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Transport's impact on Unemployment

A report for the Department for Transport

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1 INTRODUCTION

The current TAG guidance (DfT, 2019) for appraisal offers a framework for estimation and valuation of a number of wider economic impacts including agglomeration, labour supply impacts, movement to more or less productive jobs, increased output under imperfect competition and dependent development. The key to identification of wider economic impacts is to understand associated underlying market failures which prevent transport user benefits being a full representation of economic impact.

Current TAG guidance does not provide scope in appraisal for the estimation and valuation of any wider economic impacts from the impact of transport investment on unemployment as it is predicated on full employment following guidance from the Green Book. Within the current framework of the Green Book, the economy is assumed to be at full employment, so with regard to transport projects there is 100% displacement of any employment impacts from elsewhere at the national level, unless generated by a change in labour supply. We see this as potentially a restrictive omission in consideration of potential benefits from transport investment, particularly in areas with higher unemployment rates where there is a potential role for job creation. In the context of the current levelling up agenda it is important to establish the full range of potential benefits which may be relevant in less developed areas. The principal aim of the report is to contribute to the understanding of the role that unemployment impacts could have in an appraisal framework. This will be conducted through a review of the relevant theoretical and empirical literature to understand the various types of unemployment, the distinctions (and linkages) between them, the relevant market failures which lead to additionality, existing approaches to estimation and valuation of unemployment impacts from transport investment.

2 TYPES OF UNEMPLOYMENT

1. Frictional unemployment

This is short term and arises due to movement of people between employment. It can exist in situations of full employment and is as a result of voluntary job search and turnover of labour in the economy. It is also referred to as 'voluntary' or 'equilibrium' unemployment as it describes a process of transition between or into employment.

2. Structural unemployment

This type of unemployment is persistent and found where there are some underlying market failures, for example due to spatial or skill mismatches between workers and firms, or wages sticky above the market clearing rate (e.g. minimum wage) or other labour market regulations. Structural unemployment can still occur at full employment, ie be part of the natural rate of unemployment.

Also related to this is unemployment resulting from thin labour markets. Thin labour markets are characterised by few job options, ie suitable vacancies only arising periodically. The lack of suitable vacancies could be due to remote locations, poor information networks, low skill levels or poor mobility resulting in low job accessibility in deprived areas. Manning (2003a) discusses the various sources and also suggests job differentiation and costs of recruitment act as frictions. The market failure here is through search costs in these markets which are higher than elsewhere either through a lack of information, mobility or actual vacancies, affording a degree of monopsony power to employers.

3. Demand deficient unemployment

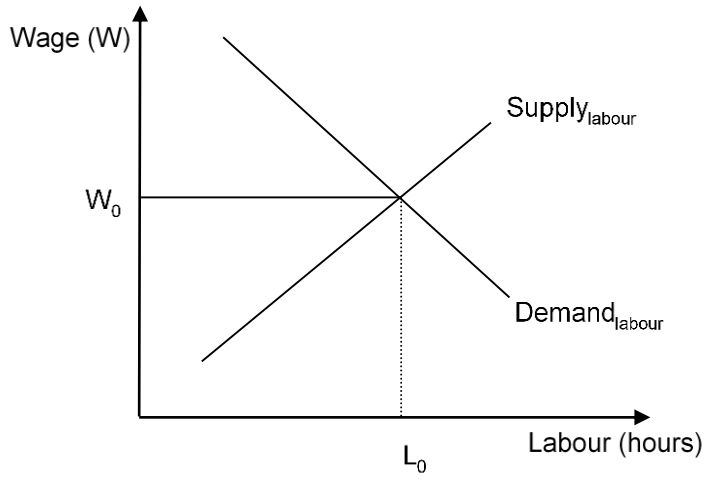
Demand deficient unemployment occurs in recession conditions where there is insufficient demand to maintain full employment. In the Keynesian paradigm, market failures such as in that'sticky downwards' wages would lead to workers not ready to accept reductions in nominal wages leading to unemployment above the natural rate, so could be considered in the same fashion as structural unemployment. In such a situation there is a clear role for government intervention (e.g. fiscal or monetary) to help stimulate the economy. Transport investment could be such a vehicle. In a neo-classical paradigm, the economy would self-correct back to full employment through adjustment of prices, interest rates etc so this would not be considered structural in that it is temporary adjustment back to full employment. In rural economies, seasonality of employment is a common feature.

Both structural and demand deficient unemployment can be considered as involuntary or disequilibrium unemployment because there are some workers willing to work at the prevailing wage who cannot find work. Whilst the causes and macroeconomic implications of demand deficient vs structural unemployment may differ, in terms of the treatment of the labour market and interpretation of resultant surpluses from transport induced reductions in either demand deficient or structural unemployment, the analysis is very similar. Without market failures in the labour market, demand deficient unemployment would not be observed in the labour market but we would see lower levels of equilibrium employment and higher rates of voluntary unemployment. It is worth noting that although a demand deficient market could be in equilibrium this could be at very low wages at which the term 'voluntary' becomes potentially moot if it doesn't offer workers a basic living wage.

3 VALUATION OF TRANSPORT LED REDUCTIONS IN UNEMPLOYMENT

A useful place to start this discussion is to imagine a situation of a perfectly competitive labour market with no market failures. As such we are looking at a market clearing equilibrium at the intersection of the labour market demand and supply curves, as illustrated in Figure 1. The labour demand curve ($Demand_{labour}$) maps out firms' willingness to pay for different amounts of labour and here this is equivalent to the marginal revenue product, ie the additional contribution to output, for each additional unit of labour (expressed here in hours). The supply curve $Supply_{labour}$ represents how much labour is willing to be supplied at a particular wage and this takes into account the opportunity cost of employment from alternative uses of time (e.g. leisure) and other potential lost monetary benefits from employment, eg social security payments.

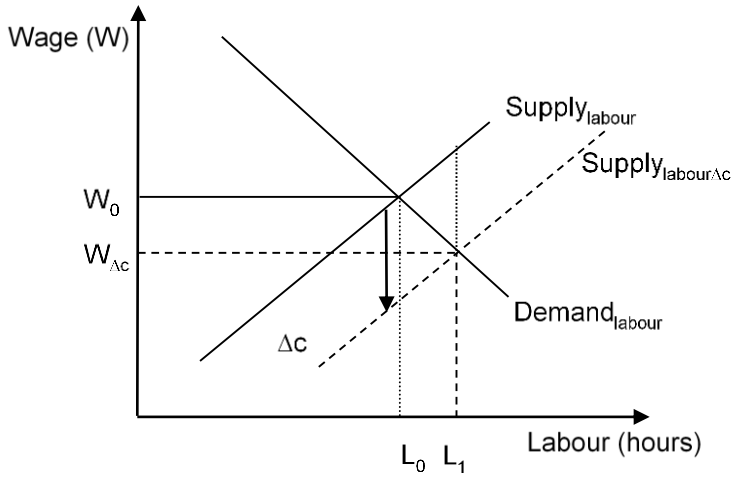
Figure 1: Equilibrium in an undistorted labour market



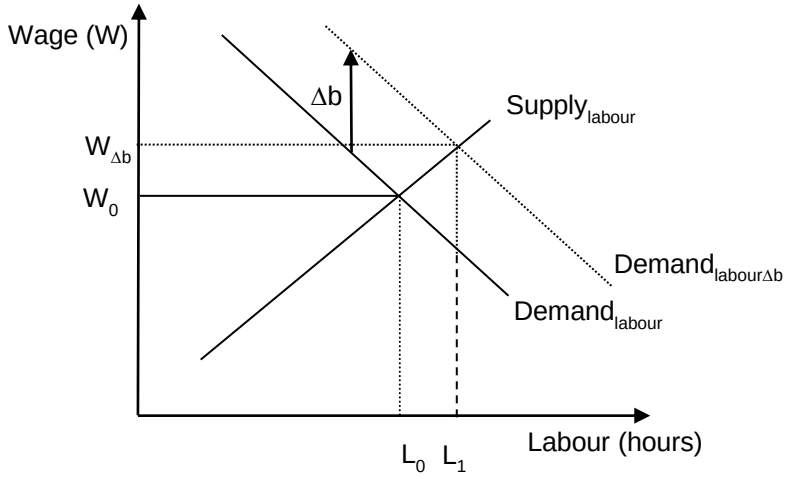
If labour markets are perfect, that is there are no distortions and they clear at wage W_0 and Labour L_0, then the economic value of additional employment is at the margin is completely offset by the opportunity costs experienced by the workers (eg the giving up of leisure time). However, as we will see in what follows, if market distortions exist then the economic value of the additional employment will more than offset the opportunity costs and there will be an economic surplus.

Figure 2: Equilibrium in an undistorted labour market following changes in transport users' consumer surplus

a) Commuting cost reductions



b) Freight/business travel cost reduction



From a transport perspective, a change in transport user benefits (the primary market) leads to changes in secondary markets, eg labour and goods markets. Here we focus on the labour market that reflects changing conditions in the primary transport market. Firstly, we consider the example of a reduction in commuting costs in

Figure 2a. Reductions in generalised cost of travel by Δc effectively increase the real wage (i.e. net of transport costs) and can induce a labour supply response with more people willing to enter the labour market and work at the prevailing market wage.

In

Figure 2a, a reduction in commuting costs leads to a shift outwards to the right in the labour supply curve $Supply_{labour\Delta c}$ as wages net of transport costs increase, so workers are consequently willing to supply their labour at a lower market wage. The surplus from the user benefits in the primary market is passed through to employers in the form of lower wage costs ($W_{\Delta c}$), workers through wages not fully offset by the reduction in commuting costs and an increase in output due to these lower costs.

In the case of reduction in business and/or freight costs by Δb shown in

Figure 2b, there is an output response from firms due to lower non-wage costs and in order to expand output they require more labour, so there is a shift outwards in the demand curve to $Demand_{labour\Delta b}$ in the labour market and a higher market clearing wage, $W_{\Delta b}$.

Any surplus in secondary markets to firms from lower wages caused by commute cost reductions or to workers from higher wages in labour market from a reduction in freight costs is a reflection of the transport user benefits in the primary market and thus to include these along with transport user benefits in an appraisal would represent double counting. Boardman et al (2011, ch.5) show that the economic surpluses from a transport scheme are most accurately measured in the primary, ie transport, market.

There are extensive treatments of valuing increases in employment in articles and textbooks (Reiss, 2014, Boardman et al., 2011 pp105-108, Haveman and Farrow, 2011, Jenkins et al., 2018 Chapter 12) through the use of the shadow wage rate (SWR) which is the economic opportunity cost of labour. This can be considered as the social cost of labour – the value of activity lost when new employment is created. Any positive difference between the social cost of labour and the market wage rate is interpreted as the social value of creating the employment opportunities. The principle here is that when the shadow wage is below the gross market clearing wage there is an additional surplus to creating employment or reducing unemployment. More specifically, the wider economic impact of additional employment is the difference between the market wage and the shadow wage, ie as the shadow wage reflects the social cost, any positive difference between market and shadow wage captures the additional surplus to society (ie WEI) from the additional employment.

In the undistorted case, Reiss (2014) describes the undistorted shadow wage (SW) as simply the market clearing wage, W_0. In other words, at equilibrium in Figure 1: Equilibrium in an undistorted labour market

where demand matches supply at W_0, there is no additional welfare benefit to additional employment at the margin as the economic value is offset by the opportunity cost for workers (leisure time and out of pocket costs associated with working).

In the following sub-sections we will examine the sources of additionality following transport led reductions in unemployment. Each of these cases is linked to a particular market failure, i.e. only when market failures exist is it necessary to consider additionality.

3.1 Labour Taxes

Labour tax is a widely considered market distortion for consideration of WEI through the labour market, i.e. tax on earned income, which distort the market by driving a wedge between the wage the firm is willing to pay and the wage received by the worker.

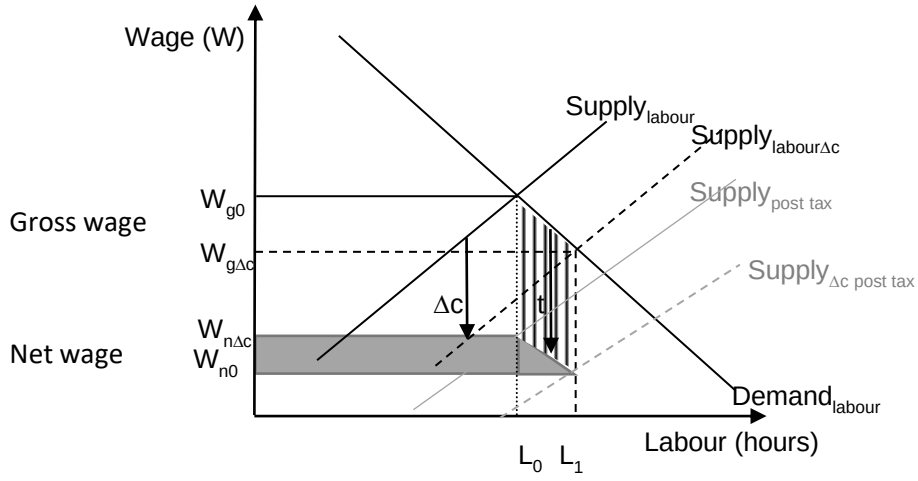
This impact is demonstrated in

Figure 3, which is a replication of

Figure 2a but under taxation at rate *t*. (the tax rate of the marginal unit of labour). The figure shows both gross (pre-tax) market clearing wage before and after a transport intervention and also net, post-tax, market clearing wages at marginal tax rate *t*. Thus, at any rate of employment there is a gap between MPL which the firm pays and the net wage. At the initial point of equilibrium L_0, the value of output produced by the marginal worker is their gross tax wage W_{g0}, of which they receive W_{n0},. Given workers make their supply decision based on net wages, W_{n0} represents the opportunity cost of the marginal worker, ie the shadow wage, in the initial equilibrium. Employment effects triggered by a transport intervention will lead to higher tax revenues, the vertically lined shaded area $t^*(L_1-L_0)$, for the exchequer. These WEI would be in addition to the standard user benefits (e.g. from increased and cheaper commuting) which are shown in the block shaded area between the two post tax supply curves.[2]

This element of WEIs is covered in current appraisal guidance and described in TAG Unit 2.3 (DfT, 2019b). The vertical shaded area is referred to as the tax wedge in TAG, and in the more general framework presented here this represents the surplus of social value above the net wage. TAG Unit 2.3 also covers movement to more or less productive jobs (M2MLPJ) where workers or firms may relocate in response to a transport intervention, but the net level of employment remains the same. This can yield wider economic impacts if there are productivity differentials between affected regions or industries (see Venables, 2007). This is clearly based on land use change. In terms of valuation of impacts additional to those from user benefits, again this is driven by the tax wedge.

Figure 3: Equilibrium in labour market with tax distortion following transport user benefits



In the presence of taxation market failure, following Riess (2014), at market equilibrium, the shadow wage can be inferred algebraically as the wage at which the marginal worker would be indifferent between an additional hour of leisure and the financial benefits of (an additional hour of) employment:

$$SW = MVL = (1-t).W_0 - \beta \qquad (1)$$

where *t* is the marginal labour income tax rate and here we include an extra term, β, to represent any unemployment/low income benefits lost when an individual takes additional

[2] The block shaded area the representing benefits of cheaper commuting would not be included as an additional WEI benefit as it would represent a double counting of user benefits.

employment. These effectively shifts up the reservation wage of individuals. In general the wider economic impacts of an increase in employment are based on the difference between the market wage and the shadow wage for any change in labour, which in the case of

Figure 3 would be:

$$WEI = (W_0\text{-}SW)*(L_1\text{-}L_0) \quad (2)$$

Whilst this analysis is represented in labour hours space here it is analogous to number of workers and the decision of an individual worker to enter the labour market from inactivity.

3.2 Structural unemployment

The current TAG guidance is predicated on full employment, i.e. where there is low unemployment principally frictional in nature, where workers are temporarily moving between employments and no structural unemployment. Thresholds may vary due to interpretation or locational or temporal (eg the financial crisis or COVID) context but Boardman et al (2011) characterise purely frictional unemployment rates to be around 5% or less; Riess (2014) at around 4%. However, due to its persistence, structural unemployment can still occur when the economy is at full employment. Also, in some areas higher unemployment rates prevail than elsewhere[3]. Boardman et al (2011) suggests rates above 10% represent structural unemployment. Boardman et al (2018) suggests at frictional levels of unemployment, most of any employment effects from a transport scheme will represent displacement from other jobs or from workers previously outside the workforce. Rates between 5 and 10% contain a mixture of both frictional and structural unemployment. Structural unemployment definitions typically involve estimation of differing ratios of vacancies to unemployment across different sectors, eg Jackman and Roper (1987)), although the measure is complicated by measurement of matching efficiency which differs in different sectors (Smith, 2012).

Unemployment resulting from such market failures is labelled involuntary as workers are available and willing to work at the prevailing wage rate but not enough work is available. In areas with higher unemployment rates there is a role for job creation, ie further employment growth or reductions in unemployment create a value (in terms of the marginal product as represented by the gross wage) over and above the economic opportunity cost of employment, ie the shadow wage. The situation is demonstrated in a simplified form in

Figure 4, with a freight/business travel cost reducing transport intervention analogous to that in

[3] For example, focusing on 2018 data from the Annual Population Survey for Local Authorities[3] (with sample sizes >1000), primarily the largest rates of unemployment were outside of the south, with rates of 7% or above in Hartlepool, Middlesbrough, Birmingham, Wolverhampton, Blackpool, South Tyneside, Stoke-on-Trent and Sunderland. https://www.ethnicity-facts-figures.service.gov.uk/work-pay-and-benefits/unemployment-and-economic-inactivity/unemployment/latest/downloads/unemployment-by-local-authority.csv

Figure 2b, but with a structural market failure represented by a market wage W_0 held above the clearing wage, leading to involuntary unemployment measured by the gap between the supply and demand curves. Post intervention the labour demand curve shifts out following the reduction in business costs and the unemployment level falls by L_1-L_0, but there still remains disequilibrium. Market clearing rates of labour pre and post intervention, L_0* and L_1* are included for reference. The shaded area representing the gap between the labour supply curve, ie the opportunity cost of employment, and the market wage W_0 for the additional workers measures the additional surplus.

At this point, the shadow wage cannot be observed from the market wage or estimated based on tax rates, as it is impossible to identify with certainty the shadow wage of involuntarily unemployed workers. Intuitively we would assume that shadow wages are lower for involuntarily unemployed than for the voluntarily unemployed, as the opportunity cost of leisure is likely to be lower for undesired leisure time (Haveman and Farrow, 2011). For simplicity,

Figure 4 makes the arbitrary assumption that they are drawn from that part of the labour supply function between L_0 and L_1 but there is no particular reason for this. Abstracting from issues regarding taxation, one approach in the textbooks here (eg Riess (2014), Sartori et al (2014)) is to adjust the shadow wage based on the assumption that the additional workers are assumed to have reservation wages around the margin of the current employment level, ie that additional employment come from those who value it the most, with an adjustment for the unemployment rate (which Riess et al., (2014) suggest is net of search, ie frictional unemployment):

$$SW = (1\text{-}UR).W_0 \qquad (3)$$

Boardman et al (2011) suggests the newly employed could be distributed equally along the supply curve between the origin and the point at which it equals the market wage, which if one assumes the supply curve intersects the origin, simplifies to

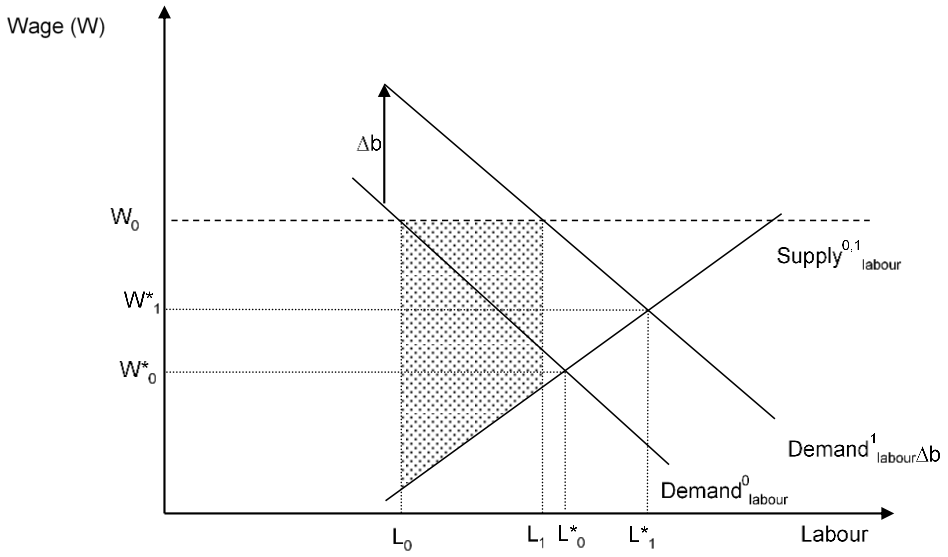
$$SW = 0.5W_0 \qquad (4)$$

These different approaches could yield markedly different valuations of shadow wages and wider benefits from reduced unemployment. Higher rates of SW estimations highlighted in section 4 suggest approaches based on assumptions similar to those used in (3) rather than (4) are used in practice and would lead to more conservative estimates of WEIs.

A more general specification incorporating the labour supply and structural unemployment WEIs using (3) and equation (1) can easily be presented as:

$$SW = (1\text{-}UR).\ [(1\text{-}t).W_0 - \beta] \qquad (5)$$

Figure 4: Labour market with structural unemployment following changes in transport user benefits


Wage (W)
Δb
W0
W*1
W*0
Supply0,1labour
Demand1labourΔb
Demand0labour
L0
L1
L*0
L*1
Labour

3.3 Thin labour markets

Another source of additionality is through the market failure of thin labour markets where there are few work options, more specifically suitable job vacancies available. Whilst for the purposes of categorisation this falls under the heading of structural unemployment its source is different and relates to a different stream of literature. Manning (2003a) discusses the two prevailing models of monopsony being based on market power of firms stemming from either differentiated jobs or from search costs. In the extreme case of perfectly competitive labour market workers will leave firms and costlessly find work elsewhere if wages fall below market rate. He adds that from the perspective of the worker, thinness is evident from the lack of available vacancies, which could be the case even with a large number of potential employers. So thinness can be a broader concept than monopsony. Thin labour markets could be due to remote locations, low skill levels or poor mobility: characteristics of deprived areas, but also of certain demographic groups such as females with constraining outside work commitments eg Munford et al (2018). Laird (2011) also highlights the literature suggesting un-skilled, low-skilled and various ethnic groups may face thin labour markets due to lack of accessibility. Manning (2003a) suggests a broader definition of thin labour markets involving a labour market with differentiated jobs in terms of skills as well as mobility (commuting) and search costs for workers which provide firms with a degree of market power – under such conditions many labour markets could be considered 'thin' with no clear threshold of thin and thick

Search costs in thin labour markets are higher than elsewhere as there are fewer available vacancies - these costs represent a market failure and provides hiring firms with a degree of monopsony power. The impact of this is shown in again in the context of a reduction in commuting costs in

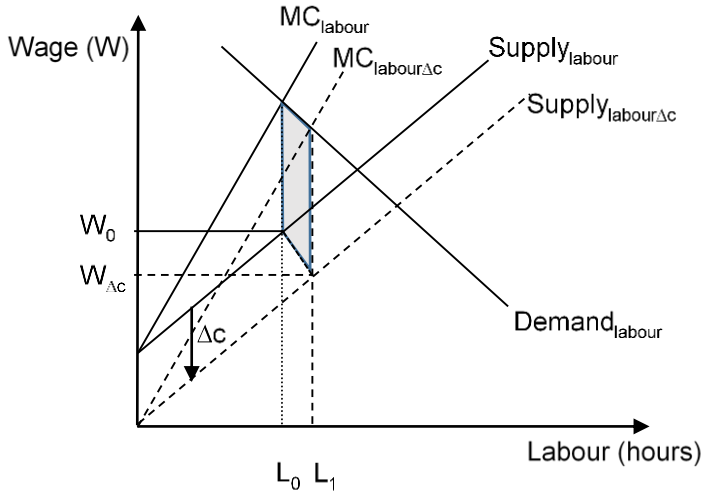
Figure 5. In markets with monopsony power, firms have the ability to set wages and in doing so restrict employment levels and wages below that which would be observed under perfect competition (ie marginal product). In order to hire more workers, monopsony firms have to increase wages in accordance with the upward sloping labour supply curve $Supply_{Labour}$, but face a steeper marginal cost of labour curve. This is because an additional unit of labour will require a higher market wage to be paid to all workers (the MC of labour curve is twice the slope of labour supply curve) MC_{Labour}[4]. The profit maximising level of labour is at the point where the MC_{Labour} intersects the labour demand curve (ie Marginal Revenue Product of Labour), but firms only need to pay workers W_0 to supply this level of labour. Following the reduction in commuting costs, analogous to

[4] With a linear supply curve, (Average cost of labour) W=a+bL; Total labour cost is L(a+bL); $MC_L=\delta TC/\delta L$ = a+2bL.

Figure 2a, there is a shift in the labour supply curve with more workers willing to enter the labour market. Firms hire an extra L_1-L_0 units of labour at a lower wage and in doing so make additional surplus from the extra profitability from these extra workers, the shaded area in the diagram.

Again, this surplus represents an element of additionality not captured in transport user benefits in this context, ie there is extra economic value (to firms in terms of additional profits), over and above that captured through transport user benefits.

Figure 5: Thin labour market following changes in transport user benefits



If the wedge between the Marginal cost/product and wage could be estimated (along with knowledge of the labour demand elasticity) then this surplus could be estimable. There is also potentially a variant here where better transport improves mobility such that labour markets become less 'thin' breaking down monopsony power.

3.4 Other issues

On the demand side, there may be market failures in capital or land markets, exchange rate controls, agricultural subsidies, imperfect competition, which can lead to output levels below full employment. Such market failures also present difficulties in valuing changes in output - with the market failures not clearly identifiable in the labour market it is harder to identify their effect, particularly through partial equilibrium approaches.

In estimation of the value of additional employment/reduced unemployment there are complications related to where additional labour is drawn from, whether it be already employed elsewhere, frictionally (voluntarily) unemployed, or involuntarily unemployed. In more developing contexts, employment changes can represent a shift from the informal to the formal labour market, (ie labour market dualism, eg Del Bo et al. (2011) and Florio, 2006). There are degrees of underemployment (where workers do not work desired number of hours or are in inappropriate jobs for their skill sets), which may be related to market failures too.

It is also worth noting that imputing health (Norstrom et al., 2019) and human capital impacts (Ljungqvist and Sargent ,1998) of unemployment could reduce the shadow wage of unemployed, ie there are positive non-wage benefits for individuals of being in work associated with access to training, well-being and health, especially compared to long term unemployed. There may also be distributional implications of any change in employment if different groups in society (eg based on income or geography) are affected, in which case distributional weighting of impacts may be appropriate (HM Treasury, 2022).

It is also important to note that the marginal product of labour can be much higher than the gross wage, even in 'undistorted' settings as firms incur overhead costs above the wage rate to employ workers. These would include compulsory payments towards social insurance, pensions and also non-pecuniary benefits such as maternity and paternity leave. Wardman, Batley et al. (2015) estimated this to be in the region of 30% of the gross wage, including employer social insurance contributions of 13.8% for the basic rate tax payer. At least some of these extra benefits (the social insurance contributions) do feature via the tax wedge calculations of the current TAG guidance. In this, more realistic, situation an undistorted labour market equilibrium occurs when the opportunity cost of labour equals MPL ie the gross wage paid to workers plus overheads.

We have treated unemployment as a binary issue here and underemployment has not been dealt with in this note but there are situations where people work fewer hours than they wish or are overqualified for their occupation. In these situations there is a level of underemployment for which there may be market failures leading to surpluses which in principle is covered by the same framework as presented here. In the literature the treatment of underemployment is associated with situations where there are dualistic labour markets ie formal and informal labour markets which are not directly connected. These could arise due to lack of skills, over-regulation and other market failures in formal markets, Such situations occur typically in less developed countries (Little and Mirrlees, 1974) and are also discussed in relation to Cohesion Fund EU countries (Florio 2006, Del Bo et al (2011))

Various labour market (and other market) failures may be occurring simultaneously, differentially in different locations/sectors, making identification of additionality complex.

There is not always a clear demarcation as to the categorisation of unemployment. There is seemingly some grey area between frictional employment (also referred to as search unemployment, which can vary due to a number of factors) and thin labour markets where search costs are higher. Also some discussions of structural unemployment encompass aspects such as spatial mismatch which would also correspond to search costs and thin labour markets.

4 EVIDENCE

4.1 Structural unemployment

Elhorst (2003) highlights that regional variations in employment within countries are significant and important Whereas Macroeconomic studies suggest that the major explanation of unemployment disparities between countries is found in differences in labour market institutions, the national dimension to these clearly does not explain the full variation in rates regionally. High rates of regional unemployment can lead to downward spiral effect through a net loss of population and reduced demand for locally produced goods and services

If workers are perfectly mobile and perfectly substitutable, shifts in the sectoral composition of demand for labour, should have no effect on the unemployment rate, i.e. losses in contracting sectors are exactly matched by employment gains in expanding sectors. However, if frictions are present, then shifts in employment demand can lead to at least temporary differentials in unemployment.

McCormick (1997) finds increased wages coupled with employment growth in South West and East Anglia suggested that demand shocks were the source of employment growth, prompting in-migration from lagging regions by non-manual workers. In contrast, the manual labour market is spatially inflexible, with changes in participation following shocks stabilising the differentials.

A differential relationship between the regional and the national unemployment rate can also be based on an equilibrium approach (Byers (1990) and Martin (1997), rather than a cyclical, relationship. Martin (1997) highlights that regional unemployment trends in EU show a high degree of synchronicity and persistent disparities. This persistence in disparities suggests stable ‘equilibrium’ relationships in terms of ratio between regional and national rates. Using an analysis of UK regional data, he finds such a persistence has two possible sources –

1. adjustments around different equilibrium mean ratio (which itself reflects Keynesian demand side and compositional differences)
2. disequilibrium phenomenon – where labour market adjustment mechanisms are weak and slow, so differentials caused by demand, structural or technological shocks persist over time.

Even if markets worked perfectly and were in equilibrium with free movement, there may be regional differences linked to variations in amenities, wages and unemployment benefit such that each region could be at a different natural rate of unemployment (Marston, 1985). Based on the lack of evidence on adjustment, Martin concludes the persistence mostly reflects the existence of an underlying interregional equilibrium structure of unemployment differences.

Elhorst (2003) conducts an empirical and theoretical literature review on regional unemployment differentials. In exploring this relationship further, Elhorst finds the regional unemployment rate depends on various supply, demand and wage setting factors. The work highlights a checklist of important variables to explain regional differentials. Higher levels of unemployment are observed when:

- the population is relatively young- population growth rate exceeds employment growth rate;

- the labour force participation rate, net migration and net commuting rate are relatively low;
- the employment growth rate is relatively small
- the proportion of households in the public rental sector is relatively high.
- the social security system is relatively generous and minimum wage level is relatively high;
- the region is gifted with amenities – these are traded off against higher unemployment;
- wages in relation to labour productivity and cost of living relatively high. Unionisation high;
- sectoral shifts in demand are relatively high, while industrial diversity is relatively low;
- the vacancy rate is relatively small;
- the market potential of the region is relatively low;
- the educational attainment of the population is relatively low;
- unemployment rate in contiguous or hinterland regions is relatively high; and
- the share of long-term unemployment is relatively high.

Whilst in principle each of these factors is important to include in empirical models, there may be data issues, but more critically, certain variables may be endogenous and also highly correlated.

Overman and Puga (2002) look at unemployment rates across European regions between 1986 and 1996 – a period of polarisation of unemployment rates. They find this polarisation is primarily driven by changes in relative labour demand. They found evidence that unemployment outcomes mirror those of neighbouring regions (irrespective of whether cross-border). Whilst the divergences in labour demand were due in part to initial clustering of low-skilled regions and badly performing industries partly due to shared characteristics of low skills and poorly performing industrial sectors, part of the explanation of this has an economic geography dimension: Integration of regions (both intra and internationally) has led to spatial concentrations of employment – if regional forces do not fully adjust (due to worker mobility and institutional constraints on regional wage disparity), geographical location becomes important. The reinforcing nature of agglomerations plays a key role

So overall, they conclude whilst there are structural differences and demand differences causing differences in unemployment in between regions which may be viewed as temporary or permanent, the economic geography framework suggests we would expect variations in regional unemployment in a similar way to how we see variations in regional productivity within a spatial equilibrium and that the process of agglomeration may accentuate this.

4.2 Thin labour markets

As demonstrated in

Figure 5, in thin labour markets search costs (see Rogerson, Shimer and Wright (2005) for a review of search models) drive a wedge between the marginal product of labour and the wage, leading to workers not being fully compensated for their commute. If search costs (ie the gap between the wage and marginal product curve) could be estimated then this surplus could be estimable. The most direct way to approach this would be estimate the wage elasticity of labour supply but this is confounded by the endogeneity between employment and wages and there is a large variation in elasticities found in the literature (Evers et al, 2008).

Other approaches to identifying this wedge in the literature involve models of job search to determine the degree to which commuting costs are compensated (Manning, 2003a; van Ommeren and Rietveld, 2005; Rouwendal and van Ommeren, 2007, Laird 2011). Such approaches, as exemplified by Manning (2003a), are based on workers with longer commutes having a larger reservation wage to offset these additional costs and thus seeking out higher paid jobs. In other words, workers trade-off wages and commute such that there exists an implicit compensating differential. Such compensation is implicit in that wages themselves do not systematically vary by location. However, at longer commute distances the number of acceptable offers falls away such that full compensation is unattainable.

These approaches are complicated by the inherent endogeneity between wages and commuting, ie that wages are a function of commute costs but also that commuting costs are a function of income in that high paid workers commute further, perhaps so they can live in more desirable locations. Also the urban economics literature would suggest that commute costs are capitalised into land prices. To address this, instrumental variable based approaches (eg Manning, 2003 and Laird, 2011) are used in some of the literature and other approaches include identifying individuals subject to exogenous shock in their commute through changes in firm location or transport infrastructure (Munford et al, 2018, Mulalic et al (2010).

Manning (2003a) uses UK Labour Force and British Labour Force Survey data provide evidence for his theoretical predictions, ie that those with longer commutes are not, on average, fully compensated for them and that there is substantial ‘wasteful’ commuting, ie where workers in A commute to B and otherwise ‘identical’ workers in B commute to A. Whereas Manning undertakes an aggregate analysis, Munford et al., (2018) provide support for Manning’s model but only for women. Mulalic et al., (2010) also find evidence of partial compensation for commuting costs for Denmark.

Rouwendal and Van Ommeren (2007) examine explicit compensation through direct commuting cost reimbursement across equally productive workers in the same company using data from the Netherlands. In this context, compensation for commuting cost may be interpreted evidence of monopsony power in that firms have the discretion to award higher wages to otherwise identical workers. Their panel data analysis demonstrated a positive effect of commuting time on reimbursement, based on workers who move location. Ie interpreted as evidence of monopsony power where firms differentially compensate in order to save recruitment costs.

Using wage regression models which include commuting cost estimates with Scottish Household Survey data, Laird (2011) looks for evidence of thin labour markets in rural areas but also for low skilled and females. Results suggest that the lack of compensation of commuters living and working in remote rural areas is taken as evidence of thin rural labour markets. He also found supporting evidence for thin labour markets for the low skilled and women. Of the papers covered, only Laird attempts to estimate the full commuting generalised cost.

Pilegaard and Fosgerau (2008) take a broader approach to search costs and imperfections in the labour market where search imperfections arise regarding lack of perfect information on opportunities in the labour market. This leads to uncertainty for workers inherent in the choice between less frequently occurring local job opportunities and higher chances of finding employment further afield but with higher commuting costs. Pilegaard and Fosgerau introduce search unemployment into a simple CGE model and found 30% additionality to a CBA of a 10% reduction in inter-regional travel times stemming from search costs, although this falls with higher values of time.

4.3 Shadow wage rates

It is worth noting that most applications of the shadow wage approach are in respect to the project costing itself rather than wider benefit estimation. In that regard, a considerable proportion of the benefits are regarding displacement of employment from one region to another; where these regions have the same conditions there will be no additionality from displacement but additionality may arise where areas have different shadow wages and in this vein some approaches attempt to categorise different area types. Skilled workers would usually be expected to already be in employment, so would be displaced from one job to another, so will have a shadow wage close to the current market wage. It is likely that low skilled have lower shadow wages, given they may have switched from lower paid jobs or from unemployment.

Because of difficulties in measuring unemployment, reservation wages or marginal productivity, various simplified approaches have been applied for estimation of the shadow wage. Florio et al. (2018) review of economic appraisals of European Union Cohesion Fund projects find that the shadow wage approach has been used quite extensively, largely drawn from values provided by the EC's shortcut formula (Sartori et al, 2014), which is effectively a combination of equations (1) and (3), although the resultant values are not reported.

$$SW = W*(1-t)*(1-UR) \quad (5)$$

where W is wage, t is tax, UR is unemployment rate.

One more sophisticated approach is outlined by Del Bo et al (2011) who estimate SW as a proportion of market wage to yield Shadow Wage Factors (SWF) for each NUTS2 region in the EU based on being assigned to one of the following categories:

(I) fairly, socially efficient (FSE) with an average SWF of 0.99;
(II) experiencing Quasi-Keynesian (ie structural) unemployment (QKU) with an SWF of 0.54;
(III) Urban labour dualism (ULD) with an SWF of 0.8; and
(IV) Rural labour dualism (RLD) with an SWF of 0.62.

Each category is categorised with weightings attached to the market wage and marginal product measures, adjustment factors for national price distortions and a set of regional welfare weights. A higher shadow wage factor represents a lower difference between actual and shadow wage, hence a lower WEI.

Table 1: Shadow wages and conversion factors (Del Bo et al, 2011)

Regional labour market conditions	Hourly shadow wage Rate	Shadow Wage factor
FSE (fairly socially efficient)	45.2	0.99
QKU (quasi-Keynesian unemployment)	12.1	0.54
ULD (urban labour dualism)	27.1	0.80
RLD (rural labour dualism)	5.2	0.62

This suggests where labour markets are functioning well (FSE) and unemployment low at frictional levels below there is little chance of a demand driven change in employment and the shadow wage is around the market wage. The QKU approximates to the situation where there is structural unemployment. The dualistic labour markets (ULD and RLD) are of less relevance to UK context and to changes in net level of unemployment as they assume a surplus based on displacement of employment between formal and informal sectors.

4.4 Applications in Appraisal

Laird and Mackie (2014) apply a methodology analogous to the shadow wage approach for estimation of impacts of a range of rural case ex-ante studies featuring road enhancements, ferry and bridge toll removals in remote rural Scotland. Based on the evidence on commuting costs from Laird (2011) it is assumed that workers in remote rural areas, the low skilled and females face thin labour markets.

In the application of a transport appraisal clearly any net additional job in a remote area will have a wider impact above transport user benefits (see equation 1). Further, displacement of employment to remote rural areas will create a net surplus for employers of skilled male displaced employment, as other workers are already judged to face thin labour markets in all areas so there is no change in surplus. This requires a number of assumptions: firstly an estimate of the number of jobs created broken down by rural areas vs elsewhere (where there would be no additional welfare benefit to creating employment). Then within the remote rural area an estimate was made as to the proportion of jobs which were additional at the national level and which were displaced. Local data on skill and gender levels of the workforce were used to then identify the proportion of the displaced jobs that would create additionality, i.e. be filled by skilled male workers.

In the second stage the welfare benefit per job per year is estimated and applied to each new job to which an additional welfare surplus should be attached. In the case where there is additional surplus, this is given by the gap between the marginal product of labour and the wage received by the worker (as shown in

Figure 5). Whilst there is no specific evidence on this gap for rural Scotland, Mackie and Laird use, Manning (2003b) who argues that for UK as whole, the evidence indicates the marginal product of labour is 20% higher than the wage. This proportion is used in conjunction with local wages and this proportion are then used to identify the welfare benefit for each job created for which a surplus should be applied.

When applied to the four case studies this approach yielded an wider impact estimate (uplift) of 1-21% with the upper level estimate the only case study involving net additional employment.

Elhorst and Oosterhaven (2008) conduct an appraisal of various Maglev schemes using a Spatial Computable General Equilibrium model for the Netherlands incorporating imperfect competition in goods and labour markets. The two key projects covered involve an urban conglomeration alignment connecting the Randstad cities (Amsterdam, The Hague, Rotterdam and Utrecht) and a core-periphery alignment connecting northern cities Amsterdam and Groningen where there is structural unemployment. Using simple assumptions about labour market demand and supply elasticities and the size of the wedge between productivity and demand, they show that structural unemployment (which they categorise as spatial market re-location) impacts can be significant and work in either direction. For the core-periphery alignment there is a positive impact as migration causes an increase in labour supply to the tight labour market of the Randstaad and reduces unemployment in the rest of the country leading to a positive impact. Their findings illustrate the relevance of involuntary unemployment effects to a transport CBA- the valuation of involuntary unemployment may change benefits by between -1% and +38%, which were considerably larger in magnitude than the estimated agglomeration benefits.

Mott Macdonald for Cambridgeshire County Council (2014) conducted an appraisal of wider economic benefits of a new rail service between March and Wisbech (which does not currently have a station). This was relevant on the basis that both March and Ely have structural levels of unemployment (as demonstrated by supplied ILO figures with future predictions of 'Do Nothing' rates), thus job creation can have a net positive benefit. Based on additional land utilisation from assumed additional economic growth (1% for March and 10% for Wisbech) from the scheme, the report estimates an additional attributable 161 FTE jobs for the central scenario by 2031. This work is interesting as it attempts to value the additional employment from this rail service in the spirit of the shadow wage approach outlined in this report. Of these 161 extra jobs, 10 were in March which was forecast to return to frictional rates and thus disregarded as not net additional. Of the remaining 151 jobs realised by 2031, net new employment of 106 was estimated based on a linear profiling of no reduction and a 1:1 reduction based on how close the rate was to a rate of 10% at which any further unemployment is deemed purely structural. Based on these new jobs an additional total welfare benefit was estimated using average wages in Fenland adjusted by the 0.69 TAG market wage adjustment for new labour market entrants and the Boardman et al (2011) shadow wage estimate of half the market wage (see equation 4).

The unemployment related benefits were highly sensitive to underlying assumptions about how the local labour market would adjust to full employment in the absence of the scheme. If predicted background rates fell below the 5% threshold for categorisation as frictional, then there will be no additional impact.

The work is also interesting in that it applies a further additional value of job creation to the new jobs which are created in deprived areas, taken to be an indication of the government's willingness to pay for reducing spatial inequalities following guidance from English Partnerships (2003).

As a side note, the M2MLPJ benefit was negative as it was assumed the created jobs were in part displaced from other areas which were more productive. Results would be sensitive to assumptions regarding the extent and location of this displacement. The study also conducted a WITA analysis for standard level 2 benefits of agglomeration and labour supply effects.

5 SUMMARY AND DISCUSSION

The theory and evidence reviewed here provides a foundation for justification of inclusion of additional wider economic impacts in appraisal. There is evidence that regional unemployment differentials and persistent structural unemployment exists in different regions. This suggested that various market failures conflate to create sources of surpluses. There is also some evidence to suggest that certain, if not most, labour markets could be categorised as 'thin' to some degree in the sense that search costs and frictions mean there is a market failure which provides employers with some degree of market power. This is demonstrated through a lack of full compensation for commutes.

There is an established framework for estimation of the valuation of transport induced reductions in unemployment, however it is not fully parameterised and there are various different assumptions used in the different applications that have been reviewed. These include different approaches to estimating the 'wedge' i.e. the gap between the wage and the economic opportunity cost of employment. Where the evidence on the gap between marginal product and shadow wage is based on observed wages there may be missing elements of the calculations in regards to difference between marginal product of labour and the gross wage and also in regard to firms in thin labour markets paying workers below marginal product. Transport may serve to reduce imperfections in thin labour markets but we have not found examples of welfare implications of this in the literature. It is also not clear to what extent the wage underestimates marginal product of labour in the absence of other distortions.

Applications of methods to estimate the level and value of unemployment reductions in transport appraisals are scarce and not necessarily consistent. Depending on how employment changes are estimated and how a transport scheme impacts the labour market, a judgement call as to what proportion of any new jobs are displaced from elsewhere (possibly requiring a call on 'where' elsewhere is), what proportion are drawn from involuntarily and voluntarily unemployed, and what proportion are new labour market entrants. Riess (2014) carries out an indicative exercise on this for UK using various assumptions about where new labour is drawn from. Also difficult is making unemployment projections for do minimum cases.

Typically there can be additional economic value in creating employment for unskilled workers, and no or little additional economic value in creating employment for skilled workers, for whom the gross of tax wage is assumed to represent their marginal opportunity value. Some division of labour markets (in terms of regions and /or skill levels) might be appropriate in valuation of reductions in unemployment.

The current DfT TAG approach takes each market failure separately and then treats the contribution of the different WEIs additively. Jenkins et al. (2018 Chapter 12) set out frameworks for the identification of the shadow wage rate under a range of different labour market conditions. With the many market failures discussed here in multiple interconnected markets it may complex to calculate all surpluses through a partial equilibrium approach. Worked examples based on actual appraisals may well be useful.

6 REFERENCES

BOARDMAN, A. E., GREENBERG, D. H., VINING, A. R. & WEIMER, D. L. 2011. *Cost-benefit analysis: concepts and practice*, Cambridge University Press.

Byers, : J. D. (1990) The Cyclical Sensitivity of Regional Unemployment: An Assessment, Regional Studies, 24:5, 447-453, DOI: 10.1080/00343409012331346124

Cambridgeshire County Council (2014), Wider Economic Benefits of a Rail Service Between March and Wisbech , Mott Macdonald

Department for Transport, 2019a, TAG Unit A2.1 Wider Economic Impacts Appraisal, https://www.gov.uk/government/publications/tag-unit-a2-1-wider-economic-impacts

Department for Transport, 2019b, TAG UNIT A2.3 Employment Effects, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/940845/tag-a2-3-employment-effects.pdf

DEL BO, C., FIORIO, C. & FLORIO, M. 2011. Shadow wages for the EU regions. *Fiscal Studies,* 32**,** 109-143.

Elhorst, J.. (2003). The Mystery of Regional Unemployment Differentials: Theoretical and Empirical Explanations. Journal of Economic Surveys. 17. 709-748.

ELHORST, J.P. and J. OOSTERHAVEN. 2008. Integral cost-benefit analysis of Maglev projects under market imperfections. *Journal of Transport and Land Use*, **1**(1), pp. 65-87.

English Partnerships (2003) *Calculating cost per job. Best Practice Note 15*. Issue date October 2003.

Evers, M, de Mooij R, van Vuuren D (2008) The wage elasticity of labour supply: a synthesis of empirical estimates. De Economist156: 25–43.

FLORIO, M. 2006. Cost–benefit analysis and the European union cohesion fund: On the social cost of capital and labour. *Regional Studies,* 40**,** 211-224.

HAVEMAN, R. H. & FARROW, S. 2011. Labor expenditures and benefit-cost accounting in times of unemployment. *Journal of Benefit-Cost Analysis,* 2**,** 1-9.

Hazans, Mihails. (2004). Does Commuting Reduce Wage Disparities?. Growth and Change. 35. 360-390. 10.2139/ssrn.748247.

HM Treasury, 2022, Green Book, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

Jackman, Richard and Stephen Roper (1987), “Structural unemployment”, Oxford Bulletin of Economics and Statistics, 49 (1) 9-36.

Jenkins, G. P., Kuo, C.-Y. & Harberger, A. C. 2018. *Cost Benefit Analysis for Investment Decisions,* Cambridge, MA, Cambridge resources International Inc.

JOHANSSON, P.-O. & KRISTRÖM, B. 2022. On the social opportunity cost of unemployment. *Journal of Economic Policy Reform,* 25**,** 229-239.

LAIRD, J.J. 2008. *Modelling the economic impact of transport projects in sparse networks and peripheral regions*. Ph.D. thesis, University of Leeds.

LAIRD, J.J. 2011, LABOUR MARKET FRICTIONS – EVIDENCE FROM REMOTE RURAL AREAS, unpublished research paper

Laird, JJ and Mackie, PJ (2014) Wider economic benefits of transport schemes in remote rural areas. Research in Transportation Economics, 47. 92 - 102 (11). ISSN 0739-8859

LITTLE, I. M. D. & MIRRLEES, J. A. 1974. *Project appraisal and planning for developing countries*, Heinemann Educational Books.

Ljungqvist, L., & Sargent, T. J. (1998). The European Unemployment Dilemma. *Journal of Political Economy*, *106*(3), 514–550. https://doi.org/10.1086/250020

McCormick, B. (1997), Regional unemployment and labour mobility in the uk, EER 41, 1997, 581-589

MANNING, A. 2003a. The real thin theory: monopsony in modern labour markets. *Labour Economics*, **10**, pp. 105-131.

MANNING, A. 2003b. *Monopsony in Motion: Imperfect Competition in Labor Markets*. Princeton, NJ: Princeton University Press.

MARSTON S. T. (1985) TWO VIEWS OF THE GEOGRAPHIC DISTRIBUTION OF UNEMPLOYMENT, *Quart. J. Econ.* **110.**

MARTIN, R., (1997) REGIONAL UNEMPLOYMENT DISPARITIES AND THEIR DYNAMICS, REGIONAL STUDIES, 31:3, 237-252

MULALIC, I. J.N. VAN OMMEREN and N. PILEGAARD. 2010. Wages and commuting: quasi-natural experiments' evidence from firms that relocate. Tinbergen Institute Discussion 25 Paper TI 2010-093/3. Report dated 8 September 2010. Amsterdam: Tinbergen Institute, Amsterdam
Munford, L., Rice, N., Roberts, J., Jacob, N., (2018), The disutility of commuting? The effect of gender and local labour markets, Sheffield Economics Research Paper Series no. 2018010

Norstrom, F., A.-K. Waenerlund, L. Lindholm, R. Nygren, K.-G. Sahlen, and A. Brydsten. 2019. "Does Unemployment Contribute to Poorer Health-Related Quality of Life among Swedish Adults?" *BMC Public Health* 19: 1–12. doi:10.1186/s12889-019-6825-y.

Overman, H. G., Puga, D., & Vandenbussche, H. (2002). Unemployment Clusters across Europe's Regions and Countries. *Economic Policy*, *17*(34), 117–147. http://www.jstor.org/stable/1344673

PILEGAARD, N. and M. FOSGERAU. 2008. Cost benefit analysis of a transport improvement in the case of search unemployment. *Journal of Transport Economics and Policy*, **42**(1),pp. 23-42.

RIESS, A.-D. 2014. Shadow Prices for the Economic Appraisal of Projects. Report prepared for the Projects Directorate of the European Investment Bank.: European Investment Bank.

Robalino, D. A. & Walker, D. I. 2017. Economic Analysis of Jobs Investment Projects. Guidance Note. Washington DC: World Bank Group.

Rogerson, Richard, Robert Shimer, and Randall Wright. 2005. "Search-Theoretic Models of the Labor Market: A Survey." *Journal of Economic Literature*, 43 (4): 959-988.

ROUWENDAL, J. and J. VAN OMMEREN. 2007. Recruitment in a Monopsonistic Labour Market: Will Travel Costs be reimbursed? *Tinbergen Institute Discussion Paper TI 2007-044/3*. Report dated 23 April 2007. Amsterdam: Tinbergen Institute Amsterdam.

SARTORI, D., CATALANO, G., GENCO, M., PANCOTTI, C., SIRTORI, E., VIGNETTI, S. & BO, C. 2014. Guide to cost-benefit analysis of investment projects. Economic appraisal tool for cohesion policy 2014-2020. Brussels: European Commission.

Smith, Jennifer (2012), Unemployment and Mismatch in the UK, University of Warwick, https://warwick.ac.uk/fac/soc/economics/staff/jcsmith/uk_unemployment_dynamics_during_the_financial_crisis.pdf

VAN OMMEREN, J. and P. RIETVELD. 2005. The commuting time paradox. Journal of Urban Economics, **58**(3), pp. 437-454.

Wardman, M., et al. (2015). "How should business travel time savings be valued?" Economics of Transportation **4**(4): 200-214.