Multifunctional land use in the Amsterdam South Axis area: a cost-benefit analysis*

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Paul Besseling, Jos Ebregt, Rafael Saitua, Ioulia Ossokina

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

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Abstract

This paper evaluates the welfare effects of a large multifunctional land use project involving urban construction and infrastructural investment in the Amsterdam South Axis area. Using the technique of partial cost-benefit analysis we explicitly compare the benefits and costs of combining different land uses in the South Axis project.

The analysis suggests that combining different land uses in the considered specification of the project is too costly in comparison with the benefits it yields. Modifying the transport infrastructure results in land benefits since it creates space for construction of new buildings and leads to an improved quality of the location. However, these benefits prove to be insufficient to justify the size of the investments in adjusting the transport infrastructure.

Key-words: multifunctional land use, partial cost-benefit analysis, Amsterdam South Axis

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** Address: CPB Netherlands Bureau for Economic Policy Analysis, P.O. Box 80510, 2508 GM The Hague, The Netherlands; email address i.v.ossokina@cpb.nl.

1 Introduction

The spatial planning concept of multifunctional land use has been gaining in popularity in the Netherlands during the last decade. Multifunctional land use involves combining different socio-economic functions in the same area.[1] It aims furthermore at welfare enhancement through exploitation of the economies of synergy between combined land use functions (Vreeker et al., 2004, Rodenburg and Nijkamp, 2004). This paper evaluates the welfare effects of a large multifunctional land use project involving urban construction and infrastructural investment in the Amsterdam South Axis Area.[2]

This paper is related to a rather small literature that studies the possible synergy effects of combining different land use functions. Several studies analyse the dependence between the residential property values and the pattern of surrounding land uses.[3] Geoghegan et al. (1997) find that increased diversity and fragmentation of land uses around a residential property makes a marginal positive contribution to the property price. Other studies find a positive dependence between the house prices and the existence of various land uses in the neighbourhood such as: the recreational and commercial land use (Song and Knaap, 2004) or permanently preserved open space (Irwin, 2002 and Irwin and Bockstael, 2001).[4] Relatively little research has however been performed on the costs involved in the creation of synergy effects of mixed land use, such as for example investment costs connected to combining different land uses in the same restricted area.[5] In this paper we compare the benefits of multifunctional land use with the costs that their creation may involve, for a specific project. Such an exercise may provide important information on the welfare effects of combining different land uses.

We evaluate the welfare effects of the South Axis multifunctional land use project using the technique of partial cost-benefit analysis.[6] The South Axis project creates extra space for urban construction by tunnelling the existing transport infrastructure. In this study we distinguish three direct effects of the project: effects on the land market, effects on the transport market and external effects.[7] Furthermore, an indirect effect on the employment is taken into account. As the aim of the partial cost-benefit analysis is to give a first impression of the costs and benefits of a project, the first two direct effects are quantified and the other effects are assessed qualitatively.

[1] In this it overlaps with other planning concepts of mixed land use that have been proposed to reduce urban sprawl and to promote spatial and environmental quality.

[2] This paper is based on a study performed by CPB Netherlands Bureau for Economic Policy Analysis (Besseling et al., 2003).

[3] By using patterns of surrounding land uses as an explanatory variable, these studies make an extension of the widely used traditional hedonic models which explain residential property prices using just specific features of point locations (such as for example the properties of the parcel and the distance to amenities).

[4] Song and Knaap (2004) provide an overview of earlier studies on the subject.

[5] Coupland (1997) discusses the possible costs of multifunctional land use.

[6] Partial cost-benefit analysis quantifies the most important direct effects of the project and analyses qualitatively other effects. Comprehensive cost-benefit analysis aims at quantifying all the project effects. Apart from the cost-benefit analysis, multicriteria analysis has often been suggested for use in the evaluation of multifunctional land use projects. For the comparative discussion of the mentioned methods see e.g. Rouwendal and Rietveld (2000).

[7] External effects are included in the direct effects of the project as is recommended by the Dutch Guide for cost-benefit analysis (Eijgenraam et al., 2000).

The technique of cost-benefit analysis is often applied in pre-feasibility studies of the welfare effects of large investment projects on a national scale and has for the case of 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 synergy effects of multifunctional land use.[8] These two aspects play an important role in the present study. In this paper we suggest an approach for how they can be accounted for in the cost-benefit analysis.

This paper is organized as follows. In Section 2 a description is given of the South Axis investment project. Section 3 presents the methodology used in the cost-benefit analysis. The effects of the project on different markets are discussed in this section. Section 4 is devoted to the realization of the described methodology. We discuss the calculation of the effects of the project and present the overall balance of costs and benefits. We find that combining different land uses in the considered specification of the South Axis project is too costly in comparison with the benefits it yields. The reason is as follows. Modifying the transport infrastructure results in land benefits since it creates space for construction of new buildings and leads to improved quality of the location. Although the land in the South Axis area is very valuable due to its unique location, the land benefits prove to be insufficient to justify the size of the investments in modifying the transport infrastructure.[9] Section 5 analyses some of the uncertainties involved in the project and performs a sensitivity analysis of the outcomes of the cost-benefit analysis. Section 6 concludes.

2 The South Axis project

The Amsterdam South Axis area is situated along one of the country's major transport corridors[10] and in the vicinity of both the Schiphol airport and the cultural centre of Amsterdam. Due to this unique combination of location characteristics, the South Axis is usually seen as a prime location for offices of domestic and foreign companies. The South Axis investment project aims at exploiting the position of the area by creating there a new high quality urban district including a business quarter and a living neighbourhood and by adjusting the transport infrastructure to the needs of this district.[11]

[8] These two effects do not get much attention either in the published foreign studies that use the technique of cost-benefit analysis (see for example Layard and Glaister, 1994).

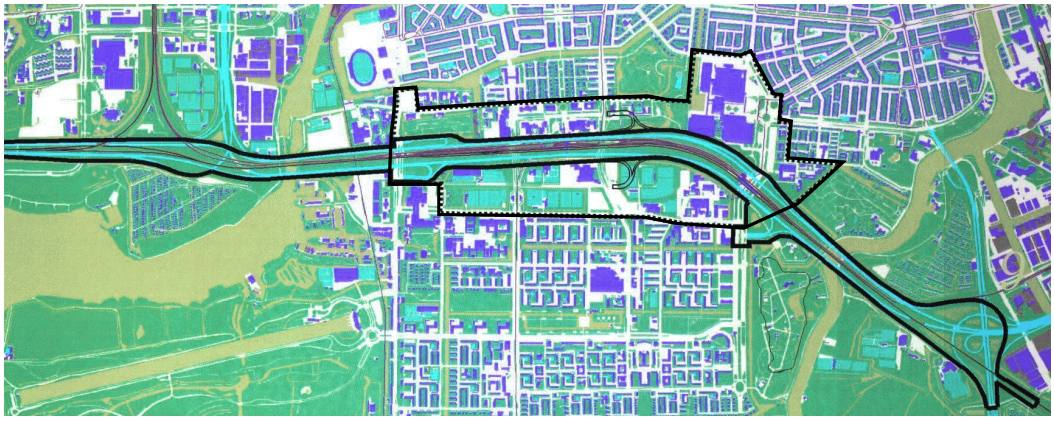
[9] Several existing studies of the South Axis project base their evaluation of the project to an important extent on the fact that considerable benefits can be expected from the unique location of the South Axis area (see e.g. Municipality of Amsterdam, 2005). This paper presents a quantitative estimation of the most important benefits and costs of the project. In this way it provides policy makers with additional information which can be used in the decision-making concerning the South Axis project.

[10] This transport corridor is formed by the motorway A10 and the railway going through Amsterdam South. The train station Amsterdam South/ WTC forms the core of the South Axis area.

[11] This project is one of the six so-called key-site projects specified by the Dutch government. These projects involve development of the areas around the stations of the new High Speed Rail (HSL) - the railway connection from Amsterdam to France and Germany. The ambition of the South Axis project is to create a new city centre in the area, much like La Defense in Paris, Das Bankenviertel in Frankfurt or Canary Wharf in London, albeit on a smaller scale.

Two features of the South Axis project make it a clear example of a multifunctional land use project. First, additional space for construction of offices and residential property is made available by tunnelling the A10 motorway and the railway. The space where the tunnel is built, is thus literally being used twice, increasing the land productivity at the location. Second, on the scale of the whole South Axis area, the synergy between the land functions 'working' and 'living' is considered of paramount importance for the success of the project (Municipality of Amsterdam, 2005). The synergy effects of spatially bringing these two land functions together increase as a result of the creation of the tunnel. By moving the transport infrastructure underground, a physical barrier between the Amsterdam districts South and Buitenveldert is being removed. This creates a large connected urban area in which different land uses can impact each other. Figure 1 gives an impression of the project area.

Figuur 1 The project area Amsterdam South Axis



2.1 The project in absolute terms

Below we discuss the details of the two parts of the South Axis investment program, (i) the urban construction and (ii) the investment in transport infrastructure.[12] The former part involves the construction of offices and residential property (around 900,000 square meter gross floor area each) as well as shops and other facilities (approximately 300,000 square meter gross floor area). Furthermore, almost 18,000 parking places are to be created. The completion and bringing into use of the different categories of the real estate is fairly uniformly distributed in time and covers the period until 2035.

The described investment program implies amply doubling the office capacity in Amsterdam South in comparison with the current situation (in 2002 the office floor area in the whole of Amsterdam South amounted to approximately 770,000 square meter). As a result of the construction program new business activity is

[12] In this study we analyse the South Axis project as it was formulated in 2003 (see project alternative Dok 1a from Besseling et al., 2003). Several adjustments to the project plans have been proposed since then.

expected to be attracted to the project area, bringing along jobs. A quite substantial rise in employment is therefore foreseen amounting to approximately 30,000 persons during the period between 2003 and 2037.

The second part of the South Axis project involves expansion and adjustment of the transport infrastructure. First, the railway and the motorway A10 are to be tunnelled. The infrastructure is furthermore to be expanded by:

- doubling the number of tracks for heavy rail (from 2 to 4);
- considerable enlargement of the train station Amsterdam South/ WTC (from two to six tracks with platforms and from one to four turn tracks);
- building out the motorway (from two times three main lanes and a hard shoulder to two times two main lanes and two times two parallel lanes).

A number of changes in public transport, which are outside the scope of the South Axis project, will further improve the accessibility of the South Axis area compared to the present situation. These include: construction of the metro connection between Amsterdam Central Station and Amsterdam South WTC, the so-called North-South line and the adjustments which the Amsterdam Central Station is due to undergo.

2.2 The project in relative terms

In order to perform a cost-benefit analysis of the South Axis project, we need to specify the reference scenario – the scenario that describes the relevant developments in the project area in the situation when the project is not implemented. The reference scenario that is used in this cost-benefit analysis has been composed in consultation with the project organisation South Axis and the Municipality of Amsterdam. The composition of the reference scenario is as follows. The construction program includes completion of the projects in progress and the construction plans which have been decided upon by 2003. It consists of more than 100,000 square meter office floor area, more than 12,000 square meter facility floor area, 150 dwellings for sale (around 20,000 square meter floor area) and something over 1,000 parking places. The expectation is that this construction program is completed by 2008.

The only foreseen adjustment in the transport infrastructure concerns the transformation of the hard shoulders of the A10-motorway in main lanes. As a consequence the A10 becomes a motorway with two times four main lanes. The train station Amsterdam South undergoes some adjustment as well.

As mentioned above, one important consequence of completing the South Axis project should be that new business activity is attracted to the area bringing along jobs. We assume that the bulk of the new jobs that are expected to arise in the South Axis area if the project is implemented, will be located elsewhere in the

Netherlands in the reference scenario.[13] Tables 2.1 and 2.2 give a detailed overview of the urban construction and transport investment programs in the South Axis project in comparison with the reference scenario.

Ideally the most attractive (in terms of maximizing the social welfare) of possible autonomous development alternatives should be chosen as reference scenario.[14] The described reference scenario includes however a moderate investment program that hardly makes any use of the location advantages of the South Axis area. The reason to choose for it was twofold. First, formulation of a more ambitious investment program was complicated by considerable information uncertainties. Second, the overestimation of the relative attractiveness of the South Axis project that results from using a modest reference scenario has no crucial implications for the conclusion of this study (see Section 4).

Table 2.1 Urban construction program of the South Axis project[a]

			Reference scenario		South Axis project	
Real estate	Price [b]	Size	Surface area[c]	Number	Surface area [c]	Number
	euro	m^2 gross floor area	m^2 gross floor area		m^2 gross floor area	
Offices	257		0		367.930	
	240		51.850		245.370	
	221		51.850		286.600	
Residential property for sale	311.074	141	13.110	93	559.350	3.967
	240.658	112	6.500	58	236.540	2.112
Residential property for rent	-	107	0	0	170.130	1.590
Hotel			0	0	28.000	1
Shops			0		14.780	
Other facilities			12.450		223.250	
Total: Offices			103.700		899.900	
Total: Residential property			19.610		966.020	
Total: Other real estate			12.450		266.030	
Parking lots				1.085		17.910
Total			135.760		2.131.950	

a Construction plans starting from 2003 (thus exclusive of the real estate that has been completed during the years before).

b The prices for offices are rents in euros per m^2 gross floor area per year. The prices of the residential property for sale are exclusive of VAT. All prices are the prices of 2003.

c Rounded off to the tenth.

[13] For national companies it seems logical that their offices would be located elsewhere in the Netherlands in the reference scenario. Foreign companies moving to the South Axis in the project scenario can be expected to recruit the majority of the personnel on the Dutch labour market. These employees would most probably be working elsewhere in the Netherlands in the reference scenario.

[14] This allows to get a clear picture of the opportunity costs of the project.

Table 2.2 Infrastructural characteristics of the South Axis project

	Current situation	Reference scenario	South Axis project
Railway tracks			
Tracks without platforms	2	2	4
Tracks with platforms	2	2	6
Turn tracks	1	1	4
NS-railway station Amsterdam South/WTC	_	Minor adjustment	Major adjustment
Motorway A10			
Main lanes	2 x 3	2 x 4	2 x 2
Parallel lanes	_	_	2 x 2
Hard shoulder	Yes	No	No

3 Methodology

We evaluate the welfare effects of the South Axis multifunctional land use project using the technique of partial cost-benefit analysis. In this study we distinguish three direct effects of the South Axis project: effects on the land market, effects on the transport market and external effects. Furthermore, an indirect effect on the employment is taken into account. As the aim of the partial cost-benefit analysis is to give a first impression of the costs and benefits of a project, the first two direct effects are quantified, the other effects are assessed qualitatively. In this section we present the methodology used in the determination of the mentioned effects. Table 3.1 gives an overview of the effects that are taken into consideration.

3.1 Effects on the land market

In terms of demand and supply at the market for urban construction land, the South Axis project has two consequences. The combination of these determines the new market price of land at the location and the change in the producer and consumer surplus as a result of the project. 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 multifunctional land use realised in the South Axis project can be expected to increase the productivity of companies at the location and thus the productivity of land in the area.[15] As a

[15] We assume that the increase in land productivity is completely reflected in the increased value of land. Therefore we consider this effect among direct effects. (The productivity benefits could also manifest themselves as higher remuneration of employees or higher profits of companies at the location, in which case they should be seen as indirect effects. The issue of the distribution of the benefits of the project is however outside the scope of our analysis.)

consequence the willingness to pay for land on the spot increases. We will henceforth refer to this increase in the land productivity as 'the improvement of the location quality'.

Table 3.1 Direct and indirect effects of the South Axis project

	Costs	Benefits	Quantified in the CBA
Direct effects (not-external effects)	*Land market*		
	0 Making land ready for building		Yes
	0 Maintenance costs		Yes
		0 New parcels in the project area	Yes
		0 Improvement of the location quality[a]	
		- New parcels to be developed in the project area	Yes
		- Already developed parcels in project area and existing real estate in the direct vicinity	Yes
	Transport market		
	0 Extension and adjustment of infrastructure		Yes
	0 Traffic delays during construction		No [b]
		0 Travel time reduction: local traffic	Yes
		0 Travel time reduction: through traffic	Yes
		0 Increase in punctuality: local and through traffic	No [b]
Direct effects (external effects)		0 Environmental effects	No [b, c]
		0 Effects connected to safety	No [b, c]
		0 Improvement of the location quality[a]	No [b]
Indirect effects		0 Increase of national employment	No [d]

a Improvement of the location quality is partly an external effect and partly a not-external effect: see section 4 for further discussion.

b This item will be included pro memoria.

c We expect this item to be of negligible size.

d Theoretical arguments suggest that this item is of negligible size.

Possible mechanisms behind the expected increase in productivity of companies at the South Axis are as follows. Tunnelling the infrastructure and using the available space above ground for urban construction brings together two Amsterdam districts - Amsterdam-South and Buitenveldert - which are currently divided by the rail. This creates a rather large unbroken urban area that will be characterised by the presence of different land uses (such as office use, residential use, recreational use, etc.) and an attractive urban design. The urban design and synergy effects between different land uses are likely to be seen by employees as attractive working conditions making it easier (and cheaper) for companies to attract highly productive personnel. Furthermore, new business activity locating in the offices to be built in the area as well as improved accessibility of all parts of the area can

be expected to have a positive influence on the agglomeration economies companies can enjoy there.[16] Thus, for example, in case the project results in internationally-oriented companies moving to the South Axis, knowledge spillovers from new cooperation links between employees can be expected.

The location quality improvement is expected to have positive implications for the value of all the new real estate completed in the South Axis area during the project, but also for the value of real estate that existed in the area and its direct proximity by 2003 - the time when this study was performed.

An important consequence of the implementation of the South Axis project is that new business activity is expected to move to the project area. This implies that - in comparison to the reference scenario - in some other locations in the country land will be available for other use than office buildings (such as agriculture, residential property building, nature, etc). For the purposes of this study we assume that in the reference scenario: (i) the business activity that moves to the South Axis if the project is implemented, is spread over different existing locations so that its influence on the local land market can be seen as marginal and (ii) the regional zoning policy at the locations in question reflects the social preferences. This implies that the choice of companies to move to the South Axis does not lead to any social costs or benefits at other locations.

Producer and consumer surplus

The effects of the project on the land market can be separated into the change in the producer surplus and the change in the consumer surplus. If the productivity of the land is completely reflected in the market price of the land, then the producer surplus for the landowner is the only surplus that arises at the market. The user of the real estate pays then in full for the advantage that she experiences from locating in the South Axis area. If the location advantage is not completely accounted for in the land price, consumer surplus arises. The location benefits for the consumer are then higher than the price she actually pays.

The change in the producer surplus depends on the new market price of the land. In Section 4 we will discuss how the producer surplus can be estimated. Below attention is paid to the existence and size of the consumer surplus in the South Axis project.

We assume that companies that are expected to move to the South Axis area if the project is implemented, would be located elsewhere in the reference scenario. As the companies pay for the relative location advantage that they enjoy at the South Axis, it seems logical to assume that they are attracted to the area by the consumer surplus.

The change in the consumer surplus caused by the South Axis project can be separated into a volume and a quality effect. The former has to do with the shift of the supply curve to the right. The latter is caused by the shift of the demand curve upwards. The price elasticity of demand determines the size of the volume effect of

[16] Investors in real estate agree that the South Axis is a prime location at the Dutch office market. South Axis owes this position not only to the concentration of economic activities in the Amsterdam region, but also to the already existing transport infrastructure, proximity of Schiphol and the many cultural and other facilities of the city of Amsterdam. In other words agglomeration economies and the synergy effects that arise from proximity to different land uses can be expected to play an important role in determining the demand for land in the South Axis.

the consumer surplus. While the exact value of the price elasticity is unknown, it can be argued that this will be rather high. The reason is that the South Axis location is competing with a large number of alternative locations. The high price elasticity of demand implies that a relatively large increase in supply of land (which takes place if the project is realised) will ceteris paribus result in a relatively modest price change. The volume component of the consumer surplus is then small. It can be argued that it is negligible compared with the residual land value itself.

The project implies however not only an increase of the land supply, but also an improvement in the location quality. For the purposes of this study we assume that the value of the location quality improvement is creamed off by the producer. The quality effect can then be neglected as well. As a result, we do not include the change in the consumer surplus in the balance of costs and benefits of the project.

3.2 Effects on the transport market

The South Axis project foresees an increase in the capacity of the motorway and the rail. This yields transport benefits of two kinds: travel time reductions and increased punctuality. In our analysis we distinguish between 'local' benefits, the advantage which accrues to companies and inhabitants in and nearby the project area, and benefits that accrue to the through traffic. Insofar as the transport benefits accrue to the companies and residents at the project location and in the neighbourhood of it, they will be reflected in the increase in the value of land. The benefits received by the through traffic are not reflected in the land prices and should be accounted for separately.

Costs of the project on the transport market include investment costs of modifying transport infrastructure and traffic delays that occur as a result of the construction activities. The estimation of the transport benefits and costs will be discussed in Section 4.

3.3 External effects

Under external effects we understand changes in welfare which the project causes to others than those involved in the decision-making about the project, and which have not been accounted for in the decisions about the project. We distinguish the following externalities:

- Environmental effects. The project influences the environment in different ways. Environmental benefits of the project include for example: a reduction of nuisance as a result of tunnelling the transport infrastructure; new recreation facilities foreseen in the South Axis project, etc. Growth of traffic may cause environmental costs in the form of an increase in polluting emissions. On the other hand, if the increase of the rail capacity will lead to substitution between transport modes, a decrease on a national scale in the emissions from road traffic might take place.

- Effects connected to safety. Tunnelling the motorway implies that restrictions arise concerning the transport of hazardous substances. Adjusting the construction program as to limit the safety risks would be very expensive. According to the Ministry of Transport and Public Works however, there exists a good alternative for transportation of hazardous substances, namely the motorway A9.
- Effects on the location quality. Improvement of the location quality has been mentioned above as a direct and not-external effect. Insofar the increase in the location quality is accounted for in the land and real estate prices, it is indeed being internalised. Location quality that is being enjoyed by the tourists and passers-by, who are not involved in the decision-making process concerning the project, is an externality.

3.4 Indirect effects

Under direct - or primary - effects we understand the effects of the project on those markets where intended impacts of the project take place. Realisation of the project can however, result in secondary or tertiary effects on other markets as well. These so-called indirect effects do not always lead to a change in economic welfare. When relevant markets are characterised by perfect competition, indirect effects only result in a redistribution of direct effects. The possibility of additional welfare changes only exists when the project impacts imperfect markets. These welfare changes can be positive or negative. The recent research on basis of the spatial general equilibrium models argues that the indirect effects yield a net welfare benefit, which is however small compared to direct effects (Bröcker, 2003). Below we consider the indirect effect of the South Axis project on national employment[17].

The possible employment effect of the project is a long run effect since the time horizon of the South Axis project is more than 30 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 being determined by macro-economic factors and institutions at the labour market. In this framework infrastructural projects have hardly any influence on the employment in the Netherlands. While the employment at the project location can rise, in the equilibrium this increase will be compensated by a fall in employment somewhere else in the country. This results in a net effect on national employment that can be neglected.[18]

[17] Employment growth, together with productivity growth, are sources of social welfare increase.

[18] In Section 4.4 attention will be paid to the regional and local employment effects of the project.

4 Implementation and results

4.1 Effects at the land market

4.1.1 Volume effect

The volume component of the producer surplus equals the value of newly issued land given the unchanged demand curve. We estimate this effect by deriving the residual value of land in the project area from the expected value of the real estate to be constructed. This approach builds on the differential theory of rent by Ricardo (1817). It is being used by municipalities in determining the rents for newly issued land and has furthermore been applied in the analysis of the effects of possible relocation of Schiphol (Nyfer, 1999) and the effects of the reconstruction of the Rotterdam Central station (NEI, 2003).

The residual value of the land can be derived as a balance of the net revenues of the real estate development of the land and the costs that must be made to make the land ready for building. The net revenues of the real estate development equal in their turn the balance of the revenues from exploitation of the real estate and the development/ building costs and the costs of maintenance. A normal return to the capital constitutes a part of the development/ building costs.

To apply this method we need to estimate the revenues of the real estate development and the costs of making the land ready for building. This requires assumptions to be made concerning the developments at the land market. 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. The South Axis project foresees yearly completion of approximately 900,000 square meter gross floor area reserved for offices during the period until 2035. Starting from 2015 more than a half of the yearly construction volume concerns the office space in the most expensive segment of the market. At the same time the South Axis project implies the construction of well over 6,000 dwellings for sale and almost 1,600 for rent. The residential property for sale belongs all to the expensive segment of the market, whereby prices are 240,000 respectively 310,000 euro for an apartment with the surface area of 112 respectively 141 squared meter. The residential property for rent belongs to the so-called social sector.

In the cost-benefit analysis we have performed calculations on the basis of the above mentioned parameters (see table 2.1 for the detailed description of the construction program). We think however that the use of these parameters may lead to an overestimation of the land benefits. While the projected pace of land issue and the expected price level in the business district of the South Axis fit with the market conditions and historical developments in the last decennium of the 20-th century[19], this does not guarantee that they can be seen as realistic for the future. In Section 5 we will further go into the uncertainties surrounding the yields from issue of land for construction purposes.

[19] See Besseling et al. (2003) for an extended discussion.

For the purposes of our analysis the level of rents paid for the housing in the social sector is assumed to be determined in such a way that the net exploitation yields exactly compensate the costs of making the land ready for building. These rents do not seem to be a good measure for the utility that tenants receive from their housing. One can expect that the tenants are willing to pay more, although they will not be capable to pay the real market price. To somehow do justice to this observation a rather rough approximation is made: the net benefits of rented housing in the social sector are set equal to a half of the yields from the cheapest category of free sector housing (corrected for the differences in the floor area between these two types of housing).

4.1.2 Quality effect

To calculate the quality component of the producer surplus we need to estimate the increase in the value of real estate in the project area and its direct proximity, which will result from the location quality improvement in the South Axis. This increase in value is assumed to take place in 2015 at the moment when the building excavation is expected to be closed. The price increase concerns all the new housing estate that is being completed after 2015, but also other categories of real estate: (i) all new housing estate completed between 2003 and 2015, (ii) real estate that was in the area of the project and the direct proximity by 2003.

For the purposes of this paper we rely on existing studies that have estimated the impact of the South Axis project on the real estate value in the area. On basis of expert opinions of large Dutch real estate agents Fakton (2002) expects a 10% value increase due to the implementation of the project. Buck Consultants International (2002) estimates that the South Axis project will result in a 15% increase in the so-called 'area quality index' that accounts for the location characteristics such as accessibility, availability and quality of facilities, economies of scale, the quality of real estate and image-effects. In this cost-benefit analysis we assume the location quality improvement to result in a 10% increase in the real estate value and provide a sensitivity analysis of the results for other values of the location quality effect.

4.1.3 Investment costs

The investment costs involved in the construction program of the South Axis project include: (i) costs of making land ready for building; (ii) development/ building costs; (iii) maintenance expenditures.[20] The specification of these costs was taken from the business case study of the South Axis project (Fakton, 2002). This cost specification was assessed at our request by a real estate expert of NIB Consult BV, a consultant agency specialised in public investment problems. NIB Consult BV (2003) concludes that the construction costs and relevant surcharges (including sales expenses, overhead, profit- and risk-premium) are estimated rather high, but that this can be explained by the specific construction requirements and spatial conditions inherent to the South Axis project. The costs of making land ready for building however (see table 4.1 for an overview of these costs) include three items which considerable size is inexplicable. These are 'acquisition' (acquisition of the rights to

[20] Development/ building costs and maintenance expenditures are not specified separately in the balance of costs and benefits as they are accounted for in the calculation of land benefits (specifically in determining the residual land value).

the parcels of land), 'making ready for building' (removing current construction etc.) and 'other'. If the comprehensive cost-benefit analysis is to be made, it should be studied to what degree this cost specification is realistic. In Section 5 we will provide a sensitivity analysis of the results of this study to the size of the costs of making land ready for building.

Table 4.1 Present value of the costs of making land ready for building [a]

Category	Million euro
Acquisition	150
Demolition	10
Making land ready for building	320
Civil constructions	30
Preparation	50
Greenery	10
Quality	10
Other	290
Total	860

[a] Amounts in present value of 2003; discounted with the discount rate of 4% per year; rounded off to the ten millionth.

4.2 Effects at the transport market

4.2.1 Railway benefits

We distinguish two types of transport benefits: travel time reductions and increased punctuality. An estimation of the former is included in this cost-benefit analysis; the latter have been accounted for as a pro memoria item. The benefits in the form of shorter travel times have been estimated using the calculations by ProRail, the company in charge of the Dutch railway network. ProRail (2003) has estimated the total benefits and has given an indication of the number of passengers with the destination South Axis and the number of through passengers in 2020. Using these figures we have distinguished between 'local' benefits (the advantage which accrues to companies and inhabitants in and nearby the project area), and benefits that accrue to the through traffic.

The estimations by ProRail have been made as follows. First of all the capacity of the current transport infrastructure has been determined, in terms of the maximal number of trains that can be put in and the maximal number of passengers that can be transported. Furthermore, the necessary transport capacity after the implementation of the South Axis project has been calculated (the necessity for extra transport capacity may arise among other things due to the expected increase in employment in the project area). If as a result of insufficient transport capacity not all passengers can travel their preferred route, average travel time will increase. These travel time losses have been quantified by studying different alternative routes offered by public transport and used to determine the travel time reductions that are achieved when rail capacity has been extended.

ProRail has estimated the travel time losses in 3 scenarios. In the 'optimistic' scenario a delay of 12 minutes occurs when the capacity of the railway infrastructure is being exceeded, in the 'average' scenario the delay is 18 minutes and in the 'pessimistic' scenario the delay equals 28 minutes. For the purposes of this study we use the estimates from the 'pessimistic' scenario, which yield the highest transport benefits from the extension of rail capacity. In this way we compensate to some extent for the lack of estimates for the benefits of increased punctuality.

The estimation results are incorporated in our analysis in the following way. We assume that the local transport benefits are included in the prices of the real estate in the project area and its direct proximity. In the net present value overview these are subtracted from the land benefits and are put separately on the benefit side. The benefits for through passengers are directly put on the benefit side.

Table 4.2 Transport benefits railway traffic compared to the 'pessimistic scenario' [a]

Local traffic [b]	Through traffic	Total
million euro [c]		
40	50	90

[a] Travel time reduction (exclusive of increased punctuality benefits); the 'pessimistic' scenario produces the highest benefits.

[b] Transport benefits that are enjoyed by companies and residents in and nearby the project area.

[c] Present value in 2003. NB: In table 4.4 all the amounts from this table are rounded off to the 50 millionth.

4.2.2 Road traffic benefits

Estimations of the benefits for the road traffic have been performed by the Office for Infrastructure, Traffic and Transportation of the City of Amsterdam. The South Axis project results in negative net benefits due to extra congestion and vehicle loss hours which are caused by the expected large increase in the number of employees in the project area.[21] These effects are however minor: they are rounded off to zero in the exploitation overviews.

It has to be mentioned that the effects of the project for the road traffic are partly distribution effects. The largest part of the employees who is expected to work in the project area once the project has been realised, would work elsewhere in the Netherlands in the reference scenario. In these other locations there will be some degree of congestion in the reference scenario. This makes the extra congestion and vehicle loss in the South Axis project (leaving the regional effects out of consideration) even smaller. As a consequence we neglect the effects of the project for the road traffic in the eventual comparison of benefits and costs.

[21] The reason is that the A10-motorway in both the project scenario and the reference scenario consists of 4 lanes.

4.2.3 Investment costs

The investments in transport infrastructure within the South Axis project can be separated into the costs of extending the infrastructure and the costs of adjusting it (the latter are borne in order to improve the location quality). The value of the total costs has been provided by the Ministry of Transport, Public Works and Water Management. Although no subdivision of the total costs between the aforementioned two groups is available, it would come as no surprise if the adjustment costs accounted for more than a half of the total infrastructure-related expenditures.[22]

Another cost item that will take place as a result of construction activities are traffic delays. These costs, which often turn out to be considerable, are included as a pro memoria item.

4.3 Net present value of the project

Table 4.3 gives an overview of the parameters used in determining the net present value of the South Axis project. The whole analysis is conducted in real values. This implies, among other things, that the outcomes are valued in the prices of the starting year and that the present value of the costs and benefits is calculated with the use of real discount rates. We use the value of the real discount rate (4%) that has been recommended by the Dutch government for computing the net present value of publicly financed projects (Ministerie van Financiën, 1995).

Table 4.3 Parameters used in the net present value calculations

Real risk-free discount rate (all costs and benefits)	4% per year
Risk-premium for macro-economic risks (land benefits and transport benefits)	3% per year
Time horizon	Infinite
Annual growth rate real estate prices	1,2% per year
Value increase of the real estate in 2015 due to the improvement in location quality	10%

Project effects can be prone to macroeconomic risks – risks that cannot be diversified as they have to do with the developments which impact the whole economy. Land benefits are such an effect. In times of high economic growth the value of land and real estate grows much faster than in times of low economic growth. Investors are only ready to invest in real estate when they receive a compensation for bearing this uncertainty, the so-called risk-premium. Thus they require a higher return on real estate than on for example government bonds. For project effects that are prone to macroeconomic risks, we increase the discount rate with a risk-premium of 3%.[23] This value of risk premium has been recommended by the Commission for Risk Valuation (Ministerie van

[22] This conclusion has been made on basis of the comparison of the South Axis project with other existing investment plans for transport infrastructure at the location.

[23] Another effect which we consider to be prone to macro-economic risks is transport benefits. These are however of much smaller size than land benefits.

Financiën en CPB, 2003). The resulting discount rate of 7% fits well with the real estate returns over the past years: an average of 6.6% over the last 26 years and an average of 8.8% over the last 10 years.[24]

The not-macroeconomic risks involve, for example, the relative attractiveness of the South Axis area in comparison with other business locations, the realised value of the investment costs, etc. As these risks that can be diversified we do not use a risk-premium. The influence of the not-macroeconomic risks on the balance of costs and benefits of the project will be studied in the following section using the sensitivity analysis.

In the South Axis project both, the costs and the benefits are expected to be spread over a rather long period of time. For this reason we use in the cost-benefit analysis an infinite time horizon. The economic life of the real estate is assumed to be 50 years, the land is assumed to be used for construction again thereafter.

In the calculation of the present value of the real estate yields (a part of the residual land value determination) we assume an annual growth of the real estate prices equal to 1.2% per year.[25] This has to do with the relatively low productivity increase in the construction industry. We assume that the relatively low growth of productivity in construction fully translates in an increase in the relative real estate prices.

The results of the cost-benefit analysis are summarised in table 4.4. The yields from land issue (these are in other words the yields from exploitation of real estate) form the largest part of the total of benefits. From the three categories of real estate - offices, residential property and other real estate - the offices yield the largest benefits. The effect of improved location quality equals almost one third of the total of the land benefits (450 million euro in the total of 1.500 million euro). The transport benefits turn out to be small compared to the land benefits.

The costs of making land ready for building equal around 50% of the total investments in transport infrastructure. These costs together exceed the benefits by large, leading to a negative balance of costs and benefits.

Some of the included pro memoria items can be expected to be of considerable size. On the cost side these are traffic delays during the construction, on the benefit side - external part of the location quality improvement.

Table 4.4 Costs and benefits of the South Axis project (relative to the reference scenario) [a]

		million euro
Costs	Extension and adjustment of transport infrastructure	1.800
	Making land ready for building	750
	Transport delays during the construction	pm
(a)	Total costs	2.550+pm
Benefits	Land benefits exclusive of location quality improvement and value increase due to transport benefits to local traffic	
	- Offices	350

[24] In Section 5 we will provide a sensitivity analysis of the cost-benefit balance to the assumption about the risk-premium.

[25] This figure is based on the historical average increase of the real construction costs in the period 1969 – 2001.

	- Residential property	350
	- Other real estate	250
(b)	Sub-total land benefits exclusive	950
	Location quality improvement	
	- Land benefits 2015-2036	150
	- Value increase in 2015 of the real estate completed in 2003-2014	100
	- Value increase in 2015 of the real estate that has been completed by now	200
(c)	Sub-total location quality improvement	450
	Transport benefits local traffic	
	- Railway	50
	- Road	0
	- Increased punctuality	pm
(d)	Sub-total transport benefits local traffic	50+pm
(e)	Sub-total land benefits inclusive	1.450+pm
	Transport benefits through traffic	
	- Railway	50
	- Road	0
	- Increased punctuality	pm
(f)	Sub-total transport benefits through traffic	50+pm
	External effects [b]	
	- Environment	pm
	- Safety	pm
	- External part of location quality improvement	pm
(g)	Sub-total external effects	pm
(h)	Total benefits (e) + (f) + (g)	1.500+pm
NPV	Net present value (h) - (a)	− 1.050+pm

a Present value in 2003, rounded off to the 50 millionth. Totals have been rounded off after adding up not-rounded off amounts; the totals can thus not always be derived as a sum of rounded off amounts.

b We expect these items to be practically zero.

4.4 Regional distribution of project effects

In this paper we assume that the implications of the South Axis project for national employment can be neglected. Substantial employment effects of the project can however occur locally. These effects may be especially important for the population of the Amsterdam region and the local authorities. This section discusses regional employment effects of the South Axis project.[26]

[26] Other possible regional effects of the project, such as effects on the housing market or transport market, are left outside the scope of this partial cost-benefit analysis.

The impact of the South Axis project on regional employment has been earlier studied by Ernst & Young Consulting (Ernst & Young and Regioplan, 1999). In this study we follow the general lines of the approach developed by Ernst and Young.

The authors distinguish temporary and structural employment effects. The former concern the construction activities in the project area and perish after the project has been completed. In this study we leave the temporary employment effects out of consideration. The structural effects leading to a permanent increase in jobs in the South Axis area can be separated into two groups. The first one involves jobs that move to the South Axis from the Amsterdam region, the second has to do with employment that originates outside the region.

The structural employment effect can relatively easily be estimated. The largest part of the employment in the project area will be office-related. The potential increase of the office-related employment in the South Axis can be derived as a product of the increase of the gross floor area of offices in the project area and the so-called office coefficient: the average space used (in terms of square meters of gross floor space) per employee. The estimations of this coefficient from the CPB-project Business Sites Monitor (BLM) suggest that for the South Axis area the value of 30 square meter per person would be reasonable (CPB, 1997). Using this coefficient, we estimate the local employment increase as a result of the South Axis project to be 30,000 persons (the planned office capacity is ca 900,000 square meter).

Shops and other facilities that are planned in the South Axis area lead to new employment as well. For the retail we use the coefficient of 60 square meter per employed person, for hotel and catering industry that of 100 square meter (CPB, 1997). Summarising, the realisation of the South Axis project can be estimated to lead to the total employment growth in the project area equal to ca 32,500 persons (see table 4.5).[27]

Table 4.5 Local employment effect South Axis project

Category	Office-coefficient	Surface[a]	Employees
		m^2 gross floor area	
Offices	30	900.000	30.000
Shops	60	15.000	250
Other facilities	100	223.000	2.230
Total			32.480

[a] Rounded off to the thousandth.

Companies' locating in South Axis will furthermore stimulate the activity of the supplying industries in the region. A traditional method to estimate the size of this effect is a form of an input-output analysis. In this study we leave this effect out of consideration since using a complicated model which is necessary for this type of analysis goes beyond the scope of the partial cost-benefit analysis.

[27] This is less than the employment growth estimated by Ernst and Young, who use lower values of office-coefficients per worker.

The question that remains is what is the origin of the estimated employment increase in the South Axis area. It is known that most companies that re-locate in the Netherlands stay within the borders of the original municipality. According to Ernst and Young this applies to the Amsterdam region as well: in the years 1994-1998 60% of all re-locations to Amsterdam-South and Amsterdam-Buitenveldert originated from the region self. It is thus likely that the realisation of the South Axis project will mostly attract companies from the Amsterdam region. Applying the percentage suggested by Ernst and Young to the earlier presented outcomes gives a rough estimate of the regional distribution of the employment increase. Table 4.6 gives an overview of the local, regional and national employment effects of the South Axis project.

Table 4.6 Regional en national employment effects of the project

Region	persons
Project area South Axis	32.480
Amsterdam region exclusive of the project area	− 19.480
The Netherlands exclusive of the Amsterdam region	− 13.000

5 Discussion

In this section we provide a sensitivity analysis of the results of this study to the assumptions used. This concerns the assumptions we have made but also the assumptions made by external parties whose estimates we have used in the analysis[28]. We start with discussing the crucial assumption for the determination of the benefits of the project – that concerning the employment growth in the South Axis area. Then we present the outcomes of the sensitivity analysis.

5.1 Employment growth in the South Axis area

The level of employment growth in the South Axis area, which is induced by the project, has important implications for the value of project benefits. First the demand for office space is determined to an important extent by the employment in the industries that are characterised by a high percentage office-related employment.[29] The demand for office space determines in its turn the yields from issue of land for construction purposes, which are by far the largest item at the benefit side of the South Axis project. Second, the developments in employment growth have implications for the demand for transport in the area.

[28] The nature of the partial cost-benefit analysis implies that in the calculation of the net present value we had to rely in many instances on estimates provided by external parties, which not always could be seen as completely independent.

[29] Other relevant factors influencing the demand for office space are: the value of this percentage and the value of the office-coefficient (the office space used per office employee).

The office-related employment is concentrated in a rather small number of industries. The main among them are banks and insurance companies (77% office-related jobs) and other services (47% office-related jobs). Together with the government sector the mentioned industries make the largest contribution to the office-related employment in the Netherlands. In the 1990's the industries in question experienced a spectacular growth. The prospects for this century are, however, much less bright. CPB-scenario's for the economic development in the medium and long term suggest that the employment growth in these industries are likely to experience a sizeable drop in the period until 2020 and become negative in the period 2021-2030 (see table 5.1).[30]

Table 5.1 Employment growth 1991-2030 [a]

		All industries	Services exclusive of government, education and health care	Bank and insurance, business services, hotel and catering industry
		Average change (percentage per year)		
1991-1995		0,6	1,9	3,0
1996-2000		2,9	4,0	9,6
2001-2010	EC	0,9	1,2	1,7
2011-2020	EC	0,8	1,1	1,6
2021-2030	EC	− 0,1	− 0,2	− 0,2
2001-2010	GC	0,9	1,4	2,1
2011-2020	GC	1,0	1,6	2,8
2021-2030	GC	− 0,4	− 0,4	− 0,4

a 1991-2000: Realised values; in years of employment; only employees on the payroll (not self-employed).
2001-2030: Estimations for the scenario's *European Coordination* and *Global Competition*; in persons who work at least 12 hours per week; source: Jansen et al. (2001).

The employment growth in financial and business services plays a crucial role for the future demand for office floor space at the South Axis. In the construction program for offices the expected pace of land issue and the expected price level fit with the market conditions and historical developments in the last decennium of the 20-th century.[31] The employment fall which is expected to take place in these industries around 2020 presents thus a serious risk for the extensive office-building plans in the South Axis project.

Uncertainty under consideration is partly tackled in the project by allowing the exact specification of the construction program to be flexible. If market conditions on the office market turn to be unfavourable, the construction program can be adjusted by replacing some offices buildings with apartment buildings.[32] The yields

[30] The decrease in employment in the third decennium of the 21th century foreseen by the CPB-scenario's is an implication of expected demographic developments in the Netherlands.

[31] See Besseling et al. (2003) for further discussion.

[32] The construction program for residential property is – in contrast with the program for offices - modest. With approximately 265 dwellings per year the South Axis will make a minor contribution to the housing stock (the total of newly built residential property in the Netherlands is 60,000 per year). The expectation is that the demand for the housing in the South Axis area will be largely sufficient to meet this extra supply at the current price level.

from the latter are in general less uncertain than the yields from the former. However, the average return from investment in residential property is lower than that from investment in offices. The flexibility of the program thus does only partially compensate for the negative impact on the land benefits of the uncertainties on the office market.

On the transport market we think that given the expected developments (especially the expected fall in employment starting around 2020), a 2% autonomous growth in the rail transport in the period 2020-2037, which is foreseen in the calculations of ProRail (2003), is likely to be an overestimation. From 2020 on the volume of the through traffic in the rush hour will most probably not grow any more. This overestimation has been partly corrected in our analysis by neglecting all the transport benefits that will be realised after 2037.

5.2 Sensitivity analysis

In the previous sections we have discussed the assumptions made in this cost-benefit analysis, and the possible uncertainties that surround these assumptions. In this section we analyse how sensitive the outcomes of the cost-benefit analysis are to these assumptions. The assumptions in question include:

- The value of risk premium for macro-economic risks (see variant 1-3 in table 5.3). In the cost-benefit analysis (CBA) a risk premium equal to 3% has been applied in the calculation of the net present value of the land and transport benefits and a risk premium of 0% has been applied to the costs of making land ready for building.
- The annual growth rate of the real construction costs and real estate prices (variant 4). In the CBA we assumed that these grow with 1.2% per year as a result of the relatively low productivity increase in the construction industry.
- The level of real estate prices (variant 5). As discussed in the previous section, in the construction program for offices (as described in the South Axis project) insufficient account has been taken of the expected developments at the office market in the first decennia of the 21-th century;
- The level of the investment costs (variant 6). In the specification of the costs of making land ready for building (Fakton, 2002) the size of several items seems to be inexplicably high;
- The size of the increase in the real estate value due to the location quality improvement (variant 7 and 8). No widely accepted methodology exists to determine the value of this value increase. In the CBA we used an estimation based on expert opinions;

Furthermore, the assumption about the number of dwellings for rent in the social sector is included into the sensitivity analysis (variant 9). Table 5.2 shows the results of the sensitivity analysis.

Table 5.2 suggests that the conclusion of the cost-benefit analysis is rather robust to the assumptions made. Neither of the considered variants results in a positive balance of costs and benefits of the project. At the same

time we see that the value of the cost-benefit balance of the project is rather sensitive to the assumptions concerning the calculation of the land benefits (the value of the discounting rate, the level of real estate prices). This could be expected given that the yields from land issue form the largest item on the benefit side. The composition of the urban construction program (namely the presence of residential property for rent) turns to have a rather minor influence on the outcomes.

Table 5.2 Net present value of variants

Variant	Net present value in 2003 relative to the base variant million euro [a]
0 Base variant	0
1 Risk premium for land and transport benefits 2% per year (instead of 3%)	750
2 Risk premium for land and transport benefits 4% per year (instead of 3%)	− 450
3 Risk premium of 3% (instead of 0%) for costs of making land ready for building	150
4 Annual growth rate of 0% (instead of 1,2%) of real estate prices	− 600
5 Starting prices real estate 15% lower	− 550
6 Investment costs increased with 20%	− 500
7 Urban quality: no price increase real estate in 2015 (instead 10%)	− 450
8 Urban quality: 15% price increase real estate in 2015 (instead 10%)	250
9 Only residential property for sale (none for rent)	50

[a] Rounded off to the 50 millionth.

6 Conclusion

This paper has evaluated the welfare effects of a large multifunctional land use project involving urban construction and infrastructural investment in the Amsterdam South Axis Area. Using the technique of partial cost-benefit analysis we have explicitly compared the benefits and costs of combining different land uses in South Axis.

We have distinguished three direct effects of the South Axis project: effects on the land market, effects on the transport market and external effects. Furthermore, an indirect effect on the employment has been taken into account. As the aim of the partial cost-benefit analysis is to give a first impression of the costs and benefits of a project the first two direct effects were quantified, the other effects were assessed qualitatively.

We have found that the project as it was specified in 2003 has a negative balance of benefits and costs. The main reason is that combining different land uses in the current project specification proves to be too costly in comparison with the benefits it yields. Tunnelling the transport infrastructure results in land benefits since it

makes space for construction of new buildings and leads to the improved quality of the location. However, these benefits alone are insufficient to justify the size of the investments in adjusting the transport infrastructure.

Some qualifications to the performed analysis are due here. First of all the partial character of the cost-benefit analysis implies that not all costs and benefits could be quantified. As a result, pro memoria items are present both at the cost and the benefit side of the analysis; these items have not been accounted for in the calculated net present value. To our opinion, however, it is not likely that quantifying these pro memoria effects will lead to a drastic adjustment of the conclusion of this study.

Furthermore the construction program involves large uncertainties. The size of the yields from the considerable enlargement of the office capacity that is foreseen by the project, depends to a large degree on the developments in the market for office buildings. This market is very sensitive to the business cycle and shows large fluctuations in price and returns. In this study the calculation of the net yields from exploitation of office real estate has been based on a rather optimistic future economic scenario that extrapolates the favourable economic developments of the last decennium of the 20-th century. It does not account for the possibility of a structural fall of employment in financial and business services, which, according to current forecasts, can be expected around 2020. The possibility of the employment fall presents a serious threat to the market for office buildings and, consequently, to the land benefits of the project.

The South Axis project in its current specification yields a negative balance of costs and benefits. Given the excellent location of the South Axis area it should however be possible to design an urban construction program that clearly contributes to the welfare in the Netherlands. To our opinion, the starting point of such a design should be a less costly specification of the adjustments to transport infrastructure. Phased completion of the transport facilities is one of the possibilities to keep the costs down. The construction program should, to our opinion, however, stay ambitious. The South Axis area provides space to realise this ambition, and the unique location of the South Axis ensures the attractiveness of the area for business.

Finally, if our analysis is to be extended to a comprehensive cost-benefit analysis, the following steps can be undertaken. First of all, the pro memoria effects need to be quantified. Furthermore, it can be recommended to examine critically the costs of making land ready for building. We found several items in this cost specification to be inexplicably high. Finally, we think that a risk analysis of the real estate market should be a necessary part of the comprehensive cost-benefit analysis of the project.

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