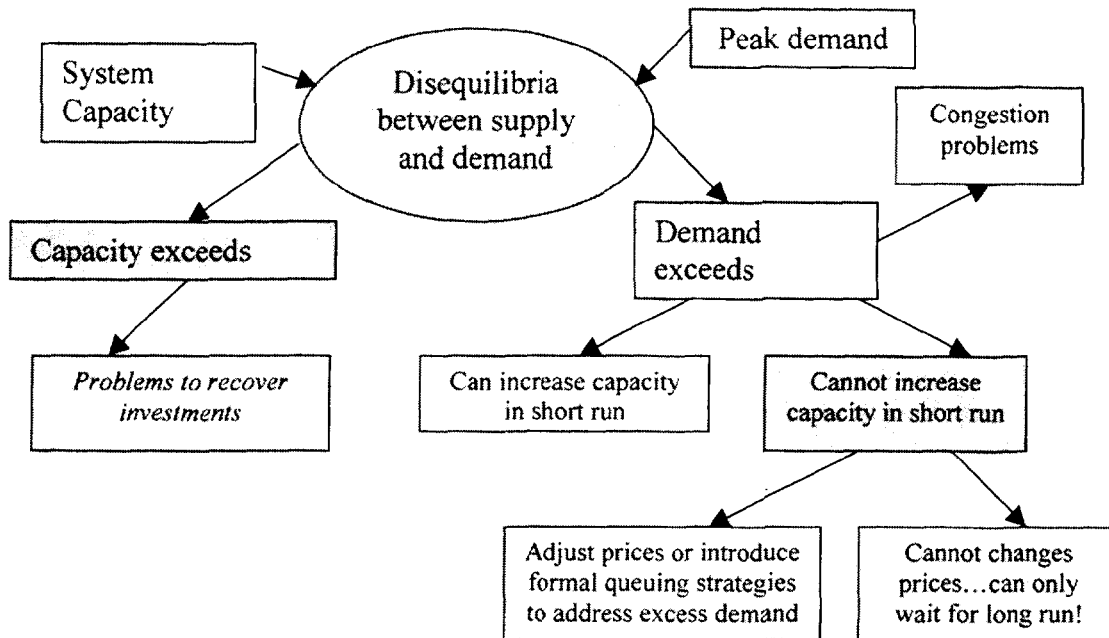
But mistakes do happen and there is enough experience to be able to argue that overoptimistic demand forecasting is common. For instance, traffic forecast for some of the most publicized toll roads projects overshot actual traffic from 25% (Cuernavaca-Acapulco in Mexico) to as much as 60% (M1-M15 Highway in Hungary or the average for the Mexican toll road program). Most of Asia's BOTs projects for toll roads were based on very optimistic growth assumptions pre-dating the fallout at the end of the 1990s.

A wonderfully detailed review of the main urban rail projects in 8 US cities by Don Pickrell (1992) provides similar evidence. It shows that the forecast that led local governments to advocate 10 rail transit projects over competing less capital intensive options grossly overestimated rail transit ridership construction and underestimated rail construction costs and operating expenses.[11] In 7 out of 8 cities, actual ridership was less than half of its forecast level. Skamris and Flyvberg (1997) provide a useful survey of the few publications documenting cost overruns and overoptimistic forecasts. Their conclusion is that traffic forecasts that are incorrect by 20-60% compared with actual developments are common in large transport infrastructure projects in a sample of countries including developing countries and the UK, Denmark and

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[10] Of course, the most cynical among our readers will try to argue that overoptimistic forecasts will eventually become realistic forecasts if demand is given enough time to grow to be consistent with the size of the project. Once more, whenever possible, this is what makes variable duration contracts attractive since they require a less precise forecast of demand.

[11] Pickrell, D.H. (1992)

Sweden. [12]Excess capacity is indeed resulting in a renegotiation of many road contracts in Latin America and East Asia[13] the users or the providers. It is for instance, difficult to re-use a railway or an airport runway and yet the builders have to be compensated. This is why to the extend possible, when demand is hard to forecast, it makes sense to try to follow a progressive or piecemall approach to investment. But this advise can be hard to follow (indivisibility of investment).

3.1.1.Why does overinvestment arise?

The first reason in the context of privatization is that one of the changes often brought by the private operators is the introduction of cost reflecting prices and a switch from taxpayers to users for the responsibility to pay for the service and an increase in prices.[14] If users are sensitive to prices, a regulator would want to know how much. Users shop around. If the use of toll roads is deemed too expensive, users look for free alternative itineraries—this is why the existence of substitutes must be reflected in the demand forecast. But these changes are also important because they influence available income and this in turn appears as the income effect in the demand estimate. Income elasticity also matters and this is too often ignored by governments and regulators. In sum, users are often more sensitive to prices and to "income effects" than expected. This is why when there is no or little tradition of payment of fair prices, the introduction of efficient pricing policies can result in significant trend changes and the past is a poor indicator of the future. Since many planners rely on trends to forecast demand, this can lead to significant overestimates.

3.1.2 What can a regulator do to deal with an overoptimistic forecast?

When the contract duration is fixed—i.e. cannot be changed without penalties or renegotiation--, the main option is to cut tariff or and subsidize the operator. From an efficiency viewpoint—i.e. to ensure that resources are allocated to their best use and that costs are minimized--, tariffs should be set at least to the short run marginal cost. From a financial viewpoint, this is not good enough since it does not allow the recovery of the costs of capital and hence results in a deficit. On the other hand, trying to include investment amortization in the tariff results in a demand inconsistent with the investment made—i.e. a lower demand than what the government may want to cover. This means that the optimal tariff reduction or subsidy will depend on the specific objective of the government. This objective will have to be spelled out for a regulator to be able to act in this kind of situation in a manner consistent with the political preferences without threatening the commitments made to the private operator.

One option is to allow the use of two part tariffs designed to allow the recovery of both operational and capital costs. The idea is to set a unit price equal to the short run marginal cost and at the same time to levy a fixed charge to recover the capital cost.[15] In practice, this is done

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[12] Skamris and Flyvbjerg (1997)

[13] . In most cases, the outcome is a longer contract and/or some explicit subsidy. Changes in tariffs are not that politically acceptable and hence more seldom used. But it may be useful to remind the reader that the renegotiation is not necessarily a proof of failure. In many instances, it means a better use of new information. In a nutshell, when considering the winners and losers of the renegotiation, the experience suggests that the users are often winners when they can get a better service from the private operator. The government ends up somewhat of a loser as they end up having to continue financing the sector through subsidies more than they had expected. In net terms however, the sector represents a lower burden on public funds than when the government was operating the sector.

[14] This is why prices often increase initially, but they will often increase as a result of clauses in contracts that allow the adjustments to changing macroeconomic conditions. Many private operators for instance will claim the right to be able to pass through variations in exchange rates or increases in inflation through tariff increases.

[15] From a more conceptual viewpoint, this allows a recovery of the cost from the consumer surplus.

by thinking of the infrastructure as a "club" and have frequent users pay an annual fee and then have them pay the marginal cost every time they use the facility. Occasional users who are not members of the "club" end up paying a higher usage fee every time they use the facility. This is in fact how many governments finance their toll roads. What is labelled a subsidy may sometimes be simply seen as a pass through of the revenue from the vehicle owners licence fee that finances some of the fixed costs of facilities. This device is mainly used for rail infrastructures and seaport traffics.

What is interesting from the viewpoint of the government concerned with the risks of having to pay subsidies, is that this pricing strategy can allow the operator to explore alternative forms of price discrimination between its users. It can recover the fixed part of the tariffs by differentiating it enough and adjusting it to the willingness to pay of all potential users. This tariff discrimination allows the recovery of a larger share of the investment than a flat fixed charge would allow. The rule would be as follows. First, identify the various user groups. Second set the fixed charge in relation to the degree of "dependency" the users have on the service. The groups most dependent on the service provided—i.e. the groups with the demand least elastic to prices-- will be charged the most—e.g. truckers who need to minimize transport time and cannot use alternative longer and slower roads. The groups most likely to drop out of the market when tariffs are too high—those with a demand most elastic to prices—will be charged the least—e.g. tourist who can also enjoy the scenery on the slower road. This is not as simple as it seems. For instance, the trucker working for an exporter of time sensitive merchandise may seem to be a "captive" client of the road, but if the fixed charge becomes too high, it may payoff to subcontract with a rail company. Similarly, it may be useful to be able to differentiate between a tourist and a commuter to charge more from the commuter but few politicians would take such a decision with impunity.

3.1.3   Politics vs. economics

The main problem with these solutions is in fact not technical but political. The policitican will not hurt commuters who are likely to represent its electorate and make life easier on tourists. For most politicians, a good tariff design is often like a good tax design: it exports the burden to non-voters. So what can be done in the case of an overoptimistic forecast? The answer is a bit cynical. First, if the earnest goal of the government is to minimize subsidies, it should not give up considering price discrimination. It "simply" requires a little bit of creativity and a strong commitment. Second, if this does not work, subsidies are the most likely outcome. In this context, the two part tariff idea is useful because it allows a better targetting of the subsidies. The government should focus its subsidy on part or all of the fixed part of the tariff. Often, in this context, to limit the costs of subsidies, the government will have to replace the willingness to pay concept by an ability to pay concept. This allows a focus of the subsidies on the share of the fixed part to that would have accrued to the poorest users of the infrastructure to ensure the need to achieve a financial balance does not result in an exclusion through prices of the poorest users. Finally, if this does not work or is not enough, an extension of the contract duration, or a slower investment requirement will generally do the trick. In fact, the Engel et alt (1997, 98) mechanism which avoid setting the term of the concession contract granted to an operator would avoid many of these problems...although not necessarily all of them.

3.2. How to deal with an overpessimistic demand forecast?

Undershooting demand is less common in the general context of transport privatization but it does happen and it is hence worth discussing briefly. In case of an overpessimistic forecast, the main outcome is a lack of transport capacity and hence congestion.This can be quite dramatic in the short run when it is impossible to revise investment plans to adjust quickly to the larger than expected demand. This is a common problem in urban transport modes, metro rides are often underestimated at peak time, urban access roads in many of the largest urban centers witness permanent traffic jams at rush hours and in some cases throughout the day as in Bangkok.

3.2.1.Why does underinvestment arise?

Underestimation arises for two main reasons: (i) privatization changes the perceived transport services, changing the nature of the demand and (ii) the reformers have failed to recognize the network aspects of the demand. The first effect is quite well documented in several of the suburban rail concessions in Latin America where demand was underestimated quite significantly. The main reason for the underestimation was that most policymakers were concerned that the potential passengers of the privatized services would be reluctant to pay for what they use to get for close to nothing. The source of the underestimation was the failure to recognize the existence of a rationed demand for quality. The passengers are actually buying a different transport product because they now get a safer, timelier and more reliable service.

There are many instances in which the demand for a specific mode is also suprisingly stronger because the supply of another mode is deteriorating unexpectedly or faster than expected.[16] More generally, when a forecaster at the project level does not take in account the interactions with a much wider transport network, it is easy to underestimate the derived demand stemming from the network characteristics of a transport system. Since the network externalities can go either way the sign of the correlation between the various modes is not always the same. An improvement in a bus system may improve the demand for train or for subways if it fucntions as a feeder as in many of the Brazilian Northeastern large cities. If these characteristics are not accounted for, demand will generally be underestimated and underinvestment or underpricing are the likely outcome. Implicit subsidies are created which can be addressed through changes in pricing strategies which account for the complementarity of transport services and infrastructures.

3.2.2 What can a regulator do to deal with an overpessimistic forecast?

If for whatever reasons, demand is temporary or occasionally stronger than expected but a long term adjustment in capacity is not needed, the short run solution generally recommended by economists is a temporary rationing through prices. This means that prices have to increase to ensure that demand falls to meet the available supply of infrastructure. The problem is more complex when recurrent or lasting congestion appears. One solution then is to set the toll or tariff equal to the long run marginal cost plus a markup to reduce demand. The revenue from the markup over and above what should be the optimal price can be signficant if it is not dissuasive enough and could be allocated to finance new infrastructures. Part of the demand may disappear as a result of this pricing strategy and never return if the prices are not adjusted down again.

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[16] The underestimation of demand for a mode can mean the overestimation for a competing mode....

This also illustrates the importance of serious cost-benefit analysis in projects which detailed analysis of willingness to pay under various environments.

The problem with the pricing solution is a political one in the context of privatization. There are many episodes in which toll or fare increased have lead to riots and regulators or politicians are thus reluctant to engage into pricing changes that are too sensitive politically. A more general solution that can address this problem is to avoid fixed term contracts with varibale fares and to award variable term contracts with set fares or fares subject to minimal changes. Under a flexible duration contract, if the demand is stronger than expected and capacity increase is needed, the operator keeps the business for a duration that is consistent with the investment recovery time at a given fare or toll level. This approach is increasingly popular in the transport sector and is the de-facto outcome of many renegotiations in Latin America as discussed in Estache (2000).

3.3 Summing up: the need for accuracy

This brief overview of the various ways of getting demand forecast wrong clearly shows that there is room for improvement. But it also shows that regulators have at their disposal various instruments to fix things when they are wrong and better yet to it get it right the first time around. This is fact often the best solution. Indeed, once the government has decided to rely on private operators to provide transport services and infrastructures, it is getting into a permanent relationship with these private operators. Their interactions create a history and both sides build up a reputation during the development of this history. A government prone to mistakes will expose itself to tougher negotiation with the private operators and increase the incentive operators have in contesting regulatory decision on the basis of the doubtful value of their supporting analysis. A strong regulator with a record of sound, well founded decisions will not have to give in-complex and tense renegotiations. Moreover, a reliable predictable regulator also implies a lower regulatory risk. This is turns means that private capital requires a lower rate of return and is hence easier to attract. [17] In nutshell, even if regulators have instruments that allow the correction of forecasting mistakes, these corrections are generally not challenge-free. This is why investing in getting it right to from the start may be the best strategy to begin with for a new regulator. Since this means considering the construction of demand forecasting models early on in their regulatory tenure, it is be useful to briefly review the theory and practice of demand modeling and forecasting.

4. The main forecasting methods

As any basic microeconomics textbook would remind the non-specialized reader, the demand for a transport service or infrastructure is the economist's jargon to describe the measure of the willingness to pay for this service or infrastructure. A well documented study of demand should allow the regulator to track down how the use of these services or infrastructures will change with changes in the fares or tolls charged by the operator but also with the income level of its users and with the environment in which these users function. It is quite important indeed to recognize that the demand for transport is a demand derived from the demand for other activities because it is an input into these other activities. Roads, railways or ports are used by productive sectors to distribute products or send staff to represent them. Individuals travel to work or to visit places. Few travel for the sake of travelling.

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[17] Alexander, Estache and Oliveri (1999)

All this means that a regulator interested in forecasting demand must understand the various sources of the demand for a specific service or infrastructure and their interactions—i.e. the demand for metro services is influenced by changes in the bus fare; or a recession reduces product shipments but may also employment and hence the demand for workers' transportation as well as the average income of the potential users of the transport services or facilities. This is quite important when transport privatization takes place in the context of a restructuring economy in which severe industrial and employment adjustments result in dramatic shifts in the nature, composition and level of the demand of transport.

While the demand for transport can be studied at the very aggregated level and the level of expenditures allocated to the transport sector in the macroeconomic accounts provide useful information on overall trends, it will generally not be sufficient to generate the information needed by a transport privatization commission or regulator. The analysis of the demand for transport required to simulate the effects of various combinations of quality of service (travel time, frequency, coverage, reliability,...) and fare or toll levels or to assess the impact of regulatory decisions requires a much more "microscopic" study of a specific geographic network. It will have to be designed to the allow the assessment of the network effects of the various combinations of prices and quality considered by the government on traffic levels for each mode for each segment of the network while accounting for a large number of specific socio-economic characteristics or similar determining factors. In general terms, these factors are all picked up in the various stages of the classic transport modeling efforts.

The "classical" theory supporting the modeling of transport demand for a specific transport infrastructure or service has a strong microeconomic foundation, that is a strong concern for an understanding of the specific factors that influence users of transport infrastructure or services. It is however framed into a more general framework which reflects the strong influence of more traditionally engeneering approach to the processing of data. It starts with a clear assessment of the area to be covered by the transport service under study. The next stage is to divide this area into various zones and to collect detailed information on each one of these zones. This data includes population levels, activity types and levels, employment, commercial areas, educational and recreational institutions,...and a detailed analysis of the travel patterns and preferences of the users. The information is then processed in 4 stages to determine transport demand: generation of trips, distribution of trips, modal choice—which is where most of the economic underpinning of demand modeling is introduced--and route selection. [18]

Although in theory all types of transport demand can be conceptualized this way, in practice, however, the approach has been essentially followed for urban transport, and to a lesser extent for intercity rail passenger travel. Moreover, the analysis of demand for other transport infrastructures or services has generally focused more on the analysis of modal choices and in some cases of route allocation, the stages at which the key variable relevant to a regulator such as quality are explicitly adressed and the stage at which actual demand models are estimated. This classical model is slowly being adjusted by practitioners to better reflect the activism of users. When congestion is an issue, a research field is to also model explicitly the preference for the choice of departure or arrival time of the users. In addition, there is a recognition that the generation and distributional choices are increasingly complex in many instances as the options are increasing (probably most importantly the recreational options).

Table 1 synthetizes the classical steps of demand modelling and the main regulatory each stage can adddress. Annex 1 provides some insight into each of these steps. The more analytical

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[18] This approach is most typically associated with the forecast of passenger transport demand but conceptually it can easily be adopted to describe the various stages of the determination of freight transport demand as well even if there are very few studies which have done so explicitly.

aspects of the various stages of the classical transport model are presented in the Annex inspired by Ortuzar and Willumsen (1994) . While these stages are still the norm in the sector and many extensions are still finding their way in the applied litearature, they have serious limitations which cannot be ignored. For instance, the idea of showing the transport problem as a sequence of 4 sub-models implies an order which is not necessarily realistic.

Table 1. The "classical"stages of the idenfication of the demand for transport

Stage	Transport decisions	Policy and Regulatory Issues in the context of privatization	Modeling
Trip generation	How many trips does the user based in some specified location wants to take in day/week/month?	Is there an obvious unmet willingness to pay for improvements in services which could be met by a new project or a concession to improve existing services?	Land planning and zoning
Trip distribution	Where is the user going with each trip among all possible destinations of interest to the transport service provider?	What would be the optimal size of the project to be packaged for private sector participation?	Origin-Destination matrix
Modal distribution	Which transport mode does the user adopt for each trip? What are the factors influencing that decision and to what extent	What price-quality combination should the privatization commission aim at and how much margin should the regulator give to the private operator to adjust price and quality given the overall objectives of the "privatization" Also, how much coordination is needed between different modal regulators (if these are at different government levels for instance)	Demand models -Agreggated -Disaggregated
Route allocation	¿Which route between the origin and the destination does the users pick under various types of service packages? (most important for roads and rail)	How do pricing (including access pricing) and quality rules influence the efficient use of the transport infrastructure?	Network simulation models

A more modern vision is now increasingly common and recognizes that the behavior of users needs to be modeled as economist would tend to recommend. This vision must allow for changes in opinion with changes in transport characteristics (e.g. congestions) and it must allow for flexibility in the face of very different time and data constraint. As illustrated by the next section, the most effective practioners seem willing to learn from theory and improve their odds of successful demand forecasting. This is clear in the modeling of demand in the railways sector and in urban transport. Some of the sectors seem to be more resistant to make the most of opportunuties offered by theory focusing instead on increased sophistication in data analysis through econometrics and expert opinion as is the case in the ports sector and to some extent in the airport sector (see section A.3.1. of the annex).

5. Demand forecasting in practice

This section describes some case studies to illustrate the ways in which regulators, privatizers or planners have used the various demand forecasting described in the annex. It covers examples in which demand forecasting is used in activities which were privatizes as is the case for the Mexican suburban rail and the French toll roads. It also presents cases in which the public sector is still very much a key players as for the Spanish airports and the Belgian ports. In some instances, the experience with the use of modern demand forecatsing techniques is too recent to be able to do a *post-mortem* comparing forecast and realized but since to the extent that they signal a trend characteristic of their specific sector, the exemples are quite informative. To the extent possible, the process and the degree of use of the information generating by the forecasting teams is discussed to illustrate the importance of the political decision to use the information for its relevance in the regulatory process.

5.1 Mexico City Commuter Train Project[19]

This case is a textbook approach to demand forecasting.[20] It involves a decision in 1998 to invest in a commuter rail line to reduce pollution and congestion in Mexico city. Over 70 percent of the Mexico city transportation market traveled exclusively by road in 1994 when out of 20.5 million total weekday trips, buses accounted for 48%, cars 24% and metro 2%. Two or more public modes were used by 22% of the travelers. The main concern was to forecast how effective the commuter rail would be in capturing a sufficient share of this market. The demand projections would be used to increases the transparency of the prospects to any potential private investor but also to develop the capital and operating program for the commuter service, the financial analysis which would eventually be used by the regulator to estimate the requirements of financial support by the government.

The data available was reasonable although not perfect. The forecasters could rely on a 1994 survey of trips origin and destinations in Mexico city conducted by the Mexican National Institute of Statistics. They also has estimated trip growth rates to allow an update of the matrix. These growth rates (1.2% average annual from 1994-2030) is based on population growth estimates and land use trends. Data on the characteristics (trip time, costs, frequency, reliability…) of bus, commuter rail and metro travel in Mexico collected by a local consulting firm and a couple of traffic counts at key locations in the corridor. The forecaster then conducted a stated preference survey of potential commuter rail users to estimate users preferences for alternative public transportation modes. The demand is based on diversion from other modes of public transportation only (buses and metro). It excludes diversion from cars (to get a lower bound) and ignores induced demand as well. The results are then introduced into a model generating trip volumes for the commuter rail. It includes up to 2030 estimates of annual passenger demand, annual passenger-kms, demand on weekdays and weekends and boarding and

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[19] Based on: Mercer Management Consulting (1998), "Commuter Rail Demand Study for the Buenavista-Huehuetoca Line", prepared for the Mexican Communications and Transport Secretariat

[20] Another , less "textbooks", set of very relevant illustrations is provided by D. Pearmain (2000), "The measurement of users' willingness to pay for improved rail facilities", in Ortuzar (2000), op. Cit.. It includes a brief survey of the UK experience with WTP methods and a couple of examples illustrating some of the implementation difficulties of the stated preference method in the context of a variety of decisions potentially important to regulators such as the extent which investment decisions in facilities impact on revenues.

lightings by station. The consultant also identified the main sources of uncertainty which could invalidate the forecast.

The stated preference survey had a crucial role. It generated data on the preferences, recent trips and demographic characteristics of 800 potential commuter rail users in the corridor— including quotas for time-of-day, age and gender of users. The respondents were recruited at 16 bus stops in or near the corridor from 5 am to 8.30 pm and were offered a fee of up to 200 pesos to participate in the interview. They were offered the option of being interviewed at their home or and an interview site next to the bus station. On the interview day, they were guided though a 30 minutes computer-based interview.

The questionnaire was designed to estimate the trade-off between time, cost ad other service factors. It essentially asked the user to pick among of alternatives differentiated according to walking time, waiting time, time in mode (bus, rail, subway), total trip time, total tip cost and total number of transfers. The experiments were customized based on the attributes of the intercepted tip to ensure realism. The choice experiments clearly show that potential users place different values on walking time, waiting time, in-vehicle time and transfers between modes. They value their time at 3 to 9 pesos per hour (roughly UScts25 to 75) depending on the use of time. In contrast to other locations where in-vehicle time seems to be preferred to walking time, Mexican seem to generally perceive time spent walking comparable to time spent traveling. Mexicans prefer to spend time walking to travelling than waiting (as anywhere else). They see transfers as equivalent to 13-15 minutes of traveling. This means that the speed advantage of subway or commuter rail transfers is offset by 15 to 30 minutes for 1 to 2 transfers. Overall, they prefer the commuter rail to bus or metro (but this may be biased by the perception of additional security).

The network data is used to assign each trip in the total market to a specific mode or combination of modes based on the user trade-offs between travel time, cost and modes obtained from the survey and on the characteristics of each model. This is done for the proportion of trips for each Origin-Destination pair that will travel by each mode of transportation. The specification of the modal choice model is a nested logit structure with the following mode combinations: (1) bus only, (2) metro only, (3) metro and bus, (4) commuter rail only, (5) Commuter rail and bus) and (6) a commuter rail, metro and bus option. The choice of mode is estimated separately for each trip, taking into account the distinct preferences of the person making the trip with respect to age, gender and other factor.

The model is calibrated to allow the reproduction of time and cost in 1998 for buses and metro and generates a commuter rail demand for each average week day assuming that commuter rail fares are set equal to the bus fares of 0.28 pesos/km. More specifically, the demand model estimates the probability that a person will choose a particular mode for their trip *for each of more than 90,000 public transportation trips*. This information is then used to estimate demand for each transportation mode for weekday demand. So for any pair of origin and destination, it computes the total trip time, the cost and the number of transfers and on that basis it estimated that the user will pick any one of the 6 travel options identified earlier. This week day demand is discounted for weekends. For the subway, this is done by applying a factor of 0.58 based on traffic counts. Annual demand is equal to weekday demand multiplied by a conversion factor for each mode as well based on a traffic count. Prospects are quite good and are likely to grow even better with an annual weekday demand for commuter rail services of about 150 million passenger in 2005 getting to over 200 in 2030.

There are some serious caveats also quite important to assess from the viewpoint of a regulator. There may be a certain degree of diversion from expected traffic due to increased use of vehicle due to changes in travel habits. On the other hand, congestion may get worse and

diversion in favor of public transportation may result in an underestimate of demand. The behavior of bus services may also have a strong influence since they are quite an important feeder service. Increases in waiting time for bus services could hurt the demand for the commuter rail. All these assumptions can be quantified through relatively simple simulations and allow the regulator to better assess the risk and ...compensations if needed.

5.2 Willingness for urban toll roads in France

Toll roads have been extensively developed in France, since the 60's. Their total length amounts to roughly 7000 km. But these toll roads are mainly intercity motorways for which traffic forecasting is a rather easy task as network effects are rather small in intercity roads ; generally speaking there is just one competitive road and the main problem is to assess the split of the total traffic between the toll motorway and the competitive road. Furthermore, a long experience exists and traffic models for these situations are well calibrated and provide good fits with the reality. This is not the case for urban toll roads, which begin to appear in the largest agglomerations. There are few lessons from the past, and network effects are so large that it is not at all straightforward to estimate the sensitivity to competition or complementarity between routes. This is why the effects of the level of tolls on the traffic of the motorways have to be much more carefully studied than for other types of roads. Currently this is done in France by relying on rather large econometric models. One representative exemple is now in operation in Ile-de-France, the region which surrounds Paris and is almost full urbanized with about 11 Millions inhabitants.

The models used to forecast traffic on new infrastructures in this area are classically built on a four steps basis. Demand data are drawn from household surveys (16 000 households) updated every 5 years, and provide trip matrixes for several purposes of travel : job, non job, and for duty vehicles. The network supply is defined by nodes and arcs linking these nodes. Arcs represents the links between each modes; they are defined by technical characteristics such as their length, the cost and speed, safety, comfort ...While this is all quite reasonable and standard, the details of the modeling are not always relying on the frontiers of the applier theory. For instance, modal choice is taken into account through a very crude model. Also, for traffic generation and distribution, the O.D matrix is drawn from current data, and induced traffic is determined as a fraction of cost decrease of each O.D relation.

The traffic model is run first to reproduce the current situation, and its parameters are calibrated so as to minimize the sum of the square differences between present and reckoned traffic on each link. Then the model is run with the new planned infrastructure, and it is run several times, for different values of toll.

More precisely, traffic modelling is developped following the following steps[21] :

Step 0, Before the study : Setting up the traffic modelling framework (the "Modèle global de la Région Ile de France"). This step is done by the regional branch of the Department of Transport, which usually runs the model ; the underlying work includes gathering data on supply (network description and encoding), demand (socio-economic characteristics of the zones into which the total area of the study is divided) and traffic countings. The result is a

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general calibration of the parameters of the model, providing Origin-Destination matrices, and traffics calculated by the model on each link of the network.

Step 1 : Calibration of the model for the year of implementation of the planned investment. This calibration is done by the franchiser, usually the political body in charge of the Région Ile de France or the Department of Transport. It corresponds essentially to an updating and a fine-tuning of the previous step.

Step 2 : Analysis of how the network works. This step is a zoom of the previous step over the area around the planned infrastructure. It is implemented by the public authority and and is designed to highlight the potential problems: where is congestion, what are the areas with low accessibility indexes...This step helps to determine the precise scheme to be achieved, for instance the number of lanes, the design of the interchanges...

Step 3 : Definition of the reference scenario. This step is also implemented by the public authority . It defines the network and the socio-economic characteristics for the various key years of the study if the planned infrastructure were not achieved. It also identifies the alternative investments which should be implemented,the regulatory measures needed and their effects on the growth and structure of traffic.

Step 4 : Calculation of the traffic in the reference scenario. The outcome of this step , run by the public authority or its traffic consultant, is to apply the "modèle global" to the reference scenario. Traffics on each link and for each mode are calculated, along with travel times, monetary costs...

Step 5 : Policy simulations. In this step the network includes the planned investment to be evaluated ; the model is run for several key years for which there is a change either in the network or in the demand. Comparison between steps 4 and 5 allows to set up the main changes between the reference scenario and the planned scenario. The conclusions are both quantitative (the rentability of the investment, cost –benefit indexes, accessibility indexes...) and qualitative (where does congestion remain, what are the possible effects on the urban development...). Usually the model is run several times, each time with a different value for tolls. It helps at setting the proper toll.

Steps 6 : Interacting with the bidders. These results are provided to the bidders, who achieve their own traffic study on those basis. They are allowed to suggest modifications to the planned investment ; they achieve their own profitability study, and deduce the toll structure and levels that they include in their bids, as well as the possible subsidies or securities they ask to the franchizer.

It is clear from this process that the public authority has in Ile de France a good knowledge of traffics and traffic modelling : it is at the source of the data used in the traffic modelling of the bidders; it operates his own model which allows to establish a diagnosis of the transport problems to be solved, and to set up the possible solutions. Its expertise in this matter allows him to audit the bids, to screen them and to rank them, to discuss with the bidders about the traffics, the subsidies and the tolls. As far as toll are concerned, the results generated by the model are quite typical results: as long as toll increase, traffic on the new infrastructure decrease. Revenues from the toll, which are the produce of the toll and the traffic, follow a Laffer curve--they first increase up to a maximum and then decrease. The toll which maximizes revenues for this specific toll road system is rather high, about 1$ per kilometer.

It is possible to calculate a profitability index associated with each toll. The profitability for the operator is maximal for the toll which maximizes revenues i.e. 1 $ per kilometer. The collective rentability is different from the former ; it takes into account, not only the revenues of the infrastructure operator, but also the consumer's surplus and the consequences on

environment. Collective rentability is maximal for a toll equal to zero a situation where the highest number of users benefit from the new infrastructure. In practice the toll regulation tries to reach a toll a bit below the toll which maximize the revenue, in order to get a revenue close enough to the maximum level , in order to make the motorway just profitable for the concessionnaire, without driving too much subsidies from the government, while managing the political sensitivity of the introduction of tolls. Increasingly also France is learning from some of the conflicts it has gone through between users unwilling to pay and local governments constrained fiscally. The decisions on the tolls are now set to levels consistent with the ability to pay of the majority of the potential users.

5.3. Forecasting Port Traffic in Antwerp[22]

Forecasting techniques used in ports tend to fit into strategic planning programs. This is important in the context of restructuring (how many ports do you really need in your country?) but more generally for most common evaluations of port expansion projects (e.g. new terminals, dock, hinterland projects,...). Most casual observers would recognize that macroeconomic trends and reforms (trade liberalization, labor market reforms,...) and the specific characteristics of each location matter but recent progress in logistics techniques and technology are also revolutionizing the demand for port activities and this needs to be taken into account by port regulators.

Consider the port of Antwerp. Located about 70km from the North sea, it stretches for some 20km along the banks of the Scheldt river. It enjoys an international maritime traffic over 115 million tons/year, sees over 16,000 ships every year and is one of the five largest ports in the world. It loads (about 1.6 million TEU), unloads (about 1.6 million TEU), stores, repackages, distributes and forwards goods. It has dedicated terminals for many commodities and handles dry and liquid bulk containers. The container traffic is about 35 million metric tons, 61% to roads and 25% to waterways. General cargo represents about 60% of the traffic. The port employs almost 70,000 people. It is subject to a strong competition from various ports in the Hamburg-Le Havre, a critical fact which makes forecasting all the more important.

Antwerp has been forecasting traffic formally since the late 60s. The Transport Economics Department of the University of Antwerp has been very active in helping the port authorities with the management of the port in general but in particular with these forecasting efforts. This is coordinated in fact by a special unit of the port, the Study centre for the Expansion of Antwerp (SEA). SEA has generally had a very clear preference to prepare a base forecast to be complemented by more detailed information and insights to be provided by experts. This approach is quite common in OECD ports and this is why it may be worth to describe it in some detail.

The whole exercise is based on a base model used to forecast for two main commodity groups, bulk traffic and general cargo. An optimistic and a pessimistic variant differentiated by the forecast of macroeconomic conditions in the OECD countries are worked on for a series of specific traffic group. Bulk traffic is divided into 10 standard categories (agriculture, food and food stuffs, solid fuels, crude oil and products, minerals and ores, metal products, raw materials, fertilizers, chemicals and machinery and vehicles not included elsewhere). Initially, for general cargo, loadings and unloadings, were pooled together and an aggregate figure was forecasted.

[22] This section is based on , Coeck, C, A. Verbeke and W. Winkelmans (1996), " Back to the Futute: an Evaluation of Traffic Forecasting Techniques used in Antwerp and Rotterdam", pp. 3-26 and Verbeke, A, E. Declercq and D. Teurelincx (1996), "The future growth of contained traffic in the Port of Antwerp", pp 51-70, both in Winkelmans, W. and T. Notteboom (eds), The issue of prognoses in maritime transport and seaport production in Belgium and Poland: a conceptual and empirical study., Garant, Leuven, Belgium

Since 1985 they have been disaggregated and analyzed for both containerized and non-containerized traffic. The analysis of the disaggregation of cargo looked into imports and exports figures for the country, transshipments and transit figures and origin/destination relations.

Forecast consists essentially of extrapolations provided by an econometric modeling of the historical traffic. The main explanatory variables for the future of traffic are taken to be: (i) the general business cycle and trends variable in Belgium (the evolution of the share of exports and imports in GDP and the evolution of industrial production) and a similar variable in a large range of trading partners (an index of GDP in the EEC, the USA and Japan), as well as international trends in containerization, the specific variable depends on the traffic to forecast; (ii) the competition (remember that there are many competing ports close by); (iii) the microeconomic features that make the port interesting for specific traffic (it is the second petrochemical port in the world for instance).

The 1996 Masterplan for the port shows how the quantitative part of the forecast was made for every major traffic groups. For general cargo, the variable used to pick up the business cycles and trends is an index of GDP in the developed world (EEC, USA and Japan). For bulk cargo, the driving force is assumed to be industrial production in the EEC. For both cases, the importance of competing ports in determining prospects is taken in the Hamburg-Le Havre range which covers all the major competing ports. It is summarized into Antwerp's market share in this corridor. The plan also presents a qualitative forecast. It covers an assessment of general cargo traffic disaggregated into specific commodity groups (iron and steel, non-ferro metals, fertilizers, wood products, vegetable and fruits, grains and animal fodders, rolling material, flowers, sugar, food and other. For bulk traffic, the experts are asked to consider ores, solid fuels, grains and animal fodder, fertilizers, sand, crude oil and chemical products (including petro-chemical).

Overtime the quantitative models' performance disappointed and it became increasingly used only to supplement a more qualitative approach. Indeed, the quantitative model was overestimating quite significantly (between 16.5% for general cargo and 37.3% for total seaborne cargo). The qualitative method generated an underestimate of 1.6% for 1985 when it was first used (with a deviation of +9.1% to −14,6% for different targeted activities). This is why the qualitative approach is in fact used to generate information which is then built-in the more aggregate quantitative forecast of the demand for port services (in terms of tons) .

But forecast modeling is an evolving science also in ports and the amazing growth in containerized traffic is generating interesting progress in the field as seen in the case of Antwerp as well. The initial step is to estimate how the overall macroeconomic prospects influence the overall general cargo traffic (defined as conventional cargo traffic + container traffic + roll-on-roll-off traffic) in the competitive region (i.e. the Hamburg-Le Havre market segment). This is taken to follow a simple trend in which an increase in 1 point in an index of the world GDP results in an increase of 2.307 in general cargo traffic in the corridor (but this effect is reassessed every year using the latest information available on the linkages between the two variables). The future containerization rate is the next aspect forecasted. It is also an extrapolation but it recognizes that the degree of containerization is limited and the growth will eventually start to decrease. This drives the choice of the functional form to a semi-logarithmic function (i.e. the degree of containerization (Y) is explained by the logarithm of a time trend (T): $Y=.61+.04 \ln T$) but the specific parameters of this equation are picked by experts rather than simply estimated analytically from past data . Jointly with the first step, it yields an overall regional containerization forecast which is an average figure since the experts recognize that its evolution will vary for the various departure/destination combinations. This is then used to generate a traffic forecast for containers in the corridor. In 1996, it was expected to increase from 140.6 million tons in 1995 to 184.5 in 2000 and 227.5 in 2005.

The assessment of the market share of the port of Antwerp is then needed before coming up with its container traffic forecast measured in Twenty Feet Equivalent Units (TEU), the standard measurement unit for container traffic. For the 1996 Master plan, the working assumption was that the market share of the port of Antwerp would remain the same at 18.4%. This results in a forecast of traffic increase from 25.8 million in 1995 to 33.9 in 2000 and 41.9 in 2005. [23]

To most purist, this is a very subjective approach to forecasting. But it is worth recognizing that this is how it works in many places. Most port projects which these authors have had to review followed the line described here. It is obvious that the analytical part of the project is weak. The quantitative methods used did not work but it is very likely that they could be improved with recent development in the analysis of time series. In the short run however, the proof is in the success of the forecast. The forecast reported here were made in 1996. They resulted in an underestimation since actual total container traffic had reached 35.4 million tons at the end of 1998 already.

5.4. The forecasting of Traffic in Spain's Airports [24]

In Spain, the forecasting of air traffic is done by a public entity, Aeropuertos Españoles y Navegación Aérea (AENA). The process is itself revealing and involves many of the approaches discussed earlier. Demand is forecasted quite technically at the airport level but the aggregate demand is the result of meetings of all the airport managers who decide collectively on the future investment needs and allocation. In general, the demand forecast distinguish between short run, medium run and peak traffic. Peak traffic forecast is needed to know when and what to do with prices in the short run to adjust demand to capacity. These estimates are compared with estimates made by users of the airport services to test for their robusteness.

Short run forecast is based on time-series techniques—moving averages, exponential smoothing and ARIMA models. They are designed to generate forecasts learning from past forecasting mistakes. They generate monthly estimates for a 12 months period for national and international traffic for all airports. Medium and long run forecasts are based on econometric models which reflect the complex interactions between mutliple variables. These are used to make forecast to 5, 10 and 15 years horizons. Figure 2 shows how AENA proceeds to come up with these estimates. This is done every year during the first quarter of the year.

Figure 2 shows that the forecast is based on past traffic trends but also on regional, national and international determinants of business cycles but also on the tourist traffic, the possibilities of substitutes offered by other transport modes and airport specific characteristics including the number of airlines present in each airport, their capacity, the size of the planes reaching each airport and their degree of occupancy. It also shows that the specific forecasting process is actually done in two stages.

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[23] This is equivalent to about 3.1 million containers measured in TEUs (divide the volume expressed in 1000 tons by the average tonnage of TEUS (twenty feet equivalent unit) that were loanded and unloaded)

[24] This section is based on Trujillo and Jacob (1999)

Figure 2: The process of forecasting demand for the medium and long run at AENA
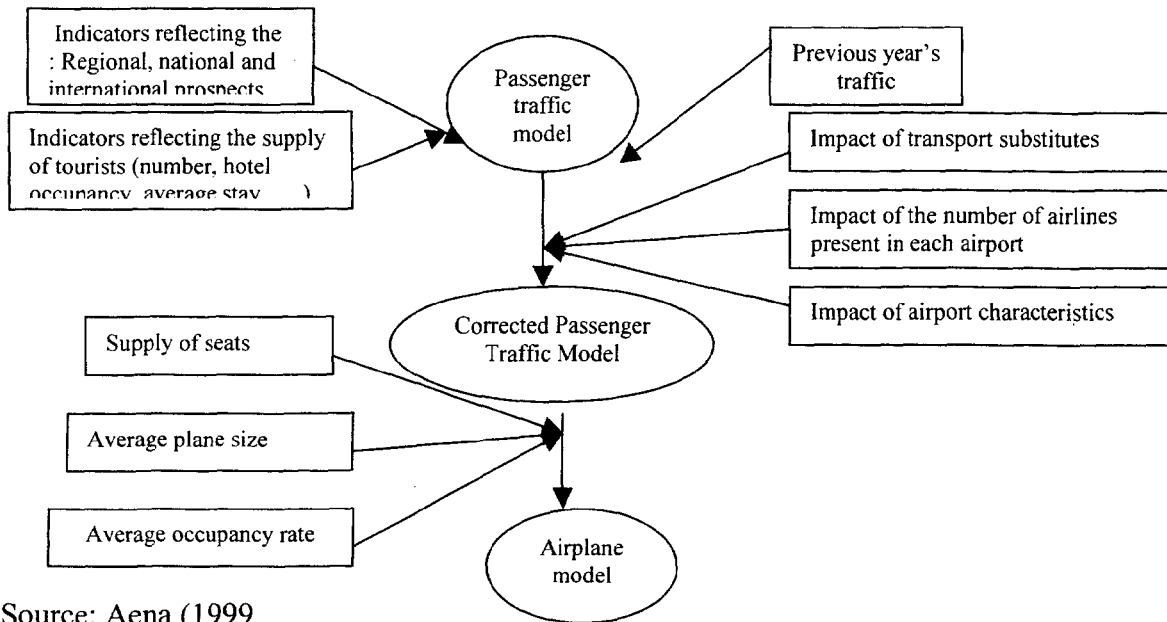
Source: Aena (1999

The first forecasts national and international passenger traffic independently as follows:

- national

$$PAXDOMt = kPAXDOMt -1^{\alpha} \; PIBespt^{\beta} \; PIBregt^{\delta}$$

- International

$$PAXINTt = kPAXINTt -1^{\tau} \; PIBespt^{\phi} \; PIBint^{\Omega} (TURt^{\upsilon})$$

where,

PAXD and *PAXINT* are national and international passenger traffic respectively; k is a constant factor and $\alpha, \beta, \delta, \iota, \phi, \Omega, \mu$ are the elasticitis to the key explanatory variables which include *PIBesp, PIBreg, PIBint* the variables reflecting national, regional and international GDP repectively and *TUR* which reflects the number of tourists, the degree of occupancy of hotels, the average stay duration, ...).

In a second stage, the regulator constructs a model to forecast the airplane traffic for each destination, relying on the passenger forecasting models just described:

$$AER_{j,t} = PAX_{j,t}/(TMA_{j,t}FO_{j,t})$$

where *AER* is the volume of airplane traffic, *PAX* is the volume of passengers traffic estimated in stage 1, *TMA* is the average size of airplanes, *FO* is the occupacy rate, *j* is the traffic segment—national or international. The model is quite effective. Forecasts done in 1997 for 1998 was only 0.13% off.

For the longer run (over 15 years), AENA relies on the *Delphi technique*, . the subjective method described earlier. First, AENA selects a representative sample of experts to consult. Next it prepares an initial questionaire submited to these experts for comments. The corrected questionaire is then sent to the experts to obtain their first individual estimates.These experts are then fed the results and the process is reiterated as long as needed to obtain a convergence of views.

AENA also makes forecasts for peak demand. This is important because AENA tries to minimize the number of peridos during which capacity is idle. In order to design its pricing policy to meet this objective, it needs to have a reasonable forecast of the distribution of peak demand over time and space. Both for passengers and airplace peak demand estimates, the model estimate related peak demand to annual traffic in the following way:

$$(PHP / PT)\% = K(PT^{\alpha})$$

where, *PHP* is the number of passengers at peak time and *PT* is the number of total passengers.

This aspect is unfortunately not very successful because the airlines are not too concerned about it. Indeed, the share of airports costs in total costs is quite small for most airlines. Moreover, for airports with a strong tourist clientele, the demand is quite insensitive to price and this makes it very difficult to rely on prices to adjust to the "use of the capacity" to demand. Excess demand and excess capacity continue to be a problem in practice (AENA, 1999).

6. Practical tips to come up with a useful forecast

Generally, forecasting in transport is based on a combination of various methods. Table 2 summarizes the main steps to follow in picking a method. This is of course a very rough set of tips but they are based on common sense for situations in which most regulators are faced with in developing countries.

Table 2 . Tips on getting rough forecasting right

Before study
• Past trend analysis • National and international economic developments • Competition from close substitutes • Forecast made by transport service companies • Expectations of traffic published by complementary industries • Forecast of peak periods • Technical development of transport means • Check out the budget constraints for the demand study • Check on data availability to decide how much to invest in data
After the study
♦ Comparison with traffic experienced in similar situations • Elasticities of traffic to prices • Achieve sensitivity and risk analysis

6.1 Before the study

To begin with, it is generally useful to have look at the past trend of the type of trip the analyst is expected to forecast. Quite suprisingly, this can be a challenge as the quality of data available from transport ministries has tended to deteriorate over the years. Assuming that enough data can be collected, it it is generally not a good idea to stop there.It is worth finding out more about the economic context in which the transport project under regulatory scrutiny is operating. The national and international environment often have an impact of these projects. So do the development of alternative transport options which can be a complement or a substitute. This can help the regulator decide if a quick decision is necessary. In West Africa, Senegal, Mali, Ivory Coast and Guinee currently have a portfolio of competing rail and road projects for which the rate of return and hence the possibility of attracting private financing is directly related to the speed with which the governments willmake the decision. Demand will go and mostly be locked in the hands of the first movers. Many of the key decision makers have a hard time appreciating the importance of speed for the demand for their transport services because they are not paying enough attention to what their neighbourghs are doing. The surprising fact is that this information is relatively easily available to a regulator or a policymaker since most of these projects are generally government initiative and are quite widely publicized. Moreover, many of the transport service companies interested in these deals have at least preliminary forecast which can provide good insight on the real prospects of a proposed investment project. It may be worth for regulators to find out more of these and to have them audited independently. Finally, complementary industries such as aeronautic or car builders also make their own forecasts for obvious reasons. All these are useful in educating a regulator in an initial stage.

Once these indicators of trend or prospects are internalized, it is often useful to try to identify potential peak demand resulting from exceptional circumstances which may justify fast increases in capacity than these trends would require. A city trying to sell itself as an great host for conferences must have the supporting transport infrastructure to deal with associated peal demands. Tourists airports also face a strong seasonality in peak demand. How much of these peaks the government is willing to address through increases in capacity and how much by allowing occasional congestion is a local choice--and it may make sense for a government to live with occasional or even seasonal congestion problems rather than overinvesting under tight budget constraints. The fact is that the regulator must be aware of the relevance of these occasional demand shocks in its assessments of the performance of the operators. They will often have the option of considering the introduction congestion pricing. If demand is in fact very little sensitive to prices in peak periods, it may pay off not to adjust capacity and to rely on prices to deal with peak demand.

Next, the regulator must ensure that technology developments are not interfering with demand forecast. For instance, the appearance of *fast ferrys* reduced the demand for conventional *ferrys* and this could result in unexpected shifts in demand as well as in financial drama for the operators of conventional ferrys. In the crossing of the Channel bewteen France and the UK, the introduction of new fast boats has resulted in a loss of traffic for trains riding through the tunnel and contributed to the well publicized financial troubles encountered by the tunnel operators. Similarly, expansions in capacity can also influence demand. For instance, the introduction of *post panamax* ships with a larger capacity to carry containers changed many investment decisions in ports since new technological constraints were appearing.

Finally, the regulator must look at its budget envelope. Most modern forecasting methods are quite expensive and to do a decent job, it is not uncommon to have to spend over $100,000

on a demand study. How to pick a method also depends on this, as much as on the data availability and the type of mode the regulators is focusing on.

Assuming that money is not an issue, in addition to the specific traffic type to be forecasted and the specific type of nfrastructure concerned, the ideal model will depend on a data availability, on how much detail is needed and on the specific goals of the forecast. Data provided by the historical operators of the service will help. For the most aggregated data this is generally possible but for more detailed data this can be a problem. Indeed, many operators will consider a lot of the relevant information to be confidential and would see as a threat to their commercial viability the obligation to disclose some data on their markets and clients. But on the other hand, precisely in the context of privatization, demand studies should be undertaken with the historical operator in preparation for the valuation of the assets to be "privatized"; this will also constitute a good initial data base for a regulator. In most countries, a useful compelemtn is data published by public (statistical offices) or private entities monitoring the sector. It is surprising to causal observers the number of think tanks or private survey firms collect and sell relevant information collected through regular surveys. Finally, all this can be compelemented by data produced through field surveys. The enthousiams for revealed and stated preferences is also generating vasts databases which often end up under a pile of dust after their initial use. A better organization of data bases should allow these surveys to become good sources of information to any regulator. Ultimately, the choice of methods will be driven by the data availability and for many of the most promising methods they new surveys are the way to go and do not require more than a couple of months to collect field data.

While data matters, the amount needed depends often on how much details are really needed from a regulatory viewpoint The devil can often be in the details but the cost of a survey is directly related to the level of detail that is needed. Of course, this depends on the questions at stake . If the concerns of the regulator is the potential payoff from the addition of service requirements such as a toilet or a business center in a train station, there are not too many alternatives to targetted field survey. But in many more general issues regarding prospects, fairly aggregate data can be sufficient as seen in the case of the port of Antwerp. The fact is that often the specific concerns are not well defined and this can results in wastes of time and resources. Targetting the issues also allow a better targetting of the data requirements and hence the design of demand studies and the choice of a methodolohy that meet their purpose in the most cost effective way.

6.2. After the study

Once the study is done, the job is not over. First, it makes sense to ensure that the validity of the results of the study can be assessed. A first benchmark consist in a comparison with th results experienced in similar situations elsewhere. It is of course difficult to find exact comparability but the "distance" between the situations can be evaluated and provide an idea of the "distance" between the results. It is often useful to request from the consulting team doing the analysis to provide a survey of their own studies or similar studies. This information should include a review of the elasticities of traffic to prices and cross-price elasticities when substitutes or complements are involved. In this context, conventional wisdom can also help and surveys can be consulted to provide first order estimates.[25] Last but not least, the study should provide a point estimate of course, or at least a narrow range. But it should also indicate how is the traffic modified under different assumptions for the exogeneous parameters, such as value of time,

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[25] For instance Oum,Water and Yong (1992) and Small and Winston (1999)

economic growth, petrol price, rate of exchange...The specific number of parameters should be picked by looking at the number of likely regulatory issues that are likely to emerge and for which regulator is likely to have to set conflicts. Safety, service quality and environmental issues are likely to arise and hence making sure that the appropriate elasticities are provided as part of the study for future uses.

7. Conclusions

Forecasting has long been a challenge. It will continue to be one for the foreseeable future. But the analytical instruments and the data processing capabilities provided by the latest technologies and softwares should allow much better forecasting than is observed in transport ministries or regulatory agencies. Privatization induces new needs for demand forecasting; it leads to pay more attention to risk than it is the case when investment is publicly financed. Furthermore the regulator has to be able to judge the traffic study made by the operators, and to find out the strategic behavior which influence these studies. For many governments and regulators the decision to avoid good demand modeling is driven by a lack of conviction that theory and models can do better than the "old-hands" of the sector. But this is particularly dangerous in situations in which the nature of the business is changing as a result of privatization. Another argument is that it is too costly. The fact is that for projects adding up to over US$100-200 million, a cost of US$100-200,000 should not be a reason to reject some effort to do reasonable modeling. In some cases, the forecasting firms are willing to sell their forecast with an insurance in case of significant gaps between forecasts and occurrences! These recent developments have to be balanced against the fact that bad forecast can result in rationing of or excess capacity which are not costless either. Subsidies are often a necessary outcome. Moreover, they can ruin the credibility of a whole concession program: a much costlier but often underestimated consequences of demand forecasting failures.

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ANNEX 1: The four stages of the classical model and their meaning for regulators

A.1 Trip generation models.

There are two main types of trip generation models. The first is the aggregated one which is essentially what the first generation of demand modelers focused on at a very aggregated level, the second is the most disaggregated approach which tries to model more explicitly the individual preferences. The aggregate model often provides a useful first order approach which eventually needs to be confirmed by more detailed studies.

A.1.1 The Aggregate Approach.

The aggregate approach determines the average number of trips for the population concerned by the project and some type of extrapolation of that information is used to forecasting medium to long run demand. This extrapolation has taken increasingly sophisticated forms and accounted for an increasingly large number of factors to explain future trip generation and hence demand. In general, the number of trips on any corridor between a specific origin and a specific destination (i.e. a road project or a rail project) will be explained by variables such as the level or type of activity or any other relevant general characteristic of the population. Consider the case of a railway company.

The general analytical form is expressed as follow:

$$T_i = k.r_i^a f_i^b$$

in the case of a project concerning mostly passengers, these variables would mean

Ti the average number of trips taken the potential transport users during a given unit of time (day/week/month) is the average number of trips per unit of time of the population of the city or neighborhood i.

r_i is the average per capita income of the potential transport users

f_i can be any additional relevant factor such as the ownership of a own vehicle in the cases of urban transport models,

$k, a\ et\ b$ are parameters

In practice, this provides a useful first order idea of get an idea of the future demand. Extrapolating the values of r and f gives a first order of magnitude. It easy to come up with because a lot of the required data is relatively easy to come by. In the case of trains for instance,

most public enterprises record a significant volume of data on volume carried, number of trips and the main characteristics of the largest clients for freight passengers or reasonable surveys of their client base. It is generally not sufficient to do much more than a valuable input into a more sophisticated analysis of prospects.

A.1.2 Disaggregated models

The second type of model is disaggregated and focuses on the individuals trip generation characteristics. The users' population and its movements are divided into homogeneous categories within which there is some degree of forseeability in the trip types and numbers. For instance, residence-office, work-related trips, private trips for private business, week end leisure trips and holidays leisure trips. The users of the transport service can then be classified according to more specific criteria: income, household composition and size, age, ownership or not of a vehicle, employment type and location characteristics.

The distinction into these various categories is important since it determines the various elements a private operator may consider in discriminating prices across users and usage types, explicitly through the design of tolls or other prices, or implicitly, through targeted discounts to frequent users. From a mode political view point, it is also important to use this kind of information to ensure that the poor are not penalized as users. [26]

From a regulator's viewpoint, their value is quite significant in particular in an urban transport context since it provides a snapshot of the users' constituency of this regulator. This in turn is likely to be critical information in most instances of conflicts between service providers and users. Indeed, the valuation of the service will significantly be determined by their individual characteristics and differences across users are important to understand for any referee or arbitrator which the regulator often is.

A.2. Trip distribution models

The distribution is the stage allocating traffic from a center to the various possible destinations and its use in the context of specific projects considered in the context of privatization is mostly concentrated in urban issues. An intercity road or rail project have

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[26] In practice, these models suggest great constancy of total daily urban or suburban trips (on average 3.5 per day per person for the last 20 years around Paris and between 3.2 and 2.4 in the country side). The main change is taking place in the modal choice with a significant increase in the use of cars. Motorized trip vary between 1.7 and 2.1 per day—increasing with the distance from the center (LEFEVRE et OFFNER (1990)). Also, while these studies in France also show an increase in the average length of the trip, the speed also increases.

essentially one destination, even if it possible to consider the inclusion of feeder services for other regions or connections opportunities. In many developing countries, the value of a road considered for private tolling depends on the existent of a supporting public network to enhance the commercial value of the private road. In many contracts in fact, concessionaire will demand the construction of this feeder road and the failure to do so is a reason for contract renegotiation (see Malaysia example). This is why the overall vision of an origin distribution important is generally important, even if it is true that it is significantly more important in an urban context.

Conceptually, an origin-destination matrix is almost always derived from a gravity model which can be justified in many ways and specified in almost as many forms. The oldest and best known is:

$$T_{ij} = k \frac{(P_i P_j)^a}{d_{ij}^b}$$

and: - T_{ij} is traffic from i to j

    - P_i et P_j are the potential users in i and j (e.g. population, number of firms)

    - d_{ij} is the distance between i and j

    - a et b are parameters

Some of the problems of this model is that its does not address differences in socio-economic profiles or differences in the economic nature of the firms covered (industrial, service,…?).

In practice, since most estimates suggested that the value of a is 1 and for b around 2, a more general formula is:

$$T_{ij} = kO_i D_j f(c_{ij})$$

and: - O_j is an "emission factor with origin i

    - D_j is an attraction factor by destination j

    - f is a decreasing function

    - C_{ij} is the generalized cost of trips between i and j

An unconstrained version of this model allows a good estimate of the elasticity of demand to transport costs and deals with both trip generation and distribution. It is quite common for inter-urban traffic studies. But the model can be subject to various types of constraints (e.g. limiting the total traffic and some aspects of the traffic exogeneously or limiting total costs). The challenge is to specify a model that is well adapted to the situation to be analyzed. A wrong specification of this part of the model can be quite dramatic not only in terms of quality of

service to be provided to users but also in terms of the possibilities to recover investment costs or imposing additional congestion costs to users. Models subjects to double constraints (both traffic exiting each zone and entering each zone are set exogeneously) are well adapted to urban traffic and suburban residence-work trips. The single constraints models (the sum of traffic exiting each zone is set) is used for all other trip purposes.

A.3. The modal choice

This is the key stage from the viewpoint of demand modeling. The underlying idea is that in many cases, demand for a specific mode is increased by reducing the demand for another mode. The modeling of modal choice is based on the assumption that this choice depends on the difference—or sometimes the ratio—between transport costs. The general form in the case of the choice between two modes is a—logistic—function which gives the probability of relying on one mode as a function of the difference between these two costs. [27]:The intuition is thus quite simple, the users goes for the most cost effective way of getting the kind of service needed. While other formula can generate the same type of outcome, this one has the advantage that it can be derived from an explicit modeling of the economic behavior of an individual—a discrete choice logit model. The real challenge is to decide whether to implement the model at the aggregate or disaggregated level.

A.3.1 The aggregate models

The aggregate approach uses very aggregated information to describe the behavior of large groups of users (passengers, tons of products transported between two cities in a given transport mode), generally over time (dynamic concerns) and sometimes across regions (geographic concerns). The behavior described is thus the average behavior without consideration to the relevance of the diversity of behavior. The analyst focuses on data made of an origin-destination pair and on the share of users relying on a specific mode in the total population. The demand is eventually assessed by recognizing that it depends on the usual relatively standard factors such as prices, the price of substitutes, quality and relevant socio-economic variables taken from macroeconomic accounts. This kind of model is for instance used to assess the distribution of

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[27] $Pr(1) = \dfrac{1}{1 + \exp \mu(C_1 - C_2)}$, where:$Pr(1)$ is the share of use of mode 1, $C1$ et $C2$ are the generalized costs of each one of the two modes—the generalized cost is the sum of the cost of using the mode and of the value of the time needed to get from origin to destination and μ is a positive parameter which drives the sensitivity of the modal choice to the differences in costs.When the value of μ is infinity, the choice is one of all or nothing. When it is 0, the modal choice is insensitive to costs.

traffic between day and night by railways companies or to model allocation between public and private vehicles in urban settings. These models are generally too aggregate to meet the needs of a regulator but they are used anyway because they can provide useful initial insights. What matters from the viewpoint of a regulator is that the cost account for many of the variables that will be subject to regulatory supervision such as tariff/tolls or government control such a fuels but these are seldom take into account in a sensitive enough way to be useful because they do not account well enough for the different characteristics of the various types of users.

The main aggregate methods can be classified in 2 groups: qualitative or intuitive methods and "mathematical or statistical" methods. Among the qualitative methods, it is worth pointing to a series of techniques based on expert assessment or field surveys of expectations designed to complement the quantitative estimates. The expert assessment is least refined since it assumes an expert can assess the impact of mutliple factors on a potential *new* business environment—since in the context of privatization, new business opportunities are typically being created.

Field surveys of expectation are targeted to anyone who can be affected by the project and is in a priviledged position to assess the prospects. A refined version of these surveys is provided by the techniques called *Delphi*, where the experts forecast and get a *feed-back* on the results from the full sample of people surveyed allowing a series of iterations until some degree of convergence is achieved. This approach is used by IATA or EUROCONTROL for instance for airline traffic forecast. These techniques can be useful at the national or regional level but are unlikely to be useful to forecast traffic and traffic risk on a given corridor. Finally, the technique of *brain-storming*, quite common in socioliogy, consists in putting together a group, for instance users, and through in a series of question to be discussed by the group. This technique is used by Puertos del Estado in Spain complement the more analytical forecasts of the spanish ports.

The more quantitative methods to forecast aggregate demand can be classified into: trends extrapolations—assuming a linear, exponential, quadratic or some other function that seems to fit past observations well--, fancier time series analysis and more sophisticated econometric work. Extrapolation is the weakest but also the most commonly used around the world. The future is assumed to be determined by what happened in the past. It is mostly useful for very short run needs and has a better chance of working on monthly data than on annual data. But this is

limiting since for many sectors it is very likely that at some point changes in trend will occur.[28] The main problem is that with monthly data, seasonal effects are likely to arise and better techniques are needed. Some marginal statistical improvements (moving averages over several months to smooth the series from its seasonally or a better analysis of the statistical model explaining the growth rate, e.g. exponential vs. linear) are common for short term forecasting. At best these methods can be used to inform or complement more sophisticated work.

Time series statistical methods (e.g. Box-Jenkins) are a major improvement over these approaches because they use the information more effectively and can be used to explain trends through a much more detailed assessment of the behavior of time series over time. They have a weak economic theory foundation and hence are more difficult to use in the context of structural changes such as a privatization. They do not leave much room either to model incentives or regulatory influences on patterns and trends.

Statistical methods can be divided into models of growth factors and econometric modeling. The growth factor models assume that the demand for transport is quite simply and directly related to specific economic indicators. Statistical correlations provide the basis of the identification of the indicators that need to be picked. Assumptions on the growth rate of these indicators drive the forecast of the demand for transport. In general, the best inputs are indications of the growth in physical outputs that will need to be transported. When these are not available, income, employment or population provide approximations of the driving forces. Once more, this mode is much too aggregated to be useful to most regulators or privatization commission. It does not do much more than provide a glorified trend.

The aggregate econometric models are probably the most useful tools in this category. They allow the recognition of the fundamental relations between the demand for transport and a large number of economic, social and political factors. They can be based on studies of historical time series, cross sections (i.e. a number of cities, a number of users at any point in time) or panels of data (which tracks the evolution over time of a cross section). For readers unfamiliar with econometric techniques,

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[28] This can be picked up by a modified exponential (traffic $= k. + a.b^{time}$ with a<0 and b<1), a logistic (1/traffic $= k. + a.b^{time}$) or

A.3.2 The disaggregated models

While the aggregated model focuses on the average choice for a given origin-destination pair, the disaggregated models focus on the specific choice of each users. The data observed is the choice of an individual user and the "pleasure" ("utility" in economics jargon) generated by each mode is reflected in a (logit) function which related this pleasure to the price of the mode, time spent and any other relevant characteristic of the individual or mode.

$$U_{ij} = \sum_k \beta_{ij}^k X_{ij}^k + \varepsilon_{ij} \quad ^{29}$$

and: i : is the individual, j : is the mode, k : represents each of the k relevant characteristics of the pair (i, j) for each individual (while for aggregated models, the average of the population is enough), β_{ij}^k : are parameters and $\sum_k$ is simply an operator saying that the "utility" is determined by the *sum of* all the relevant variable weighted by the parameters estimated from the samples surveyed and ε_{ij} :are random shocks influencing utility which need to be modeled explicitly. The specification of these random shocks is what differentiates models and determines the specific econometric technique that must be used to derive demand. They often depend on the nature and the degree of precision with which the data is collected. The lack of realism of the specification can be a problem in practice and generate counter-intuitive results as discussed in Quinet (1998). This is why the way the information is collected is something the regulators must under as well as possible. It will drive their ability to be a fair referee.

The basic information can be collected in two main types of ways: *revealed preferences* and *declared/stated preferences*. Revealed preferences are provided by a direct observation of the behavior of transport service users. They do what they prefer to do. This means that the regulator only needs to get data on the current use of transport services and/or infrastructure. The main problem is that it may not provide enough variability in the information to do good statistical work. Moreover , it is often difficult to isolate all variable relevant to a regulator.

Gompertz function ($\ln$ traffic $= \ln k. + .b^{time}. \ln a$).

[29] For instance, the choice between bus and cars can be modeled in a logit as follows

$$P_b^i = \frac{1}{1 + \exp(\beta_1(c_a^i - c_b^i) + \beta_0)}$$, where P_b^i is the probability of choice of bus, c_a^i, c_b^i are the monetary costs of cars and buses for all users,

i is the individual and β are constants ; if bus fares increase by dc , the probablity of taking the bus changes by $\frac{dP_b^i}{dc} = P_b^i(1 - P_b^i)\beta_1$;

Individual i picks mode f over a if: $C_f^i \leq C_a^i$ that is, if $h_i \leq \dfrac{p_a - p_f}{t_f - t_a}$

Declared/stated preferences are provided by responses given by a sample of potential or actual users provided when they are placed in hypothetical situations. The potential users are asked to rank, rate or pick among several options. This is generally organized through field surveys conducted around the area in which the benefits of a project are supposed to be observable. Asking users to pick or rate is faster and generally more reliable than asking for a ranking and is hence more common. The interview can be conducted in 10-15 minutes—it takes at least twice as much to ask for a ranking of options. The specific design has of course to be tailored to the type of mode in use. You have more time to interview a passenger on an intercity train than to ask the driver of a car waiting for the light to turn green. In some instances, the survey requires the users to be paid to come to a specific location to do the questionnaire.

Overall, the declared preferences approach is to some extent less demanding initially. It is however very sensitive to the quality of the questionnaire design and to the quality of the team conducting this field survey. It needs to be tested carefully as errors are easy—and common. For urban projects, it is recommended to have sample sizes of the population of about 10% when passenger flows are larger than 900 pax/hour—and assuming a response rate of 20-30%. It generally ends up being more expensive than a revealed preference study. The list should make it clear that this is quite time consuming and requires a strong commitment to success.

While the economists have all the required tools to derive individual demand forecast from these models, they are not cheap to implement. They are indeed quite time consuming and demand strong technical skills. These models require detailed surveys through questionnaires and econometric analysis—which quickly drive costs up. Their main attraction is that they can be quite effective at allowing an estimate of the probabilities that an individual with specific characteristics will prefer one mode over another. To get the demand for each mode, this individual information are aggregated. This also can be done in various ways, each introducing its own biases which must be understood if the results are to be used in any regulatory decision (Ben Akiva and Lerman 1985).

The quality of the policy advise generated from these models have made become a standard in the industry. They are being used in assessing projects in various Latin American countries at reasonable costs and some of these examples will be discussed below. One of their

useful adaptations is the inclusion of a constraints that recognizes quite explicitly that ability to pay matters in making choices. [30]

A.4. The choice of itineraries

These models are mostly used for the road sector. Without saturation, it is very similar to what was discussed earlier with respect to modal choices. With saturation—i.e. when cost depend on traffic levels--, the modelers need to implement the two Wardrop principles. The first principle states that in equilibrium, the generalized costs of every itinerary used between an origin and a destination given are equal or lower than those of any unused itinerary. The problem can now easily be modeled thanks to major progress in computer technologies. The main problem is that this is an optimum only from the view point of the individual user and in fact the second Wardrop principle suggests that the collective optimum is unlikely to be consistent with this individual optimum. What this means is that regulators must understand the sources of indifferences before deciding how to intervene. This is particularly important because one f the main policy conclusion derived from the analytical developments surrounding these principles is that the best solutions are not always what they appear to be. More specifically, the best solution to saturation is not always more investment but can include various types of price, rationing or queuing arrangements.

In comparing alternatives between a short saturated itinerary and a long unsaturated itinerary, it is important to consider that displacement effects resulting from an improvement in one route may simply maintain travel costs constant. (Ville 1970). Indeed, users will shift to the short way until congestion increase travel time while the users of the long itinerary see not change. This can be exacerbated by a situation in which a regulator accepts to reduce the frequency of public transport on the long itinerary to pay for the investment made to expand the short itinerary or as part of a negotiation with the concessionaire of this short itinerary.

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[30] Price time models can also be used to pick itineraries or to model air-rail competition and hence can be useful to any regulatory or competition agency. They assume that a user i decides as a function of the generalized cost for each mode: $C_f^i = p_f + h_i t_f$, $C_a^i = p_a + h_i t_a$

where: C_f^i, C_a^i are the generalized costs for modes a and f: p_a et p_f are the prices of each mode; t_a et t_f are the travel time, h_i is the value of time for individual i.

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