10 Cost-benefit analysis of railway station area development: The case of Amsterdam South Axis

Carel Eijgenraam and Ioulia Ossokina

CPB Netherlands Bureau for Economic Policy Analysis, The Hague, the Netherlands

10.1 Introduction

Development of railway station areas has for several years been an important issue on the Dutch spatial policy agenda. National and local governments have been financially supporting the development of the areas around the stations of the new High-Speed Rail, the railway connection from Amsterdam to France and Germany. The projects in question are designed to create a multifunctional land use environment in which synergy effects of the combination of the transport nodes with business and residential land uses can arise.[1] This chapter evaluates the welfare effects of probably the most ambitious of these projects, that which involves urban construction and infrastructural investment in the Amsterdam South Axis area. In this project the transport infrastructure on both sides of the railway station Amsterdam South/WTC is to be brought underground, thus creating extra space for high quality urban construction. The expectation is that this change in the pattern of land use in the South Axis will have positive effects on the utility of residents and productivity of companies in the area, and subsequently on the value of real estate there.[2]

This chapter is related to the literature on the effects of combining different land use functions. The literature suggests, for example, that prox-

[1] See for a discussion of the multifunctional land use concept e.g. Vreeker et al. 2004; Rodenburg and Nijkamp 2004.

[2] This paper builds on a study performed by CPB Netherlands Bureau for Economic Policy Analysis (Eijgenraam and Ossokina 2006).

imity of open space and accessibility of transport infrastructure both positively affect the prices of residential and commercial property, while proximity of industrial land use has a negative effect (see *inter alia* Cheshire and Sheppard 1995; Irwin and Bockstael 2001; and Debrezion and Willigers in chapter 13 of this book). Other studies examine the effect of a change in the pattern of land use in the neighbourhood, such as increased diversity and fragmentation of land use on the property price (e.g. Geoghegan et al. 1997; Song and Knaap 2004). However, relatively little research has been performed on the costs of multifunctional land use, such as investment costs involved in combining different land use functions in the same restricted area.[3] In this chapter we therefore compare for a specific project the benefits of multifunctional land use with the costs that their creation may involve. Such an exercise may provide important information on the welfare effects of combining different land uses, which is a relevant issue in the development of railway station areas.[4]

We evaluate the welfare effects of the South Axis multifunctional land use project using the technique of (partial) cost-benefit analysis (CBA). This technique is often applied in studies of the welfare effects of large investment projects on a national scale and has for the Netherlands been extensively discussed in a guideline by Eijgenraam et al. (2000). The guideline does not, however, pay explicit attention to the treatment of the welfare benefits from land issue for urban construction purposes and the (external) effects of a change in the pattern of land uses.[5] These two aspects play an important role in the present study. We suggest an approach for how they can be accounted for in the cost-benefit analysis.

This chapter is organised as follows. Section 10.2 describes the methodology of defining a multifunctional land use project for the purposes of the cost-benefit analysis. Section 10.3 introduces the major direct effects of the project: the financial land yields and the external effects of the change

[3] Coupland (1997) discusses the possible costs of multifunctional land use. Besseling et al. (2003) show for an earlier version of the South Axis project that the costs of bringing the transport infrastructure underground can be quite high in comparison of the benefits.

[4] Several existing studies of the South Axis project base their evaluations of it largely on the fact that considerable benefits can be expected from the unique location of the South Axis area and the (external) effects of multifunctional land use (see e.g. City of Amsterdam 2005). This paper presents a quantitative estimation of the most important benefits and costs of the project, thus providing policymakers with additional information which can be used in decision-making concerning the South Axis project.

[5] These two effects receive little attention in the published foreign studies that use cost-benefit analysis (see, for example, Layard and Glaister 1994).

in the pattern of land uses in the area, and discusses some general methodological issues. Section 10.4 is devoted to the estimation of the financial net benefits of land issue. We find that combining underground infrastructure and urban construction above ground in the considered specification of the South Axis project is too costly in comparison with the financial benefits it yields. An important rationale to exist for the South Axis multifunctional land use project should thus be sought in its external effects. External effects of multifunctional land use in South Axis are discussed in Section 10.5. We find these effects to be insufficient to compensate for the financial deficit of the project, but stress at the same time the large uncertainty margin surrounding the estimation. Section 10.6 presents the overall balance of costs and benefits and performs a sensitivity analysis of the outcomes to the assumptions used. Section 10.7 summarises some methodological lessons which can be learned from this cost-benefit analysis and section 10.8 concludes.

10.2 Multifunctional land use in the South Axis

10.2.1 Development of the South Axis area

The development of the South Axis area is a complicated project. Its most ambitious version (the Dock) involves: i.) extending and bringing the transport infrastructure underground in the neighbourhood of the railway station Amsterdam South/WTC, and ii.) developing the vacant land above the tunnel (on the Dock) in the direct proximity of the tunnel. Tables 10.1 and 10.2 show the ambition of the project in comparison with the situation during 2006-2007. The expectation is that the construction program will be completed in 2028.

Table 10.1. Real estate in South Axis: in 2006 and after the realisation of the Dock project

	2006	Dock project: additional construction volume in comparison with 2006
Offices (m^2 gross floor area)	594 000	+752 000
Residential property (m^2 gross floor area)	52 000	+1 022 000
Services (m^2 gross floor area)	654 000	+357.000
Total	1 300 000	+2 131 000
Parking lots (units)	11 000	+17 000

Table 10.2. Transport infrastructure in South Axis: in 2007 and after the realisation of the Dock

	2007	Dock-project
Railway tracks at the South/WTC station	4	6
Railway tracks east and west of the station	2	4
Motorway A10 lanes	2x4	2x5
NS railway station Amsterdam South/WTC	2 narrow platforms	3 larger platforms
Metro	no	North-South line, subway

10.2.2 Defining the multifunctional land use project at South Axis

The ambition of Dock is to create a 'second city-centre' of Amsterdam in the South Axis, which is an area comparable to La Defense in Paris, Canary Wharf in London or das Bankenviertel in Frankfurt. Expected increase in the quality of the South Axis area is an important motive behind the tunnelling part of the project. Placing the transport infrastructure below ground removes a physical barrier between the Amsterdam districts South and Buitenveldert and diminishes the nuisance currently caused by transport infrastructure in the area. At the same time new land is created where commercial and residential property can be built.

For the purposes of this CBA, we define the multifunctional land use in the South Axis as a project involving only the tunnelling of transport infrastructure and urban construction above the tunnel. To evaluate the costs and benefits of multifunctional land use we need to specify a reference alternative, i.e. give a description of how the area would look without tunnelling. Research shows that the same extension of transport infrastructure is also possible above ground. The vacant land available for construction is, in the reference alternative however, less extensive. Table 10.3 describes the characteristics of the real estate construction program in the reference alternative and in the Dock project.

By defining the reference alternative in this way, we split the South Axis project in two parts: the extension of the transport infrastructure on the one hand, and the tunnelling and real estate development on the other. In this chapter we concentrate on the cost-benefit analysis of the second part only.

Table 10.3. Construction program of the Dock project in comparison to the reference alternative

	Reference alternative: (real estate in 2006 + real estate that can be realised without tunnelling the transport infrastructure)	South Axis Dock: additional construction volume in comparison with the reference alternative
Offices (m^2 gross floor area)	594 000 + 280 000	+472 000
Residential property (m^2 gross floor area)	52 000 + 313 000	+709 000
Services (m^2 gross floor area)	654 000 + 183 000	+174 000
Total	1 300 000 + 776 000	+1 355 000
Parking lots (units)	11 000 + 6 000	+11 000

10.3 Methodological issues

10.3.1 Direct and indirect effects

In a cost-benefit analysis (CBA) the effects of the project are usually separated into direct effects and indirect effects. In this study we define direct, or primary, effects as: i.) effects that accrue to the owner or users of the project, and ii.) externalities that arise from the realisation, existence, or use of the project. Direct effects are thus connected to the markets on which intended impacts of the project take place. In the case of tunnelling only the land market is impacted.[6]

Realisation of the project can, however, result in secondary or tertiary effects on other markets as well. When relevant markets are characterised by perfect competition, these so-called indirect effects only result in a redistribution of direct effects. The possibility of additional welfare changes exists only when the project impacts imperfect markets. Recent research based on spatial general equilibrium models suggests that the indirect effects can yield a net welfare benefit, which is however, small compared to the direct effects (Bröcker 2003).

[6] As the transport infrastructure in the project alternative is the same as in the reference alternative, the transport market is hardly affected.

Direct effects of the tunnelling

In terms of demand and supply on the market for urban construction land, the South Axis project has two consequences; their combination determines the new market price of land at the location. First, the supply curve of the land available for construction purposes moves to the right (the volume effect). This happens because tunnelling of transport infrastructure makes extra space available for construction. Second, the demand curve for land available for real estate development at the location moves upwards (quality effect). The reason is that the change in the pattern of land use realised in the South Axis project can be expected to have positive effects on the productivity of companies and utility of residents in the South Axis. As a consequence, the willingness to pay for land on-the-spot increases.[7]

The factors discussed above determine the main direct effects of the Dock project: the net internal benefits that accrue to the developer of the Dock, and the external effects of the Dock on the value of real estate in the neighbourhood of the project. These effects will be discussed in-depth in sections 10.4 and 10.5 below.

Indirect effects

One of the frequently discussed positive indirect effects of large projects is their influence on the labour market and employment. In the case of the South Axis, this is a long-run effect, since the time horizon of the project amounts to more than 20 years. In the long-run it is usual to assume that the national economy converges to the general market equilibrium in which the structural employment and unemployment are determined by macroeconomic factors and labour market institutions. In this framework land development projects have scarcely any influence on the employment in the Netherlands. While the employment at South Axis will rise, in equilibrium this increase will be compensated by a fall in employment elsewhere in the country. This results in a net effect on national employment that can be neglected.

Regional relocation is another often mentioned positive indirect project effect. As a result of the intensive urban construction in the Dock, else-

[7] We assume that the effect of the change in the pattern of land use in the South Axis is completely reflected in the increased value of land in the area. We therefore consider it among the direct effects. (The effect can also manifest as a higher remuneration of employees or higher profits of companies at the location, in which case it should be seen as an indirect effect. The issue of the distribution of the benefits of the project is, however, outside the scope of our analysis.)

where in the Netherlands land will stay available for other uses (such as agriculture, green areas, and so on). For the purposes of this study we assume that: i.) the business activity and inhabitants that move to the South Axis if the project is implemented are in the reference alternative spread across different existing locations, so that their influence on the local land market can be seen as marginal, and ii.) the regional zoning policy at the locations in question reflects social preferences. This implies that the choice of companies and people to move to the South Axis does not lead to any social costs or benefits at other locations.[8]

The project can also have negative indirect effects. One example is the excess burden of extra taxation, which arises when a project yields a financial deficit (as is the case with the Dock) and public finances are used to bridge this financial deficit. A possible way to account for this effect is to include in the balance of costs and benefits a negative premium equal to a certain fraction of the government subsidy. Another negative indirect effect that can occur in the Dock project is the leaking of some benefits abroad. This can especially be the case if foreign companies are attracted to the South Axis. In this (partial) cost-benefit analysis we consider only direct effects of the project and do not address its indirect effects.

10.3.2 Other methodological issues

Risk valuation

Land benefits are prone to macroeconomic risks – risks that cannot be diversified – as they concern developments that influence the whole economy. In times of high economic growth the value of land and real estate grows much faster than during periods of low economic growth. Investors are only ready to invest in real estate when they receive compensation for bearing this uncertainty in the form of a risk-premium. Thus they require a higher return on real estate than on government bonds. In this cost-benefit analysis we account for this effect by using a risk-premium on the discount rate for the benefits.

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[8] This is an application of the general assumption always made in a partial CBA, namely that the marginal alternative project's returns are exactly equal to the discount rate used for the project under consideration.

Discount rates used

In this CBA we derive the general required return on investments in real estate from the realisation of the returns on real estate as documented in the Dutch ROZ/IPD index.[9] For effects that are prone to macroeconomic risks, we use a real (i.e. inflation-free) discount rate of 5%, which consists of a 2% risk-free component and a 3% risk-premium.[10]

The risk-free discount rate of 2% is applied to all costs and benefits of the project up to the start of construction of the Dock. For the years after the construction has started, we apply the risk-free discount rate to the costs, and the discount rate including the risk premium to the benefits.

Time horizon and present value

In the South Axis project both the costs and the benefits are expected to be spread over a rather long time period. For this reason we use an infinite time horizon in this cost-benefit analysis. The economic life of the real estate is assumed to be 50 years; we assume the land to be used for construction again thereafter. The net present value of the cash flows of the project is calculated in 2006 prices. Table 10.4 summarises the methodological assumptions discussed thus far.

Table 10.4. Parameters used in the net present value calculations

Real risk-free discount rate (all costs and benefits)	2% per year
Risk-premium for macro-economic risks (benefits)	3% per year
Time horizon	Infinite
Price level	2006

10.4 Balance of costs and benefits for the developer

10.4.1 Land benefits

In this section we estimate the benefits accruing to the owner and users of the Dock project. A company yet to be founded, the so-called South Axis enterprise, will be responsible for the realisation of the tunnel and the issue of land. The expected income of the company will consist of the land rents.

[9] www.rozindex.nl

[10] In section 10.6 we provide a sensitivity analysis of the cost-benefit balance to the assumption about the discount rate and the risk-premium.

These land rents can be estimated as a residual of the expected value of the real estate to be constructed, and the costs of construction and maintenance.[11] This approach builds on the differential theory of rent by Ricardo (1817) and is currently used by municipalities to determine the rents for newly-issued land. We assume that the South Axis enterprise will be able to cream off all the extra rents.

To apply this method we need to estimate the revenues of the real estate development and the costs of preparing the land for building. This requires assumptions to be made concerning the developments in the land market. The most important parameters in this estimation are the pace with which the land is issued, and the real estate prices that will be realised in the future. Both factors are not known with certainty in advance. In this CBA we adopt the assumptions made in the Business Case Study for the future South Axis enterprise (Deloitte 2006).

Table 10.5 gives an overview of the assumptions used to calculate the land benefits. The scope of the real estate program and the rent and sale prices have been taken from Deloitte (2006). Land rents presented in the table have been calculated using a model for constructing and operating the real estate.

Table 10.5. Overview of the land rents used in the cost-benefit analysis (in 2006 prices)

	Land rents per m^2 gross floor area	Underlying rent/ sale price per m^2	Time period of land issue
Office (rent)	1350	300	2010-2028
Dwelling (sale)	850	3145	2010-2028
Shop (rent)	3338	375	2017-2019
Commercial services (rent)	876	175	2009-2028
Non-commercial services (rent)*	145	-	2009-2028
Social housing*	145	-	2011-2016
Parking lot (sale)*	10 000	-	2020-2027

* For these types of real estate land rents were not calculated, but taken from Deloitte (2006)

The rent/sale prices reported in Table 10.5 reflect the fact that the real estate is situated in a prime location in the Dutch real estate market, characterised by very good local, national and international transport connec-

[11] Normal return to the capital is incorporated in the costs of construction and maintenance.

tions,[12] proximity of social and cultural activities of Amsterdam, and the additional location quality achieved as a result of removing the infrastructural construction from the ground level. A study of the market developments on the Dutch market for offices and residential property (Eijgenraam and Ossokina 2006 pp. 30-55) suggests, however, that use of the aforementioned parameters may lead to an overestimation of the land benefits. While the projected pace of the land issue and the expected price level in the South Axis area fit with the market conditions and historical developments during the last decade of the 20th century, this does not necessarily guarantee that they can be seen as a realistic forecast for the future. In section 10.6 we will discuss the uncertainties surrounding the yields from the issue of land for construction purposes.

Table 10.6 reports the *ex ante* balance of costs and benefits of the Dock for the developer. The cost figures have been provided by Arcadis (2006).

Table 10.6. Financial costs and benefits of multifunctional land use in South Axis (in 2006 prices)

Category	Period of time	Total expenditures (€ mln)	Present value in 2006 (€ mln)
Costs			
Tunnelling	2009-2012/17/27	1430	1220
Costs for preparing land for building	2006-2019	260	240
Maintenance	starting with 2012		40
Total costs		1690	1500
Benefits			
Land issue dwellings on Dock	2010-2028		290
Land issue offices on Dock	2010-2028		320
Land issue other real estate	2009-2028		410
Total benefits land issue Dock			1020
Balance of benefits and costs			-480

Table 10.6 shows that the balance of financial costs and benefits of the multifunctional land use Dock project has a deficit of almost €0.5 billion. This implies that the land yields are insufficient to compensate for the –

[12] For instance, Amsterdam Schiphol international airport can be reached from South Axis with the train in less than 10 minutes.

quite substantial – costs of tunnelling the transport infrastructure.[13] The realisation of the multifunctional land use Dock project therefore must largely be justified by its external effects. These effects are discussed in the next section.

10.5 External effects

10.5.1 Location quality effect

The realisation of the Dock leads to a considerable change in the pattern of land use in the South Axis railway station neighbourhood. The territory currently occupied with transport infrastructure construction will in the Dock project become available for large-scale urban construction. The new urban quarter to be built above the tunnel foresees housing for approximately 5400 households, office space for almost 16 000 employees, and a large-scale development of commercial services. Realisation of such an urban environment on the place where rail and roads were previously situated can be expected to have important external effects on the utility of residents and the productivity of companies located in the proximity of the tunnel. We next discuss the possible foundations of these external location quality effects.

Residential estate

Ex post studies of the housing market[14] suggest that the characteristics of land use in a neighbourhood can have a non-negligible influence on the utility of residents of this neighbourhood and thus on house prices there. Debrezion et al. (2006) show for the Netherlands that houses located within a 250 metre distance from the railway, cost *ceteris paribus* 5% less than houses situated farther than 500 metres away.[15] This utility effect of

[13] Financially, this deficit will be bridged by a transfer of the City of Amsterdam to the South Axis enterprise of the building lots in the direct proximity of the Dock area. The rationale for this transfer should be the size of the external effects from Dock that accrue to the City or its inhabitants.

[14] Studies discussed in this and further paragraphs are revealed preference studies using the hedonic price method.

[15] Similarly, Cheshire and Sheppard (1995) and Rouwendal and van der Straaten (2006) find that proximity of industrial land use can on the margin have a negative effect equal to some percentage of the house price.

railway proximity seems to an important degree to be caused by noise nuisance and air contamination: one extra decibel of noise has been shown to lead to a decrease of up to 2% in the house price (see e.g. Lijesen et al. 2006 and references). Also relevant are studies on possible effects of commercial land use and land use diversity on the housing prices; these find, however, less pronounced positive and sometimes ambiguous effects (Song and Knaap 2004; Geoghegan et al. 1997). Finally, negative utility effects due to loss of open space and an increase in population density can take place (e.g. Cheshire and Sheppard 1995; Irwin and Bockstael 2001).

On the basis of the discussed studies, one can expect a positive utility effect of the Dock-induced decrease in noise nuisance and air contamination, as well as of the Dock-induced increase in the accessibility of services and possibly the diversity of land use. At the same time, the increase in population density or the deterioration of the view outside the window (skyscrapers instead of green sport fields) may have a negative utility effect. In a properly working housing market these location quality effects can be expected to be revealed in house prices. As for the possible size of these effects, the above discussed studies offer a range of possible outcomes, most of which lie below 5% of the house price. Different studies stress at the same time that the size of the effects of neighbourhood characteristics on house price is very location-specific.[16]

Offices

The pattern of land use in the neighbourhood can also have effects on the productivity of companies located there. Ciccone and Hall (1996) show that a higher density of employment in an area can lead to a higher level of productivity. A considerable increase in employment density in South Axis as a result of the realisation of the Dock can thus – via agglomeration economies such as knowledge spillovers – lead to an increase in firm productivity at South Axis; its increased attractiveness as a work location for employees can cause another productivity effect of the Dock. De Graaff and Rodenburg (chapter 11 of this book) suggest that employees in South Axis have a positive willingness to pay for the increased accessibility to shopping facilities in the proximity of their offices. A Dock-induced in-

[16] Cheshire and Sheppard (1995) show that in places characterised by relative scarcity of open space, the influence of open space proximity on house prices is relatively high. Rouwendal and Van der Straaten (2006) find that, in cities with a relatively high concentration of industrial activities, the valuation by the housing market of a decrease of the fraction of industrial land use in the neighbourhood is relatively high.

crease in the accessibility of these facilities may thus facilitate (and therefore to some degree be less expensive) for firms to attract highly productive employees. The above mentioned positive productivity effects of the Dock can be counteracted somewhat by negative effects, such as, for example, the negative utility of firms which were first located in sight of the highway, and used their buildings to attract travellers' attention to the company located there.

In a properly functioning market the mentioned effects will ultimately be revealed in higher office rents at a location. Debrezion and Willigers (chapter 13 of this book) is one of the few noteworthy studies on the influence of location characteristics on office rents. Its results are generally in line with the literature on location quality effects on house prices (see above).

Methodology for valuing the location quality effect

For the purposes of this CBA we assume that the bulk of the effects of the Dock on the utility of residents and productivity of companies in the neighbourhood will be revealed in higher real estate prices. Given the broad range of neighbourhood effects that the Dock will possibly effectuate, we have taken the 5% price premium as a lower frontier for the combined location quality effect, which can be expected from moving the railway infrastructure construction to below ground level (Debrezion et al. 2006). Furthermore, we have relied on two *ex ante* studies performed specifically for the Dock project. Buck Consultants International (Buck and Glaudemans 2006) calculated for the South Axis area and a number of foreign locations a so-called 'area quality index' that accounts for transport accessibility, access to and quality of facilities, economies of scale, the quality of real estate, and image effects. Comparing the value of this index and the rent levels at several locations, they suggest that the realisation of the Dock, together with the extension of the transport infrastructure, can lead to a 15% increase in the rents in South Axis. Another study based on interviews with large Dutch real estate agents conducted by Fakton (2002) estimated a 10% value increase of real estate prices in South Axis due to the implementation of the Dock project.

Our assumption about the size of the area in which location quality effects can be expected is based on existing *ex post* studies. The analyses argue that the influence of neighbourhood characteristics diminishes quickly with distance. Orford (1999) shows for example, that the influence of the major park in Cardiff (Wales) on house prices in the neighbourhood is half as large at a distance of some hundred metres from the park than in its direct proximity. Debrezion et al. (2006) find that houses within a 250 metre distance of the railway have a larger negative price premium than houses situated between 250 and 500 metres from the railway.

In this CBA we assume the combined location quality effect to result in a 10% increase in real estate prices in the direct proximity of the Dock. We define the direct proximity of the Dock as the area with a radius of about 250 metres from the tunnel. To account for the fact that effects diminish with distance, we therefore assume a 5% price increase for the real estate at a distance between 250 and 500 metres from the tunnel.

By assuming that the external effects of the Dock do not diminish gradually with distance, but rather in two large steps (from 10% to 5% to 0%), we overestimate these effects to some degree. This overestimation is compensated in some sense by the fact that we do not quantify the part of the location quality effect not revealed in property prices (e.g. a higher utility of tourists or higher salaries of employees in the South Axis). In order to stress the uncertain character of the above calculation, we provide a sensitivity analysis of the results for two variants: i.) the value increase of real estate is 5 percentage points lower; ii.) the value increase is 5 percentage points higher and manifests in a larger area.

10.5.2 Other external effects

Consumer surplus

Land rents that have been estimated in section 10.4 using the expected market prices of real estate, are equal to the producer surplus the Dock developer receives. If companies' and inhabitants' utility from using the real estate is higher than market rents, consumer surplus arises. The location quality effect discussed in the previous section will, for example, at least initially manifest as a rise of the consumer surplus. For the real estate on the Dock, however, one can expect that consumer surplus will be so small in comparison with land rents that it can be neglected for the purposes of the CBA, the reason being that land owners at South Axis can be expected to cream off most of the location benefits of users through price discrimination. In the centre of the South Axis area near the railway station South WTC, land rents will be highest, reflecting the highest agglomeration economies that can be enjoyed there. The land rents will diminish with distance to the station.[17]

[17] This is in accordance with the monocentric model of urban development (see e.g. Fujita and Thisse 2002), which seems to be rather well applicable to the sta-

There is, however, one type of real estate on the Dock for which consumer surplus cannot be neglected: social housing. The expected land rents for social housing are less than 10% of land rents for other housing on the Dock. We assume in this CBA that the utility of the inhabitants of social housing is equal to the utility of other inhabitants of the Dock area. The difference between the land rents determined on the land market and rents requested for social housing is therefore considered as the consumer surplus that inhabitants of social housing on the Dock will enjoy.

Transport benefits

The realisation of the Dock implies an increase in the number of travellers at South Axis and a decrease elsewhere in the country. With respect to the railway, the expectation is that the net effect will be negligible because the necessary capacity of the railway is the same both in the Dock project and the reference alternative. The situation differs with respect to the highway. There is a possibility that an increase in congestion in the busy South Axis area may have effects that cannot be compensated by a decrease in congestion elsewhere. At the time this CBA was performed there was insufficient information available to value these effects. We therefore include them in the balance of the costs and benefits as a pro memoria item.

Balance of external effects

Table 10.7 gives an overview of the external effects of the Dock project.

Table 10.7. External effects of the Dock project

Category	Method	Present value in 2006 (€ mln in 2006 prices)
Location quality effect	10% and 5% of the rent/sale prices	360
Consumer surplus social housing	Land rents are set equal to the rents for houses built for sale	40
Transport benefits highway	No information available	PM
Transport benefits train, metro and station	Change in the capacity	–
Total of the external effects		400 – PM

tion area of South/WTC. The described pattern of rents can be observed in the South Axis area.

10.6 Total balance of costs and benefits

The results of the CBA are summarised in Table 10.8. The table illustrates that the total benefits of the project fall short of its costs. The cost-benefit balance is €-80 mln euro. There is, however, a large uncertainty margin around this figure, not least due to uncertainty surrounding the estimation of the external effects of the project.

Table 10.8. Summary of the welfare effects of the Dock project (present value in 2006, € mln in 2006 prices)

Category	Costs	Benefits	Total
Investment costs	1460		
Maintenance expenses	40		
Total costs	1500		1500
Land rents		1020	
Consumer surplus social housing		40	
Location quality effect		360	
Transport benefits		- PM	
Total benefits		1420 – PM	1420 – PM
Balance of costs and benefits			– 80 – PM

Table 10.9. Net present value of the variants (2006, € mln, 2006 prices)

	Difference with the base variant
Base variant (risk-free real discount rate 2%, risk-premium benefits 3%)	-
Risk-free real discount rate 4%, risk-premium benefits 3%	– 130
Risk-free real discount rate 2%, risk-premium benefits 5%	– 350
Costs tunnelling transport infrastructure 20% higher	– 260
Half of m^2 gross floor area offices Dock 2020-2028 and half of the gross floor area shops used for residential construction	– 60
More optimistic estimates of the land rents (equal to those used in the Business Case of the South Axis enterprise)	+ 60
Location quality effect 5 percentage points smaller	– 180
Idem 5 percentage points larger and applied to a larger area	+ 180

Sensitivity analysis of the above results (see Table 10.9) suggests that the assumptions concerning the size of the investment costs, the discount rate, and the size of the location quality effect have a major impact on the cost-benefit balance of the project. Results are less sensitive to the assumptions concerning the composition of the real estate construction program, the speed with which this program is realised, and the land rents.

10.7 Discussion

In this study we have used the method of cost-benefit analysis (CBA) to study, structure and quantify the main effects of a large multifunctional land use project around the railway station Amsterdam South/WTC. Cost-benefit analysis has been increasingly gaining favour as a tool to support policy decision-making, especially with respect to complicated investment projects in transport infrastructure and land development. A CBA aims to contribute to the rational and transparent assessment of all project alternatives, mostly by trying to value the totality of welfare effects of the project in the same (monetary) units; this proceeds smoothly as long as the expected effects can be reasonably well-estimated and quantified, and the prices of affected goods and services can directly or indirectly be derived from real markets. When this is not the case, a CBA method may not be able to express the balance of costs and benefits as a single figure, or may yield a balance of costs and benefits surrounded by a large degree of uncertainty. In both cases additional care is needed in presenting and interpreting the CBA results.

A well-known example of effects that are rather difficult to account for in a CBA are the implications of a project for nature, landscape and environment (see Stolwijk 2006 for an extensive discussion). The CBA of the multifunctional land use in South Axis discussed here offers another example: the whole range of effects induced by the change in the pattern of land use in the neighbourhood of the station South/ WTC. The consequences of a combination of tunnelling and urban construction involve *inter alia* a decrease in air contamination and noise nuisance, an increase in accessibility to shopping facilities, and higher employment density. These factors should contribute to an urban environment better suited in which to work and reside. The mentioned factors can thus be summarised by the term ‘location quality improvement’ and can, through their influence on the utility of inhabitants and visitors and on the productivity of companies, lead to higher real estate prices in the neighbourhood of the Dock.

Measurement and valuation of this cluster of effects nevertheless presents challenges. How should one *ex ante* measure the expected change in the ‘location quality’? And what is the precise relation between the size of this change and the real estate prices in the neighbourhood? Existing *ex post* studies provide some information on the possible valuation of separate neighbourhood characteristics. Debrezion et al. (2006) suggest, for example, that residential property located within a distance of 250 metres of the railway has a negative price premium of circa 5%, compared to the property at a distance of 500 metres. In the case of the Dock, however, it is the combined effect of removing the negative influence of the railway proximity and a number of other changes in different neighbourhood characteristics that interests us. This combined effect may very well turn out to be an unknown non-linear combination of the separate effects.

Several possible approaches for tackling this problem of estimating the complex effects of a change in the land use pattern may be considered. Thus, one could compose an index to measure and summarise the quality of a location and try to find out the influence of the change in this index on real estate prices.[18] The 'area quality index' of BCI (Buck and Glaudemans 2006) discussed in section 10.5 is such an index that can measure the change in location characteristics. However, the well-known problem with an index is the certain subjectivity implied by the weights given to different components.

Studying the *ex post* effects of similar projects may be seen to some extent as an easier option. But this approach has its caveats as well. The challenge here is to correctly separate the effects of the project on real estate prices in the neighbourhood from other possible effects. Furthermore, for locations like South Axis, finding a similar project may on its own be a rather difficult exercise.

Finally, expert opinion can perhaps provide relevant information. Real estate agents seem to be experts in projects having to do with land development. The louder criticism of their forecasts is, however, that their information is based on the most recent trends and does not (fully) account for the possibility of future economic trend changes. In the case of South Axis, a relevant trend change is, for example, the expected decrease in population and employment growth after 2020 (Huizinga and Smid 2004), which may have important negative implications for the demand for office space.

In our discussion we have illustrated some of the limitations of the CBA methodology when evaluating the effects of a change in the pattern of land use. When (external) effects of location quality improvement present an important rationale for a construction project, a CBA of this project is likely to yield a result surrounded by a rather large degree of uncertainty.

[18] This type of study is, for example, widely used in research on the impact of environmental policy on companies' location decisions. While the concept of environmental policy is broad and difficult to define, an index weighing different types of policy measures can offer a solution.

Future research should assist in developing better methods to measure and estimate these effects. Until then, additional care may be needed when presenting and interpreting CBA results for projects under consideration, for instance by showing the margins around the chosen valuation.[19] We again stress that knowing the difficulties and inherent limitations when trying to measure, quantify and make comparable often very diverse effects of a project is crucial in order to correctly interpret and use the results of CBAs for decision-making purposes.

10.8 Conclusions

This chapter has reported on a case study of the welfare effects of the development of a railway station area: Amsterdam South Axis – the area around the station Amsterdam South/WTC, in which tunnelling the transport infrastructure and urban construction above the tunnel are to be combined to create a new high quality urban district. Using the technique of cost-benefit analysis (CBA), we have explicitly compared the benefits and costs of this multifunctional land development.

The analysis suggests a methodological approach for evaluating the welfare effects of multifunctional land use projects with the help of CBA. We have inquired into the definition of multifunctional land use for the purposes of the analysis, and have investigated how internal land benefits and external effects of the change in the pattern of land use can be incorporated into a CBA. We argue that, given the state-of-the art knowledge on effects of changes in the pattern of land use, the *ex ante* estimates of these will, for the purposes of CBA, most certainly have a rather large uncertainty margin. The implication therefore is that, for projects in which these effects expectedly play an important role, extra attention should be paid by decision-makers to correctly interpret the information provided by cost-benefit analyses.

[19] To stress the uncertain nature of the results, one may also opt for presenting the results in terms of cost-efficiency and to determine the net financial costs involved in the realisation of the external effects of location quality improvement. In the case of the Dock project, these costs have been estimated at €480 mln. Under the assumption that the external effects apply to an area of 500 metres around the Dock, one can then calculate how large the effect should be per single office or dwelling in order for the project to be welfare-enhancing.

Acknowledgement

The authors thank Paul Besseling, Jos Ebregt, Ruud Okker, Herman Stolwijk, Rafael Saitua and the participants of the ERSA-2005 conference for helpful comments on earlier versions of this study. The usual disclaimer applies.

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