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The measurement of indirect effects in project appraisal

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Abstract

Imperative for growth is dominating the present economic conditions also influencing decision-making to a large extent. Therefore, the analysis of economic impacts plays a more and more significant role in the selection of transport projects. However, ex-ante project appraisal is facing an increasing problem concerning the measurement of indirect economic effects. This paper aims to investigate the accurate way of quantifying such benefits via the analysis of theoretical issues, the review of existing approaches and a case study.

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Keywords: economic appraisal; wider economic impacts; cost-benefit analysis, multiplier effect

1. Introduction

Current economic conditions have made remarkably important to select the most profitable development projects that best support economic growth. Therefore, ex-ante appraisal of projects plays a more and more significant role in decision-making. However, direct effects of a certain project can fairly be measured, accurately capturing indirect effects faces huge challenges. Cost-benefit analysis (CBA) and economic impact analysis (also known as Gross Value Added – GVA approach) are widespread methods in project appraisal both having different perspectives, thus different deficiency as well. CBA is said to be a robust framework, although, it is not able to incorporate all the benefits, and it does not provide any information concerning the effect on GDP. Whereas economic impact analysis estimates the change in total economic activity and the impact on labour market based on different econometric models or using

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multipliers provided by input-output models. Undoubtedly, the assessment of costs, social benefits and externalities are not included.

The appropriate measurement of indirect economic impacts in project appraisal is being widely discussed among professionals, though, consensus is still need to be reached. This paper first aims at further investigating theoretical questions concerning the accurate measurement of wider economic impacts avoiding double-counting. Among others, this study concentrates on the problem of distinguishing and separating effects on GDP and welfare.

Second, this paper attempts to review the different approaches in practice regarding the appraisal of indirect effects caused by transport projects. While in many countries the concept of CBA is prevailing, elsewhere the GVA approach has been given the priority, such as recently in the UK. Moreover, like in Hungary, many analyses mix the two technics together. However, applying multipliers in cost-benefit analysis not just yields substantial impact on the benefit-cost ratio thus crucially influencing decision-making, but raises remarkable theoretical problems to be discussed.

Third, this paper analyses two methodological problems via a case study. The first one investigates the relevance of wider impacts even in the case of a small-scale project. The goal of the second calculation is to shed light on a problem concerning multiplier effects. Finally, theoretical conclusions are derived.

2. Theoretical and methodological issues in evaluating transport projects' wider economic impacts

The field of transport appraisal where the methodology of CBA has evolved, offers appropriate opportunity for examining general methodological problems as well. In CBA, as it has been shown by several authors (e.g. revisited by Laird et al., 2014), prices are taken equal or a broadly approximate to marginal social cost, since the underlying assumption holds that perfect competition prevails on the secondary markets. That is, CBA conceptually excludes the appraisal of secondary markets from transport analysis. However, arguments exist suggesting the reconsideration of the approach in order to enhance the measurement of indirect effects, which is crucial in the evaluation of benefits.

Accordingly, several shortcomings of cost-benefit analyses make it necessary to enrich calculations. On the one hand, many general theoretical problems exist that still need to be solved (e.g. see Nash, 2010) such as the following:

- One of the economically most important ones is connected to the distribution of costs and benefits. Having known that the same amount of benefit is theoretically considered equal irrespective of the group of the society it belongs to, the question then arises as to what stakeholders should be given the priority by a higher weighting?
- The concept of willingness-to-pay (WTP) and willingness-to-accept (WTA) can also be methodologically criticized. From the respondent's rationality and sincerity to the so-called framing effect, many aspects of stated preference methods could be disputed. In this way, many inputs of the CBA contain a huge amount of uncertainty.
- Impacts linked to raising the additional public funds needed to finance projects are definitely proved to be high. First, all public expenditure, irrespective of the sector in which it is spent, has relevant opportunity cost, as public money can especially be considered a scarce resource. While the concept of alternative cost is a well-established element of economic theory, empirical application in analyses is still need to be improved. Second, the loss incurred by society originating from raising additional revenues to finance government spending induces huge additional costs too. The concept of marginal cost of public funds (MCF) attempts to measure this deadweight loss due to the distortion of resource allocation caused by taxation, however, its practical application is also a challenging issue to further examine.
- Some politically driven arguments criticize that CBA does not provide information on economic performance or employment. However, this can hardly be the scope of such a welfare-oriented approach.
- Gaining information regarding the effects of public spending on investments seems a reasonable claim apart from politically induced motives as well. This is hardly involved in CBA. The mentioned inclusion of multiplier effect in many Hungarian CBAs, although, in not a methodologically adequate way, presumably attempts to capture this impact.
- Moreover, even the role of CBA is often questioned, whether it is supporting or proving decisions in practice.

On the other hand, concerning transport specific benefits, completely covering all benefits is a serious and relevant question. It seems that traditionally monetized benefits, such as environmental, time, accident and vehicle operating cost savings are not able to capture all the real benefits caused by transport-related investments for the whole society, economy and environment (see DfT, 2005, Mackie et al., 2011). Next chapter examines the different ways of monetizing them in different national practices.

3. International comparison of practices in terms of assessing wider benefits

While according to the approach of the new EU CBA guide (European Commission, 2014) excluding wider impacts from quantitative analyses and instead, providing a qualitative description would be adequate and desirable (in order to avoid double-counting), it seems that in practice many attempts have evolved and been applied in different national methodologies to monetize them.

This section presents the review of national CBA approaches with a special focus on the monetization of wider economic impacts (WEIs). The comparison is based on the review of literature including a recent report from ITS Leeds (Mackie & Worsley, 2013) and information provided by other CBA experts (Lori Tavasszy, Jan Anne Annema, Oliver Lah). Leading European countries in transport appraisal have been included, completed with Hungary representing the 'late-comers', the region of Central and Eastern Europe (CEE).

Table 1 shows the results of the comparison from which the following conclusions can be drawn:

- National guidelines and specific values are continuously updated in the advanced countries but it is still a serious problem for the late-comers. Reasons in the background can be found in the institutional and political systems. Gaining detailed information about the effects of development projects does not seem to be a feature coming from the inside of the system, rather the result of an external pressure from EU regulations.
- Differences in the length of the appraisal periods and the values of discount rates make it difficult to compare similar international projects.
- Calculation of risk and uncertainties vary by countries; there is no unified methodology.
- Measuring travel time reliability and comfort effects have already been included in most national guides, except for Germany and the CEE countries.
- Calculation of WEIs are also involved in the guidelines of the most advanced countries but missing from the ones of CEE.
- Regarding the inclusion of WEIs the methodology of the United Kingdom (WebTAG, see DfT, 2014) can be considered the state-of-the-practice. The key element seems to be the agglomeration externality, however, different national approaches apply different adjustments such as the following:
  - France has a similar practice as the UK based on results from LUTI modelling and statistical analyses.
  - Sweden has a modified technique based on the relationship between accessibility and wages.
  - Germany has an own calculation method.
  - In the Netherlands SCGE modelling and ad-hoc 'add-on' methods are applied.
- Hungary's spreading practice is to include the multiplier effect on GDP caused by the investment cost as a benefit in CBA. This unique approach is not included in the Hungarian national guide (COWI, 2009) and lacks for transparent theoretical description. The method is quite controversial due to the fact, among many others, that CBA originally concentrates on welfare. This paper disputes the correctness of multipliers direct inclusion in the CBA framework but this problem raises many other questions worth to think of.

4. Case study from Hungary

With the intention to examine the scale of wider impacts and to better understand GDP multiplier effects, two different calculations have been carried out. The first presented case study aims at estimating the magnitude of WEIs based on WebTAG. The goal of the second calculation is to investigate the problem of applying multiplier effects. Both studies are based on the same case.

The selected case is a standard urban road project concerning the inner bypass section of main road no. 3 in the city of Miskolc, the fourth biggest city of Hungary with a population of around 160,000 people. Currently the main road goes through the city centre which is the most congested part of the city. The proposed new section of the road would provide a bypass on the east side of the city and that would also improve the accessibility of some nearby industrial areas.

Table 1. Comparison of transport appraisal in European countries focusing on WEIs (based on Mackie & Worsley, 2013)

		UK	Germany	France	Sweden	The Netherlands	Hungary
Date of the current guideline		2014	2003 (updated in 2010)	2013	2010 (constantly updated)	2000 (constantly updated)	2009 (updated in 2015)
Standard appraisal period (years)		60	Varies	fix period until 2070 + residual value until 2140	40-60	Varies	30
Key appraisal metrics		NPV, BCR	BCR	NPV, BCR	BCR	NPV, IRR, BCR	NPV, IRR, BCR
Social discount rate		3.5% for the first 30 years, then 3%	3%	2.5%+2% (risk premium)	3.5%	2.5% + 3% (risk premium)	5%
Tr. time savings	Monetised items (according to national guides)	Y	Y	Y	Y	Y	Y
Tr. time reliability		Y	N	Y	Y	Y	N
Safety		Y	Y	Y	Y	Y	Y
VOC		Y	Y	Y	Y	Y	Y
Air pollution		Y	Y	Y	Y	Y	Y
Noise		Y	Y	Y	Y	Y	Y
Climate change		Y	Y	Y	Y	Y	Y
Env. capital		N	N	Y	N	N	N
Comfort		Y	N	Y	Y	Y	N
WEIs		Y	Y	Y	N	Y	N
Other		Regeneration	-	-	-	-	-
Key items	Measurement of WEIs in practice	Agglomeration externality, Output change due to imperfect secondary markets, Labour market effects	Special bonuses for cross-border transport and connections with airports/seaports	Agglomeration externality, Output change due to imperfect secondary markets	Agglomeration externality (accessibility - wage relationships)	Agglomeration externality	GDP multiplication effect (effect of the invested money)
Main methods		Agglomeration: calculation of effective density and its effect on productivity Output and labour market: uplift factors on business benefits and GDP effects	n.a.	Agglomeration: calculations based on LUTI models and statistical analyses Output change: uplift factor on business benefits	Analysing the accessibility - wage relationship	Regional economic models (SCGE) or diverse ad-hoc methods	Controversial methodology based on a standard unit multiplier

4.1. Examining the magnitude of wider impacts

In this section two different calculations have been compared. Results are presented in Table 2. The second column shows the results of the 'standard case' which was calculated according to the Hungarian national CBA guidelines with a small amendment of travel time reliability savings based on the methods of WebTAG (TAG Unit A1.3 – Reliability on urban roads), since it is not included in the Hungarian guide. In the third column ('wider case') wider impacts are added according to the practice of the UK (based on TAG Unit A2.1). The computation was based on the following equations:

$$WI1_i^{k,f} = \left[\left(\frac{d_i^{A,k,f}}{d_i^{B,k,f}}\right)^{\rho^k} - 1\right] GDPW_i^{B,k,f} E_i^{B,k,f} \tag{1}$$

where, $WI1_i^{k,f}$ is the sectoral agglomeration impact for zone i and industrial sector k in year f; $d_i^{A,k,f}$ and $d_i^{B,k,f}$ are the so-called effective densities in the do-something (A) and do-nothing (B) cases respectively; $GDPW_i^{B,k,f}$ is the GDP per worker; $E_i^{B,k,f}$ is the total employment; ρ^k is the elasticity of productivity with respect to effective density in industrial sector k.

$$WI2^f = 0.1BUB^f \tag{2}$$

where, $WI2^f$ is the additional impact of output change in imperfectly competitive markets; BUB^f is the total user impacts to business journeys (data is originated from the CBA model including business travel time savings, vehicle operating cost savings and reliability gains).

$$WI3^f = 0.4GP1^f + 0.3GP3^f \tag{3}$$

where, $WI3^f$ is the additional impact of tax revenue changes from labour market impacts; $GP1^f$ and $GP3^f$ are the impacts on GDP from more/less people working and from the move to more/less productive jobs respectively. Someone can note, that parameters are not specifically designed for the Hungarian economy. However, the value of 'tax take on increased labour supply parameter' (0.4) and the 'tax take on move to more productive jobs parameter' (0.3) can be considered a sufficient estimation for the Hungarian case.

Additional benefits (reliability and WEIs) have been calculated on the basis of transport modelling results (travel time skim matrices). The model contained nearly 300 zones adequately representing the transport network. However, a LUTI model was not available for the region, therefore GP1 and GP3 impacts were estimated taken WebTAG methods and regional economic forecasts into account. It is important to note that the estimation of wider impacts is highly sensitive to parameters and input variables such as elasticities, GDP per worker values and employment forecast. For some of these values optimism bias is also likely to occur, as they are mostly derived from ambitious assumptions. Therefore, all results concerning wider impacts should be handled by care due to the high level of uncertainty.

Standard results show that the economic costs (around 28.5 million EUR in present value) are balanced with the benefits coming mainly from travel time and vehicle operating cost savings (around 30.2 million EUR in present value). These benefits are the consequences of higher speed on the bypass road. However, drivers on the new section need to cover more distance and therefore accident and environmental costs are increasing as a result of the project causing negative benefits. With a benefit-cost ratio (BCR) of 1.06 the project exceeds the threshold but it can hardly represent high value for money based on these conventional calculations.

From the point of decision-makers' view it is important to know whether the project supports economic growth, and if so, how far it can influence the economy. The second calculation ('wider case') tries to support these arguments. The computation resulted in significant wider benefits (around 13.9 million EUR in present value) which means the 31.5% of total benefits. Thus, the inclusion of wider impacts increased the BCR to 1.55. The unexpectedly high proportion of wider impacts compared to the usual can be explained by several factors. Besides the above mentioned methodological shortcomings, in this very case special infrastructural, economic and social conditions might all have contributed. First, the affected area is one of the most underdeveloped region of the country characterized by high unemployment rate. Therefore, the proposed infrastructure project represents an especially relevant development and it is able to contribute to exploit the resources of the region. Second, the planned bypass is about to improve the access between a large labour market nearby and the main industrial area of the region. Thus, bringing firms closer in time together and closer to their workforce, the investment may generate productivity gains. Ex-post observations and analysis might reveal the mechanism more precisely.

Table 2. CBA results of the case project calculating with and without wider impacts

[million EUR, price level: 2014]	**'Standard' case** **(Hungarian guide + reliability according to WebTAG)"**	**'Wider' case** **(Standard case + WEIs according to WebTAG)"**
1. Investment cost PV	23.05	23.05
2. Operating cost PV	7.34	7.34
3. Residual value PV	1.94	1.94
4. Economic costs PV (1+2-3)	**28.46**	**28.46**
5. Travel time savings PV	10.74	10.74
6. Accident cost savings PV	-0.05	-0.05
7. VOC savings PV	22.63	22.63
8. Environmental cost savings PV	-3.98	-3.98
9. Travel time reliability savings PV	0.86	0.86
10. Wider impacts PV	-	13.91
10.1. Agglomeration impacts (WI1)	-	*9.65*
10.2. Output change in imperfectly competitive markets (WI2)	-	*1.37*
10.3. Tax revenues arising from labour market impacts (WI3)	-	*2.89*
11. Economic benefits PV (5+6+7+8+9+10)	**30.19**	**44.10**
Economic Net Present Value (11-4) [million EUR]	**1.73**	**15.64**
Benefit-Cost Ratio (11/4)	**1.06**	**1.55**
Economic Internal Rate of Return	**5.6%**	**9.8%**

It seems that theoretically, wider impacts can not only be relevant in case of large-scale transformational developments, a small-scale project might also have significant wider impacts. With incorporating wider impacts projects could presumably leapfrog each other on the priority list, assuming that priorities are influenced by economic indicators (which is usually not the case, see Odeck, 2010).

4.2. Investigating the application of multiplier effect

As it has already been mentioned, many Hungarian analyses apply multiplier effect among benefits in CBA (e.g. see the cost-benefit analysis of the transport development of Buda Castle in Pro Urbe – Közlekedés – Terra Studio, 2013). The prevailing practice applies a standard multiplier value between 0.7 and 1.3 calculated on the basis of investment cost. Generally, an 'ad-hoc' constant is applied having it divided between the first 5 years with diminishing return (e.g. 35%, 30%, 20%, 10%, 5%, respectively).

The goal of this section is accurately calculating the value of the multiplier effect irrespective of the question whether its application in CBA is correct. The presented analysis also takes not just the investment cost into consideration but the operating and replacement costs as well.

Using the data of the case study and the full-detailed, 64-industry input-output (IO) table of Hungary published by the Hungarian Statistical Office. We have performed a quick calculation to demonstrate the countrywide direct, indirect, and induced effects of investment, replacement, and operating costs of the project according to the standard IO multiplier models. For a short practical guide see Ambargis–Mead (2012), Miller–Blair (2009) gives a much deeper, more theoretical, and mathematical description. We have endogenized household incomes and final consumption, derived direct requirement coefficient, and generated Leontief inverse to get Type II multipliers as the column sum of total requirement values of industries. The following industries had been concerned according to the code numbers and name tags of Hungarian industrial statistics: 41-43: Construction, 68B: Real estate activities (excluding imputed rents), 69-70: Legal and accounting activities; activities of head offices; management consultancy activities, 71: Architectural and engineering activities; technical testing and analysis, 73: Advertising and market research, 74-75: Other professional, scientific and technical activities; veterinary activities, 80-82: Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities, 84: Public administration and defense; compulsory social security. Type II multipliers contain: (1) direct effects of total output growth of related industries in which final demand increases due to the investment, replacement, and operating costs, (2) indirect effects through the supply chains of these industries and (3) induced effects through increased incomes and final spending of related households.

The project has approximately a total of 44.5 million EUR amount of all exogenous additional final demand which generates a 105.8 million EUR gross output, and a 49 million EUR GDP impact on the whole. Thus, we have GO and GDP multipliers of 2.38 and 1.1 respectively. In order to avoid multiple counting, and measure only the value added generated by the multiplication process, we use the latter, which means that every single unit of money spent in the project generates 1,1 units value added for the whole economy. However, final demand shocks caused by investment, replacement, and operating costs do not occur at a single point of time, for example, at the very start of the project. They have a defined time schedule. Multiplicative processes also need time to complete. Thus, value added gains spread out to the full length of the project. To illustrate this, we have assigned a concrete date to all project cost items, and assumed that it takes three month for every round of the multiplications process to run in all industries. It is obviously a very strong simplification; for more sophisticated approaches see references of Chapter 13.4.7. in Miller–Blair (2009). Figure 1 shows the GDP impact spreading out in time.

Based on our IO analysis we have found that the range of 0.7 and 1.3 to an approximation for the GDP multiplier would be fairly good, if both investment, operating and replacement costs were considered.

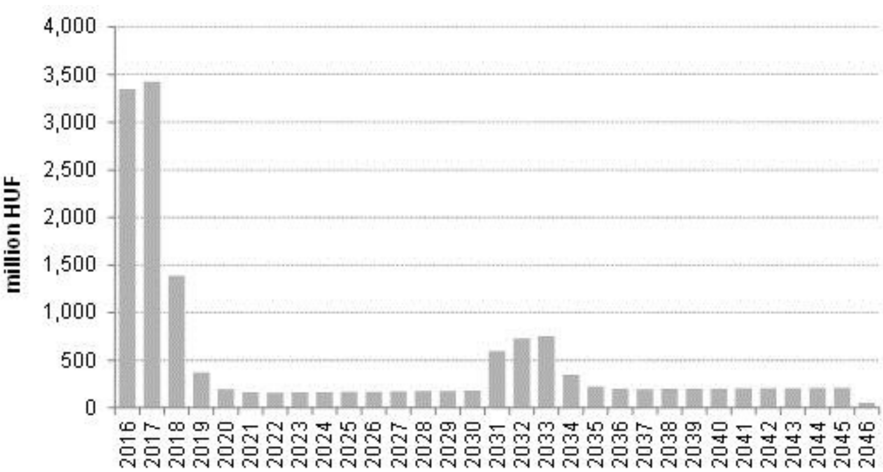

Fig. 1: GDP impact of the investment, replacement and operating costs of the case project

5. Theoretical considerations

It seems that the above computed GDP multiplier effect does not contain any of the traditionally monetized elements in CBA. Similarly, the elements of CBA do not contain any of the direct impacts of public expenditure. However, it can scarcely mean that GDP multiplier effect can simply be included as a benefit in a CBA framework. Equaling GDP effects to welfare gains has its strict theoretical requirements that can hardly be hold. Therefore, GDP multiplication should not be added to other kind of welfare benefits this way.

Moreover, each time there is an injection of new investment into economic cycle there is certainly to be a multiplier effect. This is because an injection of extra income automatically leads to more spending, that creates more and more income resulting the increase in final income. The point is, that investment could be spent in any sector of the economy, the multiplier effect assuredly runs its course. Therefore, it is suggested to emphasize the specific aspects of the multiplier mechanism of the given project based on the incremental method. That is, other alternatives should be examined on which the money could have been spent on.

Another important issue to be discussed is the fact that many benefits in CBA are actually decreasing GDP. As an example, the cost savings from vehicle operation is a benefit in CBA but from another perspective it decreases the demand for fuel, the revenue realized by petrol stations and as a consequence it also decreases final demand via a negative multiplier effect. The question is how such impacts can be accurately measured.

Besides, as Quinet et al. (2013) have noted, it is hard to foresee the state of the economy in which the multiplier effect will take place. The same investment could cause totally different results in case of economic depression or prosperity. Therefore, effects strongly depend on the status of the economic circle.

The monetization of indirect effects has become more and more important, although it is disputable among different stakeholders whether the key indicator should be welfare or GDP.

Meanwhile, this paper definitely suggests that the society's overall welfare should be given the priority. Chasing GDP might be an alluring short-term solution but it could presumably lead to a dead-lock in the long run. For evidence one can think of the undesirable elements of GDP (e.g. environmental costs, climate change, pollution, crime, inequality and so on). That is why we do suggest that a complex, welfare-oriented approach should be further improved.

Finally, it is important to recognize that two different types of mechanisms exert their influences. On the one hand, impacts in real economy caused by the result of the project have to be considered. On the other hand, the effect of financial expenditure also need to be taken into account. In case of both mechanisms welfare gains and impacts on GDP have to be separated (see Figure 2).

This paper sketches two possible methodological directions for covering all relevant effects. One direction can trace the solution for the incorporation of all wider benefits and the welfare gain from GDP multiplier effect as well in the CBA framework. In this case the transport and the secondary markets are still modelled separately. Someone can note that the Hungarian practice is absolutely not exemplary in calculating welfare gain from GDP multiplication, and there is still much work to do in this field.

The other direction suggests the establishment of a unified model (such as a CGE or SCGE model) to integrate all markets in a sole system. These models define diverse behavioural functions for all actors allowing very complex adaptation processes to be modelled (Burfisher, 2011). This option might provide the possibility for avoiding the compatibility problems between GDP and welfare approaches and it could also merge the reactions of supply and demand sides too. Actually, both ways seem to be feasible and apparently steps are taken towards each direction.

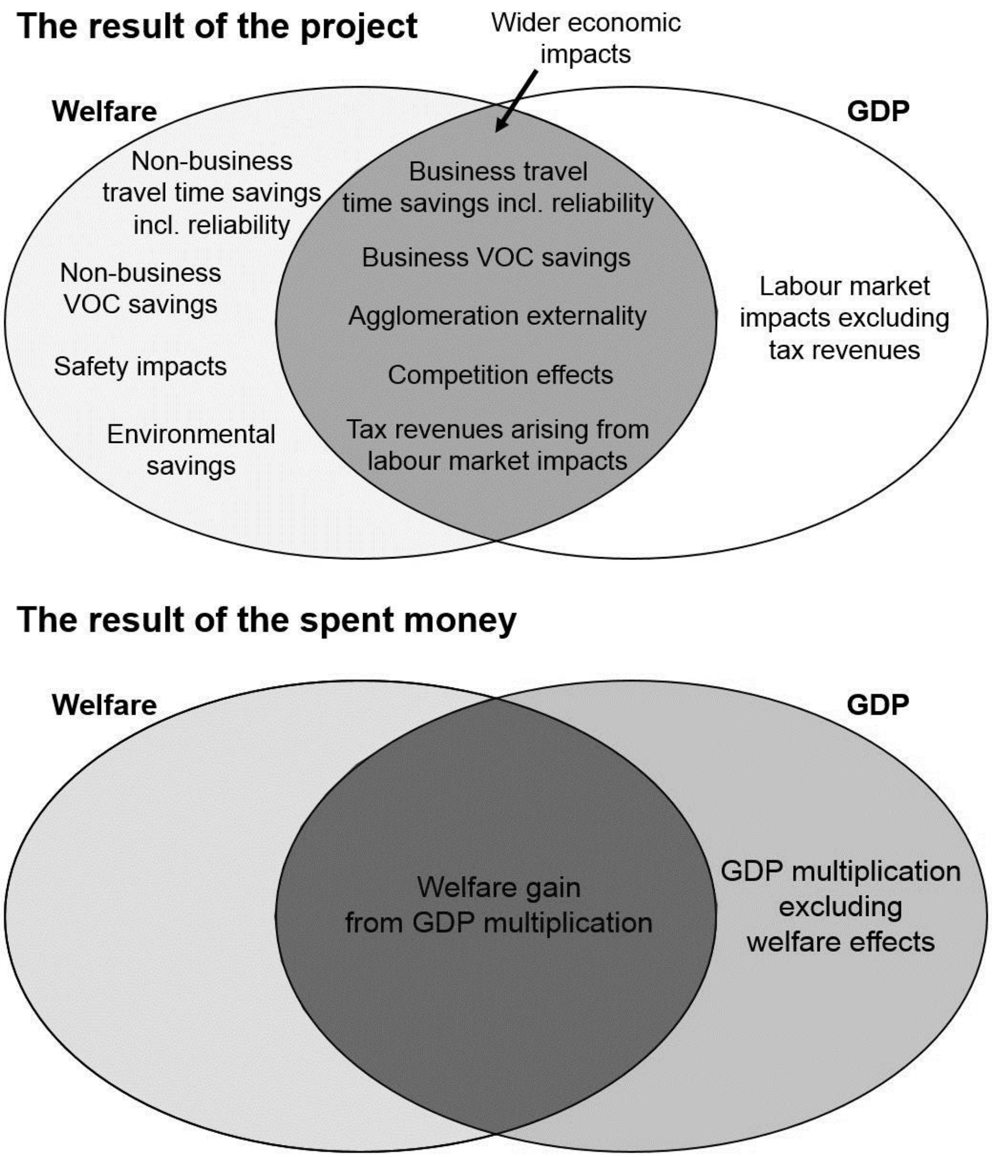

Fig. 2: Different types of mechanisms and the overlap between welfare and GDP effects of a transport project (own edition based on DfT, 2005)

6. Conclusion

This paper traced theoretical and methodological issues concerning the evaluation of transport investment projects. The study especially concentrated on the assessment of indirect economic benefits. Having reviewed the shortcomings and the different national practices of cost-benefit analyses, two methodological problems have been demonstrated via a case study. The first calculation investigated the relevance of wider economic impacts in case of a small-scale project. The results showed unexpectedly high proportion of wider impacts that could be explained by the specific infrastructural and socio-economic conditions, although, it should be handled by care due to parameter estimations. Further research with ex post observations could contribute to more accurate results.

The goal of the second calculation was to shed light on the problem of using multipliers in cost-benefit analysis. Theoretical conclusions suggested that GDP multiplier effect could not be simply included as a benefit in a CBA framework. It is important to separate two different types of mechanisms exerting their influences. The impacts in real economy caused by the result of the project and the effect of financial expenditure also need to be taken into account. In case of both mechanisms welfare gains and impacts on GDP have to be clearly distinguished.

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