Società italiana di economia pubblica
XXII CONFERENZA
NUOVE FRONTIERE DELL'INTERVENTO PUBBLICO
IN UN MONDO DI INTERDIPENDENZA
Pavia, Università, 20-21 settembre 2010

SHADOW WAGES FOR THE EU REGIONS

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Abstract

The shadow wage is the social opportunity cost of labour. After reviewing earlier theoretical and empirical literature, we define four labour market conditions: fairly socially efficient (FSE), quasi-Keynesian unemployment (QKU), urban labour dualism (ULD) and rural labour dualism (RLD). We offer, for the first time to date, a shortcut empirical estimation of the shadow wages for the EU at the regional (NUTS2) level. Our estimated values are in the form of conversion factors that translate actual observed real wages into shadow wages, as required by social cost-benefit analysis of investment projects under the Structural Funds of the EU. Our results are obtained with an empirical strategy that is easy to implement with aggregate data, differently from traditional micro-data based approaches that are costly, project specific, and often difficult to be applied because of lack of data. We find that the conversion factor for the shadow wage rate is approximately 0.99 in 63 FSE regions (mostly in regions with capital cities and in the old EU member states); 0.80 in 129 ULD regions; 0.54 in 52 QKU regions, and 0.62 in 22 RLD regions (mainly in Eastern European countries). These findings point to a high variability of labour market regimes in the EU and have important implications for project evaluation.

JEL Codes: H43, D61, R23

Keywords: Shadow wage, project evaluation, EU regions

1. Introduction

The shadow wage is the marginal social value of labour, and may differ from the observed wage because of distortions in the labour market and in other markets as well. Conversion factors translate observed market wages into shadow wages, and are a necessary input for public project evaluation, particularly of infrastructure. Under the wide scope of EU regional policy and support to public investment in the New Member States (henceforth, NMS) there is now a renewed interest in the estimation of shadow wages (European Commission (2008), Florio (2006)).

The definition and analysis of the shadow wage rate was an important research topic in applied welfare economics in the 1970s and 1980s (see, *inter alia*, Sen (1972), Little and Mirrlees (1974), Sah and Stiglitz (1985), Brent (1991)), and more recently analyzed by Potts (2002) and de Rus (2010) who proposes a "reasonable shortcut approach". Actual estimation and practical applications, however, have been limited, as discussed, for example, by Squire (1998) or Little and Mirrlees (1990), in spite of the requirements of project evaluation by international organizations,

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[2] Paper presented at the VIII Milan European Economy Workshop, June 11-12, 2009, Università degli Studi di Milano, in the framework of the EIBURS project, sponsored by the European Investment Bank. The authors are grateful for comments on an earlier draft to Gareth Myles and Silvia Salini, and wish to thank Julien Bollati for competent research assistance. The usual disclaimer applies.

e.g. European Commission (2008), Asian Development Bank (1997), or national governments, *e.g.* Honohan (1998) for Ireland, De Borger (1993) for Belgium, the Treasury Board of Canada (2002), or Saleh (2004) for Australia. One reason for the difficulty of translating theory into practice is the heavy information burden for evaluators, who are often required to use project-specific micro-data, such as in Jacoby (1993) and Barrett *et al.* (2008).

In this paper we aim at deriving a new simple framework for the empirical computation of shadow wages and conversion factors at the regional level, accounting for structural characteristics and labour market conditions. We argue that shadow wages differ in space due to underlying regional macroeconomic, demographic and labour market structures. Therefore we want to identify the main characteristics that distinguish regional labour markets in the EU. To do so, we propose to estimate a set of shortcut shadow wage formulae based on solid theoretical grounds, that are, at the same time, easily implementable with regional and national statistical data, moving away from the more precise but cumbersome and costly approaches based on project-specific micro-data. We believe that the benefit of relying on official statistics is worth the cost of a less precise computation of the shadow wage rate. We regard this as a first step in order to provide project evaluators, particularly in the NMS of the EU and in the context of regional policy, with a range of indicative values. Then, where needed and if possible, evaluators may go ahead with the more information-demanding empirical approaches, usually based on survey data and other local evidence.

Our approach is explicitly based on well established CBA theory, particularly on the Little and Mirlees (1974) and the Drèze and Stern (1987) frameworks.

After a brief review of the theoretical and empirical literature, we define four regional labour market conditions that differ in terms of per capita GDP, short and long term unemployment, migration, and the role of agriculture in the regional economy. Our taxonomy along these five main dimensions can be summarized as follows: fairly socially efficient (FSE), quasi-Keynesian unemployment (QKU), urban labour dualism (ULD) and rural labour dualism (RLD). We then identify EU regions belonging to the different labour market conditions by means of a robust cluster analysis and compute shadow wages and the corresponding conversion factors. We then present our empirical estimation of shadow wages and conversion factors for the EU regions in 2007 that may be used as inputs in social cost-benefit analysis of investment projects under the Structural Funds of the EU and highlight the role of macroeconomic regional characteristics and geographical effects.

We define the conversion factor as the ratio between the shadow wage and the observed market wage, implying that, if the shadow wage is, for example, of €10,000 and the conversion factor is equal to 0.8, the market wage is greater than the shadow wage, and the social profitability of the public project is greater when labour is correctly evaluated at shadow prices.

Our findings highlight a substantial degree of variability between EU regions, with important implications for public project evaluation. In fact, we find that the numerical estimate for the conversion factor is of 0.99 in 63 FSE regions (mostly in regions with capital cities and in the old EU member states); 0.80 in 129 ULD regions; 0.54 in 52 QKU regions, and 0.62 in 22 RLD regions (mainly in Eastern European countries). The dispersion around these averages is however rather high for some subsets and this justifies the computation of region-specific conversion factors.

The next Section presents an overview of earlier literature on shadow wages, both from a theoretical and empirical perspective and provides a critical discussion of the state of the art in the field. Section 3 lies out the conceptual framework for our analysis. Sections 4 and 5 present the data used, the empirical analysis, and results. Finally, Section 6 summarizes and concludes.

2. *Earlier literature and research motivation*

A project that uses labour as an input must normally consider this fact as a social cost, in the same way as financial analysis considers the wage paid as a financial cost to the project. The social cost of additional project employment is either the value, given a numeraire, of the marginal product of labour, or the worker's subjective disutility of effort. In principle, the two measures coincide for an equilibrium labour market, and are equal to the observable market wage. Nevertheless, even under full employment and in a competitive labour market, the market wage may differ from the shadow wage because of the social cost of displacing workers from an activity to another and because of distortions in other markets.

The CBA literature offers different shadow wage formulae based on different hypotheses on labour market conditions. This makes comparisons across studies sometimes difficult. In this Section we will provide a coherent and concise picture of early contributions and recent findings on the social cost of labour.

In an early contribution, Lewis (1954) proposed a simple closed economy model based on output loss. Society maximizes aggregate output, and consumption of different workers is given equal weight. Employment per se has no social value (for a different view on this issue, see Brent (1991)), the unemployed do not receive any subsidy, and leisure is given no value, implying the lack of a term capturing the disutility of effort. The main underlying hypothesis is that the shadow wage is equal to the lost output from the former employment, *i.e.* the marginal product of the sector of provenance (that will be the one with the lowest wages at the end of the vacancy-replacement chain. *e.g.* agriculture). With high unemployment or marginal productivity in the previous occupation equal to zero, the new job created has no real effect in other sectors of the economy. The project displaces some workers and hires some unemployed, in a proportion that represents the share of employed and unemployed in the economy. This framework has also been analyzed by Campbell-Tobal (1981).

Burgess (1989) considers a risk free closed economy where individuals have to decide how to allocate their initial wealth between private investment and lending to the government, as well as how many hours to work. The shadow wage is the weighted average between the marginal productivity of labour (assumed equal to the market wage) and the opportunity cost of lost leisure (measured by the after-tax wage). The weights reflect the proportions of incremental work effort obtained from every source.

A classical starting point for applied theory was the important work by Little and Mirrlees (1974), henceforth LM, which has provided a framework for guidelines for applied project evaluation. The authors justify the use of shadow prices because of the presence of real wage rigidity in the formal sector of the economy, which exaggerates the social cost of employment. Specifically, they identify five main sources of distortion. First, even if actual wages were equal to the value of the marginal product of labour at market prices, the former may be distorted by taxes and subsidies: hence consumption at shadow prices may be greater or less than that at market prices. Second, labour in the rural sector receives subsidies (one may think of the Common Agricultural Policy of the EU as a significant example). Third, in the formal sector there are minimum wage requirements because of government regulation or unionization that may distort the market. Finally, in some sectors high wages may correspond to even higher productivity and consumption and transferring labour from the rural sector to the urban or formal sector may entail some costs. This situation can be described as a combination of classical unemployment and dualism. We will formally present and discuss the LM framework in more detail in Section 3.

Other theoretical contributions include Marchand *et al*. (1984), who study the interrelations between the shadow wage rate and the social discount rate; Roberts (1982), who shows that in an economy with labour rationing, wage rigidity, flexible prices for goods, savings and money balances, one public good, lump sum, profit and indirect taxation, the shadow wage can even be negative under very high unemployment. Another strand of literature stemmed from the work by Harris and Todaro (1970), and Harberger (1971), which consider the role of trade and migration. This setting has been further extended in the Sah and Stiglitz (1985) contribution, which presents a general equilibrium model for shadow wages.

The basic Harris and Todaro, henceforth HT, framework is described by a two sector static model, with internal trade and unemployment. The main idea is that workers of the rural sector with lower productivity (*i.e.* income) migrate to the urban sector, despite unemployment, until the urban expected wage equals the rural certain wage. In this context, the proportion of employed on the total labour force represents the probability of being hired. The main conclusion therefore is that the shadow wage will equal the market wage if the unemployment rate remains unchanged. Fitzgerald (1976) introduces a petty urban service sector, and defines a more complex saving cost concept.

Mazumdar (1976) proposes a different migration equation that allows for different methods of financing the period of urban job research (*e.g.* income support by rural family or self financing with informal activities in the urban sector). The dynamic equilibrium obtained is shown to be a particular form of the LM solution. The result, with stringent conditions, could theoretically give a shadow wage greater than the market wage. On this issue, see also Gupta (1986). What appears from these studies is that unemployment may not be sufficient to guarantee a shadow wage lower than the market wage because of migration phenomena.

Another interesting extension to the HT model was proposed by economists aiming at a conceptually relevant formula for efficient regional employment policies in Canada. Boadway and Flatters (1981), and later on Wilson (1993), describe poor regions as those with fixed wages and unemployment while rich regions are characterized by full employment and self-adjusting productivity. The shadow wage in these models includes output loss along with changes in the imputed value of leisure and migration costs from taking workers from the labour market.

An early analysis of a two sector model, with a traditional agriculture secotr and the government project sector, is given by Warr (1973). Burgess (1989) considers the relationship between the social opportunity cost of capital in the private sector and the gross-of-tax return to capital when tax-induced labour market distortions cause the prevailing market wage to exceed the social opportunity cost of labour (shadow wage). Johansson (1982) proposes a model of a small open economy with three private firms, producing three goods (one exported, one imported, one non traded), one public firm offering a non traded good, labour and money. This setting potentially generates 2^4 rationing equilibria (for each good there may be either excess demand or supply, given the *n-1* conditions constraining the remaining market). Johansson offers welfare measures, hence shadow prices, for four cases based on Malinvaud, (1977): Walrasian equilibrium, 'orthodox' Keynesian unemployment (wage rigidity, price flexibility), fix-price Keynesian unemployment (widespread price rigidity, except the exchange rate, excess supply in both product and labour markets) and classical unemployment (excess labour supply combined with excess demand of goods). Welfare measures are shown to be different in the four cases.

It is apparent from this brief and very selective review of early theoretical literature that it is not possible to compute shadow wages, and thus infer the social cost of labour, without a model of the underlying labour market, including a theory of wage determination and migration (on this issue, see Sah and Stiglitz (1985)).

In a general equilibrium framework, the main reference is the theoretical formulation of shadow prices in a complex economy by Drèze and Stern, (1987, and 1990). Drèze and Stern (henceforth, DS) consider the different labour market conditions that may arise and their implications for the shadow wage analysis. An economy may be characterized by a competitive labour market, with almost full employment; by a situation described by involuntary or Keynesian unemployment; and by a dualistic labour market, which is examined by means of the LM rule. We shall consider each case separately and discuss them in Section 3 and in the Appendix, and use them as the basis for our empirical application.

We now turn briefly to the empirical literature. When the shadow wage is simply the marginal productivity of labour it can be directly estimated using a Cobb-Douglas production function. This formula is often used in models estimating the labour supply of members of agricultural households, especially in developing economies. A good example of this approach is Jacoby (1993) who uses data on 1034 households in 1985-86 from the Peruvian highlands region and finds that testing the equality between wages and marginal product, leads to estimates of the conversion factor between 0.37 and 0.58. Skoufias (1994) considers data from six villages in India from rainy season crop-cycle of the calendar years 1975-1979. This leads to a total of 675 farmer/year estimation in 166 households and a conversion factor of 0.83 for males and 0.63 for female workers. Adbulai and Regmi's (2000) analysis is based on a cross-sectional survey of 280 farm households in Nepal from May 1996 to April 1997. Eight villages were selected representing the three agro climatic zones of the country and they estimate a conversion factor of 0.414. See also Lal (1979) who estimates shadow prices for Jamaica, and finds a conversion factor of 0.73.

Picazo-Tadeo and Reig-Martinez (2005) compute shadow wages for family labour in the Spanish agricultural sector by exploiting the duality between input distances and cost functions. With data on citrus farms in the Valencia area, taken from the 1997 Survey on Input Use by Farms, provided by the Spanish ministry of Agriculture, Fishery and Food, the authors estimate a conversion factor of family labour of around 0.68. In a study on child labour, Menon *et al.* (2005) estimate the shadow wage using a cost function that treats household labour as a quasi-fixed factor, using data from the Nepal Living Standard Survey (1996) along with additional estimations carried out on a sample of 2,380 farm households. Their main results are that, considering families with working children, the adults' shadow wage is below the market wage, implying a conversion factor well below unity.

When turning to industrialized countries, the focus of the analysis usually shifts towards the effects of inter-regional migration and the presence of different categories of workers. An empirical application specific to the Irish economy is given by Honohan (1998) who discusses the Cost-Benefit methodology used in Ireland for the evaluation of industrial projects supported by the EU.[3] The creation of an extra job in the urban sector will induce *1/(1-u)* migrants to move (just enough to restore the equilibrium unemployment rate), where the opportunity cost of an extra job is equal to the loss of output of these migrants. Irish unemployment was very high at the time and this might justify a low shadow wage. In fact, the estimated impact of job creation on unemployment was consistent with conversion factors of at most 80%.

De Borger (1993) uses Belgian Railroads operations' data (1959-1986) to estimate a log-linear specification of the shadow wage formula that includes a variable to grasp the influence of politics on the public enterprise and its employment policy. The main result is that the mean of conversion factors over time is of 0.72.

Along the same line, Saleh (2004) uses sectoral employment and data from The Australian Bureau of Statistics (ABS). The main results are that conversion factors differ across sectors and range between 0.94 for Intermediate Clerical, Sales and Service Workers and 1.01 for Elementary Clerical, Sales and Service.

It should be apparent from this selective review of empirical applications that, in all the contributions reviewed, highly project-specific micro data were needed to compute shadow wages and corresponding conversion factors. This is a clear disadvantage when we consider the fact that governments need to evaluate hundreds or thousands of investment projects every year. Therefore, several countries have developed National Guidelines and recommendations for applied CBA which include considerations on the social cost of labour. Examples of official guidelines for investment appraisal include HM Treasury (2003) in the UK; the Italian Ministry of Infrastructure and Transport (2006), where the conversion factor for Southern Regions with data between 1995 and 2001 provides a figure of 0.59; The Australian Handbook of Cost-Benefit Analysis (2006)[4]; The Treasury Board Secretariat of Canada (1998, 2002)[5]; the Cost Benefit Primer (2005)[6] published by the New Zealand Ministry of Finance. The US "Guidelines and discount rates for benefit-cost analysis of Federal programs",[7] takes the view that "*analyses should treat resources as if they were likely to be fully employed. Employment or output multipliers that purport to measure the secondary effects of government expenditures on employment and output should not be included in measured social benefits or costs.* In contrast, the European Commission's CBA Guide (2008) remarks that "*current wages may be a distorted social indicator of the opportunity cost of labour because labour markets are imperfect, or*

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[3] The equation for the shadow wage, broadly based on the HT frame is: $w^* = w_a / (1-u) = w_m$, where w^* is the shadow wage or opportunity cost of the extra job, w_a the labour productivity in agricultural sector, w_m the urban economy wage rate and u is the unemployment rate.

4 http://www.finance.gov.au/publications/finance-circulars/2006/docs/Handbook_of_CB_analysis.pdf

5 http://classwebs.spea.indiana.edu/krutilla/v541/Benfit-Cost%20Guide.pdf

[6] http://www.treasury.govt.nz/publications/guidance/costbenefitanalysis/primer/cba-primer-v12.pdf

[7] http://www.whitehouse.gov/omb/assets/omb/circulars/a094/a094.pdf

there are macroeconomic imbalances, as revealed particularly by high and persistent unemployment, or by dualism and segmentation of labour conditions (e.g. when there is an extensive informal or illegal economy)". In this situation, the use of conversion factors is advocated and the importance of region-specific shadow wages is highlighted, due to the lower mobility of labour with respect to capital. The motivation of our research, in a nutshell, is thus to respond to the need of computable "shortcut" shadow wage formulae, that possibly do not require detailed survey data to be implemented. At the same time, we need to clearly state our conceptual framework of analysis, which is the aim of the following Section.

3. *Conceptual framework*

In this Section we go back to the fundamentals of the shadow wage concept and build on the Little-Mirrlees and Drèze-Stern analytical settings. Our aim is to provide a simple baseline shadow wage equation that lends itself to empirical estimation through national and regional statistical data. We show that a baseline equation, under certain simplifying assumptions, is a reasonable approximation of the SWR in different regional labour market conditions in the EU, through a change of variables in the argument of the shadow wage function that reflects structural differences. This formulation covers a wider spectrum of situations than the original LM framework and is broadly consistent with the DS theoretical setting. We identify and define four cases: a fairly social efficient market (FSE); quasi-Keynesian unemployment (QKU); urban labour dualism (ULD) and rural labour dualism (RLD). For each of these regional labour markets we adapt the baseline equation derived from LM and we show how it relates to the DS general equilibrium framework (with details of the derivation in the Appendix).

As mentioned in our review of the earlier literature, there is a wide consensus about the broad definition of the SWR as the marginal social opportunity cost of labour. In particular, when evaluating a public investment project, it is important to assess the net welfare impact on the society of using one additional unit of labour. In the original LM contribution, by focussing on developing countries, the core idea was framed in a context where there are two sectors: the modern/urban one and the informal/rural one. The labour markets in the two contexts are different, for example because, in the former, labour conditions are fairly regulated, e.g because of minimum wage legislation, unionization, and other institutions. In contrast, in the latter, there is a much less regulated labour market, self-employment in small rural firms, hidden unemployment, etc. Also the price structure in the two environments is different. LM suggest that, to the economy as a whole, one additional employee in a government sponsored project, has a social cost, that can be broken down in several components. We first recall the more general formula (LM, p 273), then the simplified one, that became quite popular among CBA practitioners in empirical applications. With respect to the original LM formulation, we slightly adapt notation for ease of comparison with the DS model. We denote c_1 as the average consumption of the displaced rural worker, who (possibly through a series of interrelated effects) is transferred to the urban context because of the new job opportunity; c_2 is the new consumption level after the project is launched and has hired workers; d is the cost of urbanization related to migration of the worker from the countryside (including transport costs to provide food, accommodation and other goods/services in the new urban location); e is any cost-saving associated with new employment (e.g. saving of unemployment benefits by the government); $L(\partial c/\partial L)$ is the effect of increased employment on consumption (c_2) of existing employment (L). We also consider m, the value of the marginal productivity of the rural worker. LM use welfare weights for each consumption level. Formally, $v(c_1)= dV(.)/d\ c_1$ and $v(c_2)=dV(.)/dc_2$ are the marginal welfare weights related to consumption levels c_1 and c_2, where $V(.)$ is the social welfare function; and $V(c_2)$, $V(c_1)$ are the welfare levels associated to c_1 and c_2 respectively. We shall retain the standard assumption that the welfare weights can be computed by: $v(c_i)= (c_0/c_i)^{\eta}$, where $\eta =|(c/v)(\partial v/\partial c)|$, or the elasticity of the marginal utility of consumption (for an iso-elastic utility function), and c_0 is defined as the "base" level of consumption. This is the level of consumption for which one Euro of transfer to the poor from the government budget is welfare equivalent to any other optimal use of uncommitted social income, including investment.

The more detailed LM formula is thus:

$$(1)\ SWR=\left(c_2+d-e+L(\partial c/\partial L)\right)-\left(V(c_2)-V(c_1)+v(c_1)(c_1-m)+v(c_2)L(\partial c/\partial L)\right).$$

The interpretation of the formula is the following. The first term in brackets on the right hand side is the total consumption impact of additional employment. It is a social cost, as the economy has to commit resources to support the new employee's consumption and this also has some effects on tax-payers, since they now have to pay less unemployment benefits, and to other workers, in the form of a pecuniary externality. The second term is the welfare change related to consumption: the new employees previously could only enjoy the consumption level c_1, while they now consume $c_2 > c_1$: thus there is an increase in their welfare level $V(.)$; their relatives in the rural households were sharing with them the consumption level c_1, that might have been greater than the value of the marginal productivity of the displaced worker m (as within the rural households food and any compensation is equally distributed among members of the family); and the welfare impact of increased wages/consumption on other workers because of less unemployment is evaluated at the c_2 level of consumption.

All the c_i and m variables are expressed at shadow prices, meaning that consumption and production are evaluated at prices that in turn reflect the social value of goods, e.g. after appropriate corrections for price distortions (e.g because of subsidies on food staples, monopoly tariffs in transport, etc). Thus the intuition is simple: the marginal social cost of employment is the net welfare change determined by total increased consumption, on the cost side, and by the sum of benefits for individuals of that consumption on the benefit side, evaluated through the appropriate welfare weights.

A more popular version the same LM formula, but with a number of simplifications, is the following:

$$SWR = m + \left(c^{'} - c_2\right) + \left(1 - \frac{1}{s}\right)\left(c_2 - m\right)$$

Which further simplifies into:

(2) $SWR = c^{'} - \left(\frac{1}{s}\right)\left(c_2 - m\right)$

where we can understand $c^{'} = c_2 + d - e + L\left(\partial c / \partial L\right)$; thus c' is the total commitment to consumption of the economy, c_2 is consumption in the new employment condition, and m is again the value of marginal productivity in the previous job. A new variable appears in equation (2): s, defined as the ratio between the social value of public investment to private consumption ("value of uncommitted government income, measured in terms of consumption committed through employment", see LM p 270). Thus, taking the inverse of s, LM translate current consumption in its investment value. Clearly, the fact that s is greater than unity suggests that the net present value of future net consumption generated by public investment is greater than current consumption (hence the social discount rate is related to the relationship between investment (future consumption) and current consumption. In general LM would expect that $s>1$, because of investment constraints (that justify public investment in the first place).

Thus, if the compensation of the worker in his previous job was just equal to $m=c_1$, his marginal productivity, there is a private benefit for the worker, given by the difference between his current and previous compensation level. If the worker is poor and his savings are negligible, (c_2-m) represents the benefit of moving the worker from one sector to another. This however must be translated in terms of public investment equivalent, or the LM numeraire: uncommitted social income. This is achieved by the ($1/s$) term. Thus, the greater the priority of investment relative to consumption, the greater s, and the closer the SWR is to its consumption value.

The relationship between equations (1) and (2) is not self-evident, and requires some explanation. First, c' in equation (2) should be seen as a rather comprehensive term for direct and indirect adjustments in consumption levels. Second, following LM's model, $v(c) = dV / dc$ so $V(c_2) - V(c_1) = \int_{c_1}^{c_2} v(c)dc = v(c_2)c_2 - v(c_1)c_1$, which further simplifies the second term in equation (1), leading to the formulation in equation (2). Third, if wages are more or less rigid to marginal changes in employment, $\partial c/\partial L=0$, and this indirect effect also disappears. Hence equation (1) can be simplified into:

(1bis) $SWR = c' - \left(v(c_2)c_2 + v(c_1)m\right)$.

This expression reduces approximately to (2) if you say that $v(c_2)$ is close to $v(c_1)$, and $1/s$ is close to $v(c_2)$. In other words, if you assume that the welfare weight related to c_2 and c_1 is the same (perhaps an average of the two), the only step needed to go from (1) to (2) is to justify the equality between the welfare weight of consumption and the inverse of the social value of investment.

In fact, if the social planner is benevolent and optimally allocates public expenditure, the social marginal value of public investment should be welfare equivalent to other socially valuable uses of government expenditure, notably transfers to the poor. There is thus, in principle, a close relationship between $1/s$ and the "base" level of private consumption (c_0) or income that would justify either tax exemption or an income subsidy (LM, p 243 ff). Then, under the standard assumption of iso-elastic utility, the welfare weight of a generic social welfare function defined over individual utilities is simply: $v(c^h) = \beta^h = \left(\frac{c_0}{c^h}\right)^\eta$

where β^h is the welfare weight of a specific group (in our case the average person in the region *h*, whose consumption level $c^h=y^h$, where income y^h is entirely spent in consumption), c_0 is our base consumption/income in a reference area (a country or a federation) $y^h=c^h$ is the income level of the group, and $\eta = |(c/v)(\partial v/\partial c)|$ is the (constant) elasticity of social welfare to private income/consumption.

LM state that "thus once we know *s* we can calculate *b*", i.e. c_0 in our notation, (LM, p 265). However, we dot know *s*, so here we use the inverse relation and replace the regional welfare weight instead of *s* in the standard shadow wage equation (2).

Moreover, to further simplify, we assume $c_2=c'$, i.e. we consider the net urbanization cost *d* as negligible; we interpret *m* in a generic form as the value of labour in the previous use; and given the LM assumption that private savings of workers are negligible, we conclude that $c=y=w$, where *w* is the consumption value of the wage (at shadow prices). Then, by simple algebra we derive this generic expression:

(3) $SWR^h = \beta^h m^h + \left(1-\beta^h\right)w^h$

where *SWR*, *m* and *w* are valued at shadow prices. We shall discuss later how this version of the LM formula lends itself to empirical estimation. Its ingredients are very simple: we claim that, under the above-mentioned hypotheses, the social cost to the (regional) economy is a *welfare weighted linear combination of current (post-project) and previous (ex-ante) rewards to the employee at shadow* *prices*. Thus, the core parameters we need to estimate regional shadow wages and conversion factors are those related to m, w, c_0 and η.

In principle, we could make weaker assumptions on savings, and 'take away' a part of m and of w from the consumption costs and benefits, and add a term on urbanisation costs. However, we believe this would not alter our results in a significant manner in the context of European regions, where within each region, the differences in saving rates and in prices of goods are not very strong. Before turning to empirical estimation issues, we need to show how this framework is flexible and can be adapted to different regional labour markets. In fact, as mentioned, the LM framework was proposed for the urban/rural divide. We can show, however, that equation (3) is more general and can be adapted to encompass more general labour market structures. To this end we turn to the DS setting, where originally three situations are identified: competitive labour market, Keynesian unemployment, dualistic labour market (which we further break down according to the urban or rural characteristic of the region).

According to region-specific structural characteristics, the value of marginal productivity in the previous occupation, m, varies depending upon which category the workers displaced by the project come from,[8] and we can consider different cases for the computation of shadow wages, which we will describe in detail below. We include general economic considerations in the form of price distortions. We focus on price distortions mainly in the agricultural sector, for example due to the Common Agricultural Policy. To this end, we make use of a nominal protection coefficient in the agricultural sector (NPC_{agr}) and an economy-wide coefficient (NPC) that reflects the relative importance of the agricultural sector in the economy, assuming that there are no other relevant distortions in other sectors.[9]

a) Fairly Socially Efficient case (FSE)

The first type of labour market considered is the FSE case, where labour is paid its marginal value and unemployment is frictional. Formally, if labour supplies are fixed, and thus inelastic to wages, the market wage is a market-clearing variable, and will respond to the shift in the labour supply. Therefore, the shadow price of labour is given by the marginal social product of labour that has been displaced by the project, corrected by a distributional term.

The analytical formulation for the shadow wage rate in a competitive labour market in the DS framework, with some convenient changes in notation, is:[10]

[8] From a formal perspective, m is the marginal value, while in the empirical computations we will use the average value of labour, proxied by the sector-specific market wage. A further direction of research is to compute, especially in the case of rural-urban dualism, the value of the marginal productivity of labour.

[9] In Section 4 we will provide details on the computation of these indices for the empirical analysis.

[10] Formal proofs and derivations are provided in Appendix 1.

$SWR = m + \frac{D_l}{\partial y_l / \partial w_l}$ where $D_l = \sum_h b^h x_l^h - \sum_g b^g y_l^g$ reflects the allocative and distributional effect of a raise in wages due to the creation of new employment, and where b^h is the social value of a transfer to workers, b^g the social value of a transfer to firms, x_l^h and y_l^h are the demand and supply, respectively, of labour.

If $b^h = b^g$ and $x^h = y^g$, i.e. the social value of transfers to consumers h and firms g are equal and labour demand and supply fully compensate, the additional distributional impact disappears. In this case, the shadow wage formulation in a DS setting is simply:

(4) $SWR = m$

The empirical counterpart, expressed in terms of equation (3), is:

(5) $SWR = \frac{w_{man}}{NPC}$

where w_{man} represents the market wage rate in the manufacturing sector, and NPC a nominal protection factor to account for country-wide price distortions. The *1/NPC* factor is our shortcut way to express wages in terms of shadow prices, and w_{man} is a proxy of wages in a competitive labour market.

Hence, in this case, we assume that the shadow wage is simply the prevailing regional manufacturing average wage, corrected for general equilibrium issues through the general price distortion indicator (*NPC*). We decided to use wages in manufacturing, which is typically producing tradables, while the service sector includes government and other non-traded services. In this case we are also assuming that the marginal and average productivities are the same. Constant aggregate returns in the modern sector of the economy seem a plausible assumption.

By considering a nominal protection coefficient, we are explicitly taking into account the fact that price distortions may cause market wages to diverge form the opportunity cost of labour (see for example Sah and Stiglitz, 1985).

b) Quasi-Keynesian Unemployment (QKU)

If instead unemployment is involuntary and there is wage rigidity, a situation we label as quasi-Keynesian unemployment (QKU), we assume that the workers hired by the public project will likely have been previously unemployed.

Formally, the labour market clears with rationing of supply. In this situation, the increase in employment due to the public project affects the unemployed, and thus the value of leisure time, expressed by the reservation wage. The formula for the shadow wage in the DS framework is thus the sum of the welfare-weighted reservation wage and the marginal social value of the increase in income that goes to the newly hired:

(6) $SWR = \beta^h r_w - b^h w_l$.

Here $b^h \equiv MSV_{r^h} = \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial m^h} - \upsilon\frac{\partial x^h}{\partial m^h}$ and $\beta^h \equiv \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial m^h}$.

The value of the income transfer to the worker is equal to the wage, multiplied by the marginal social value (MSV) of such transfer. This is the welfare weight of the income change minus the increase of consumption at shadow prices. See the Appendix for the details.

We suggest that a proxy for *b* in region *h* is simply $b = (\beta - 1)$, because all income is spent in consumption goods, hence the derivative of consumption to income in (6) is unity. This leads us by substitution to the empirical formula to be estimated:

(7) $SWR = \beta^h r_w + (1-\beta^h)\frac{w_{man}}{NPC}$

Moreover, while there is a vast literature in labour economics that tries to estimate reservation wages based on survey micro data, we shall consider the reservation wage value as simply to be equal to what the worker could consume if unemployed, i.e. the value of the unemployment benefit. Thus according to our short-cut formula, the cost to the economy of hiring an unemployed person is equal to the value of leisure time renounced, plus the additional consumption, minus the social benefit of this consumption. Differently from equation (1), but more or less similarly to equation (2) we ignore here the complex side effects on public finance due to a decrease in unemployment, and we focus only on the consumption side of the story.

c) Rural Labour Dualism (RLD)

In the DS setting, the dualistic labour market is characterized by the fact that there is excess labour supply that is absorbed in the informal market. Therefore the shadow wage is the value of the foregone marginal social product in the informal sector minus the social value of the increase of income to the worker: $SWR = m - b^h\left(w_l - MP_l^g\right)$.

In case of significant migration flows, if the region is predominantly rural, we are back in the presence of the rural labour dualism case (RLD) in the LM setting. As workers employed by the project were previously employed in the agricultural sector, we assume that $m = w_{agr}(1-t)$, where w_{agr} is the average regional agricultural wage rate, and *(1-t)* represents the tax wedge. By considering the net agricultural wage we are allowing for the possibility that workers in the agricultural sector may have been self-employed or not formally employed. Therefore, the empirical formula for the shadow wage rate in the RLD case is:

(8) $SWR = \beta^h \frac{w_{agr}\left(1-t\right)}{NPC_{agr}} + \left(1-\beta^h\right)\frac{w_{man}}{NPC}$

d) Urban Labour Dualism (ULD)

If the region is instead highly urbanized, immigration may be the sign that, even if unemployment is high, there might be labour opportunities in the unofficial urban labour market, and we have called this urban labour dualism (ULD) market. This situation is similar to QKU, but it differs from it because we assume that the new employee will be drawn from a combination of formal and informal employment in the urban context, while under QKU a fraction of workers were fully unemployed and their leisure time was valued as the reservation wage. Under this situation, the total stock of new employment comes from the urban informal market.

The DS formulation is similar to the one in the previous case, but here we assume that the earnings in the "black" labour market will be roughly equal to the net market wage, i.e. $m=w_{man}(1-t)$ Our testable equation is thus:

$$(9)\quad SWR = \beta^h \frac{w_{man}\left(1-t\right)}{NPC} + \left(1-\beta^h\right)\frac{w_{man}}{NPC}$$

To sum-up, starting from the LM model, we have generalized it by some reasonable simplifications. We have proposed a shadow wage rate formula that is a linear welfare weighted of past and current social costs and benefits in terms of consumption. We have shown how, by a simple change of variables, the same baseline formula can be adapted to four different regional labour market conditions, which are our interest in the EU context.

4. Data and Methods

In this paper we use a various data sources including Cambridge Econometrics (CE), Eurostat, ESPON, OECD and ILO. We have considered 266 NUTS2 regions of the EU27 in 2007.

The main variables on regional economic performance are per capita GDP in Purchasing Power Standard (PPS) levels (Eurostat), the rate of unemployment and of long term unemployment (Eurostat). Demographic and geographic data include total and active population (CE) and the annual net migration development (ESPON). Migration data is derived from ESPON's annual net migration development at NUTS3 level between 2001 and 2005 and is defined as the difference of in-migration and out-migration as percentage over total population. This information has been aggregated at the NUTS2 level using each NUTS3's population share in 2003 (median year of the interval). Regional earnings data (CE) are in employee terms and sector-specific (agriculture, energy and manufacturing, construction, market, non market services). Average and marginal tax rates (Eurostat and OECD) and the unemployment benefit (Eurostat) are at the country level. Rurality is measured as the share of workers employed in the agricultural sector (Eurostat).

The marginal and average tax rates for an average taxpayer (respectively, t' and t) were then used to compute the country-specific elasticity of marginal utility on income, $\eta_i = \ln\left(1-t_i'\right)/\ln\left(1-t_i\right)$, where i indicates the country (see, Stern (1977)).

Following the general LM formulation and Kula (2002) , the vector of η is an input in the computation of the regional welfare weights vector, β^h, based on the ratio between the national poverty thresholds (expressed as 60% of the median per capita GDP in EU countries), y^{pov} , and the region's average income, y^h , where here h stands for a NUTS2 region:

$$\beta^h = \left(\frac{y^{pov}}{y^h} \right)^{\eta} .$$

To account for price distortions, which are especially relevant for agricultural prices in the EU due to the CAP, we have considered the EU27 average producer Nominal Protection Coefficient (NPC) provided by OECD (2010). This coefficient is used to compute the region-specific protection coefficient indices for the agricultural sector (NPC_{agr}) and the whole economy (NPC_{total}). The NPC_{agr} is defined as NPC weighted by the ratio of the gross value added in agriculture over the gross value added in the whole economy:

$$NPC_{agr} = NPC \cdot \frac{GVA_{agr}}{GVA_{total}} .$$

Assuming that there is no distortion due to producer protection policies in non-agricultural sectors, the NPC_{total} is defined as:

$$NPC_{total} = NPC \cdot \frac{GVA_{agr}}{GVA_{total}} + \frac{GVA_{total} - GVA_{agr}}{GVA_{total}}$$

5. Empirical application

Following the analytical framework presented in Section 3, we first develop a classification of European regions into four groups, which we identify as "fairly socially efficient" (FSE), "quasi Keynesian unemployment" (QKU), "urban labour dualism" (ULD) and "rural labour dualism" (RLD). Hence we compute the shadow wage rates and conversion factors as in equations (5,7,8 and 9).

The classification of European regions is obtained by developing a cluster analysis based on partitioning methods, which allow the user to specify the number of clusters (Kaufman and Rousseeuw, 1990). As these clustering methods are highly sensible to the initial values used for the clustering procedure and to outliers, we opted for robust partitioning algorithms and in particular for the partitioning around medoids (PAM) function (Kaufman and Rousseeuw, 1987). The PAM algorithm is based on the search for k representative objects, called medoids, among the objects of the data set. These medoids are identified so that the total dissimilarity of all objects to their nearest medoid is minimal. In other words, the goal is to find a sub set $\{m_1,...,m_k\}$ of a set of n objects {1,…,n} which minimises the objective function:

$$\sum_{i=1}^{n} \min_{t=1,...,k} d(i,m_t) \,. \tag{10}$$

Each object is then assigned to the cluster corresponding to the nearest medoid, i.e. object i is included into cluster z when medoid $m_z \in \{m_1,...,m_k\}$ is nearer to i than any other medoid.[11]

Our cluster analysis was performed along five main dimensions: average income levels (regional per capita GDP in parity purchasing powers), regional unemployment rate (using both the short and long term rates), rurality (measured as the share of workers employed in the agricultural sector) and migration (defined as the difference of in-migration and out-migration as percentage over total population). All these variables were standardised before inclusion in the PAM algorithm. We set $k=4$ and used the Euclidean distance in (10), although results are also robust to the use of the absolute distance metric.

Table 1 shows some statistics of the variables used by cluster. Regions in cluster 1 are characterized by a relatively high income level (€33,000) and lower agricultural employment share (3%), with positive migration inflows (0.4%) and relatively low unemployment rates (4% and 1% for short and long term unemployment, respectively). We identify these regions as those corresponding to what we called the “fairly socially efficient” case (FSE). These regions are assumed to have a relatively efficient labour market. In this set we have many regions, including capitals, such as Paris, London, Wien, Amsterdam, Stockholm, mainly in EU15 countries, but also wider areas in the south of Germany, the north of Italy, Austria, south east England, some regions of Scotland, Scandinavian regions and Basque countries.

Regions in cluster 3 are instead thought to be suffering of Keynesian unemployment, characterized by higher short and long term unemployment (12% and 6%, respectively) and significantly lower than average per capita GDP (€18,700), while agricultural employment share (7%) is higher than in FSE and ULD regions, but lower than RLD regions. In this set we have both New and Old Member States regions and we labelled this group as “quasi-Keynesian unemployment” regions (QKU), among which we have regions of southern Spain, southern Italy, northern France, northern Greece, east Germany, Hungary and Poland.

Dual labour markets are detected in clusters 2 and 4. Regions in cluster 4 are relatively very poor and rural regions (per capita GDP is €10,400 and share of agricultural employment is equal to 30%), with high short and long run unemployment (8% and 4%, respectively). We regard this duality to be of the rural-urban type (“rural-labour dualism”, or RLD). We can also verify that they

[11] For a thorough description of this and other robust clustering techniques, see Struyf et al. (1997). Our empirical application was developed using the R package “cluster” (Maechler et al., 2010).

are characterized by large outflow migration rates (-0.4%). Regions in cluster 4 include mostly regions in eastern EU and Greece. Regions in cluster 2 are characterized by relatively high levels of GDP (€24,300) and very low long term unemployment (2%), and are not very rural (rural employment is similar to that of FSE regions and is on average 4%). When looking at migration rates, we see that these regions are characterized by the highest average immigration rate (0.6%), possibly indicating the presence of a pool of migrants that might be entering an informal urban sector. We classify these regions as "urban labour dualism" (ULD). They include many regions in Spain, Portugal, France, central Italy, UK and Ireland, northern Germany, Baltic and Scandinavian countries.

Figure 1 gives a visual representation of how the four labour market cases are distributed across the EU, with FSE (cluster 1) corresponding to the lightest shade and RLD (cluster 4) to the darkest.

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
FSE: Cluster 1					
GDP per capita (in PPS)	63	33093.65	9330.96	22300.00	83200.00
Unemployment rate (%)	63	4.05	1.21	2.10	8.10
LT unempl. rate (%)	63	1.11	0.58	0.36	3.46
Agricolture empl. share	63	0.03	0.02	0.00	0.09
Migration rate (%)	63	0.40	0.35	-0.39	1.28
ULD: Cluster 2					
GDP per capita (in PPS)	129	24271.32	5128.43	13900.00	47800.00
Unemployment rate (%)	129	6.36	1.62	3.40	10.50
LT unempl. rate (%)	129	2.32	1.14	0.51	4.91
Agricolture empl. share	129	0.04	0.04	0.00	0.23
Migration rate (%)	129	0.58	0.58	-0.55	2.67
QKU: Cluster 3					
GDP per capita (in PPS)	52	18653.85	7365.86	9800.00	55000.00
Unemployment rate (%)	52	11.87	2.94	7.80	20.30
LT unempl. rate (%)	52	6.35	2.39	2.48	11.81
Agricolture empl. share	52	0.07	0.05	0.00	0.18
Migration rate (%)	52	-0.06	0.40	-0.79	1.06
RLD: cluster 4					
GDP per capita (in PPS)	22	10400.00	3503.33	6400.00	18900.00
Unemployment rate (%)	22	8.27	1.99	4.30	12.10
LT unempl. rate (%)	22	4.45	1.32	1.82	7.06
Agricolture empl. share	22	0.30	0.07	0.19	0.42
Migration rate (%)	22	-0.39	0.40	-1.05	0.41

Source: our calculations on Eurostat and CE data.

Table 1: descriptive statistics on cluster dimensions.

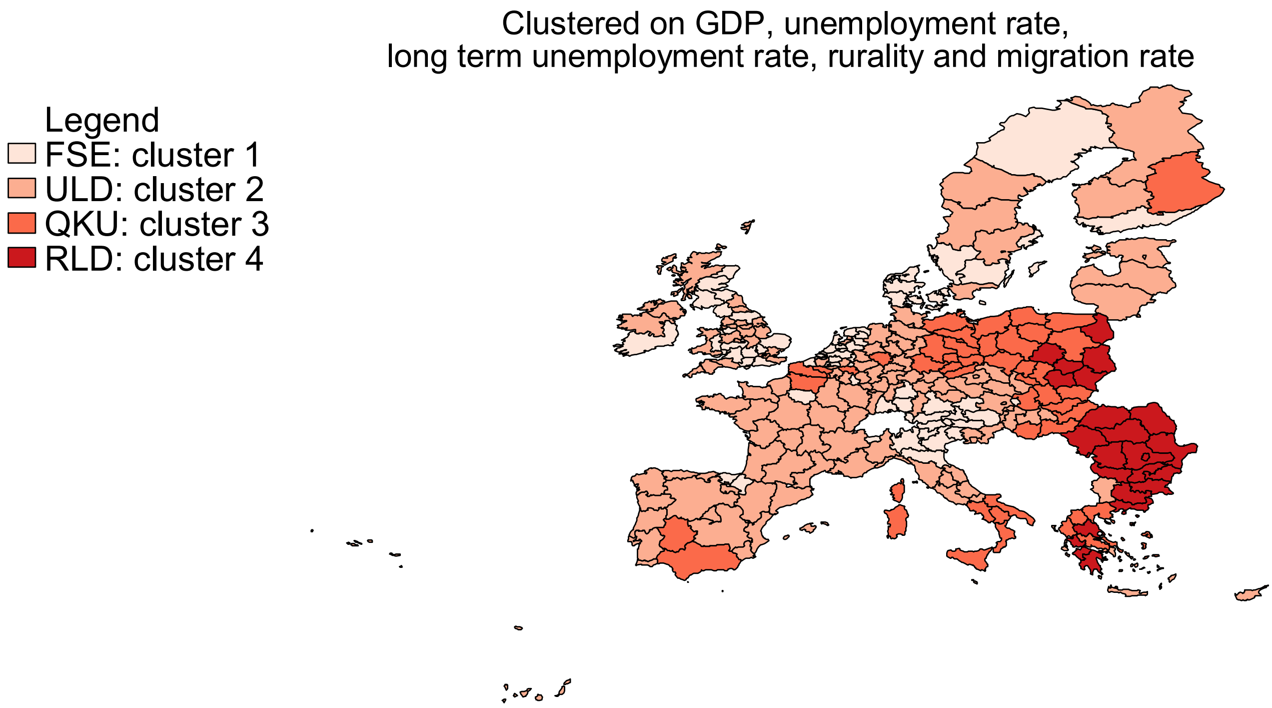

Figure 1: Cluster analysis to identify the four labour markets outlined in Section 3.

Using the formulae described in Section 3 we therefore computed shadow wages and the corresponding conversion factors (i.e. the ratio between shadow and market wage) for each region, according to the previous cluster analysis.

Table 2 shows summary statistics for the four groups defined regarding the main variables of interest.[12] The highest shadow wage is, as expected, found in regions that we classified as fairly efficient (FSE), with an average value of €45,240, for which a conversion factor with a value equal to 1 is computed. The second highest average shadow wage (€27,140) is that of highly urban regions (ULD), and the conversion factor is on average 0.80, with a standard deviation equal to 0.08. We think that these regional labour markets may be distorted due to the presence of migrants that may be willing to accept a job without being paid the corresponding social benefits. Regions classified as Quasi-Keynesian (QKD) have a lower average shadow wage (€12,111) with a conversion factor on average equal to 0.54,[13] with a large standard error equal to 0.16. Finally, the lowest shadow wages and conversion factors (average values of € 5,217 and 0.62, respectively) are found in regions with a rural-labour dualism.

[12] A detailed list of regions and corresponding conversion factors is available upon request.
[13] In the RLD case, we might be overestimating the marginal productivity in the agricultural sector (and consequently the conversion factor). If agricultural production is characterized by decreasing returns to scale, average productivity will be lower than marginal productivity and our correction for the tax wedge may be insufficient to capture this effect. LM (p 277) in fact suggest taking half the average productivity as a reasonable approximation of marginal productivity in agriculture. Applying this shortcut to our data, however, leaves results substantially unaltered.

Variable	Obs	Mean	Std. Dev.	Min	Max
FSE: Cluster 1					
Shadow wages	63	45239.47	10738.99	13871.10	66528.37
Conversion factors	63	1.00	0.00	0.99	1
ULD: Cluster 2					
Shadow wages	129	27143.10	10265.68	3255.30	50486.03
Conversion factors	129	0.80	0.08	0.61	0.97
QKU: Cluster 3					
Shadow wages	52	12111.14	8858.47	3494.42	53107.76
Conversion factors	52	0.54	0.16	0.23	0.89
RLD: cluster 4					
Shadow wages	22	5216.78	3350.83	1590.88	13928.63
Conversion factors	22	0.62	0.13	0.36	0.84

Source: our calculations on Eurostat and CE data.

Table 2: Summary statistics of shadow wages and conversion factors by clusters.

Figure 2 presents a graphical representation of conversion factors by regions. They are characterised by large variability in some countries, especially in Italy, Germany and Spain.

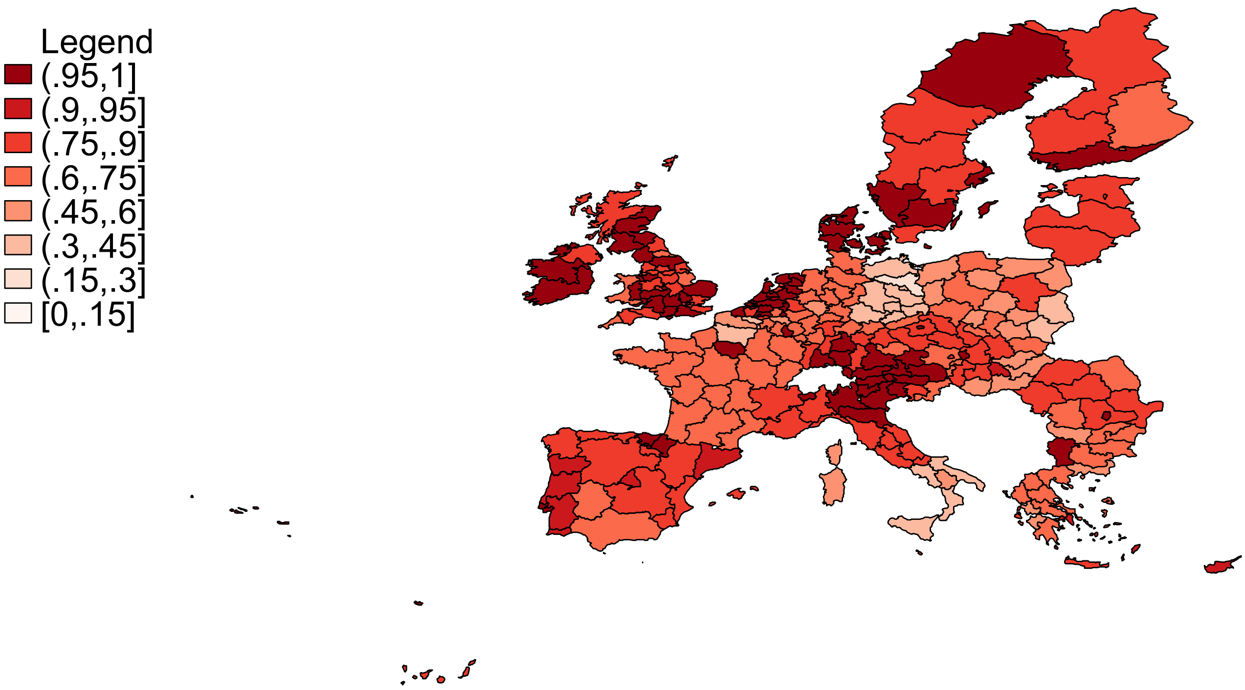

Figure 2: Distribution of conversion factors across NUTS2 regions.

The shadow wages computed according to the formulae presented in Section 3 are reflecting region-specific labour market conditions, following the taxonomy obtained through the cluster analysis based on relative GDP, unemployment, rurality and migration. We therefore assess how conversion factors are related to per capita GDP, unemployment rates, migration share and agricultural employment share, and controlling for country fixed-effects.

We estimate the relation:

$$(11)\ CF_i = \alpha_0 + \alpha_1 GDP_i + \alpha_2 Unempl_i + \alpha_3 UnemplLT + \alpha_4 Rurality_i + \alpha_5 Migr_i + \varepsilon$$

By using OLS, with heteroskedastic corrected standard errors, clustered by countries, where *GDP* is per capita GDP in PPS, *Unempl* and *UnemplLT* are short and long term unemployment rates, *Migr* and *Rurality* are the same variables used in the cluster analysis and ε is the i.i.d. error term.

Results are presented in Table 3, which shows that the conversion factor is strongly correlated with per capita GDP and rurality share.

	(A)	(B)	(C)
GDP (per capita,	0.009***	0.009***	0.009***
PPS in '000 euro)	[0.000]	[0.000]	[0.000]
Unemployment rate	-0.006	-0.047***	
(long term)	[0.721]	[0.000]	
Unemployment rate	-0.028**		-0.032***
	[0.038]		[0.000]
Migration rate	0.000	0.002	0.001
	[0.995]	[0.931]	[0.971]
Rurality (share of	-0.621***	-0.550***	-0.629***
agricultural workers)	[0.003]	[0.002]	[0.003]
Country fixed effects			
BE	-0.020	-0.003	-0.024
	[0.395]	[0.909]	[0.256]
BG	0.216***	0.253***	0.210***
	[0.001]	[0.000]	[0.001]
CY	0.037*	0.030	0.037*
	[0.068]	[0.224]	[0.069]
CZ	0.040	0.081***	0.033
	[0.266]	[0.009]	[0.226]
DE	-0.099***	-0.070**	-0.105***
	[0.003]	[0.037]	[0.001]
DK	0.064***	0.057***	0.065***
	[0.000]	[0.000]	[0.000]
EE	0.100**	0.139***	0.094***
	[0.016]	[0.000]	[0.007]
ES	0.114***	0.028	0.125***
	[0.005]	[0.190]	[0.000]
FI	0.066	-0.016	0.078***
	[0.155]	[0.349]	[0.009]
FR	-0.043*	-0.065***	-0.041
	[0.084]	[0.004]	[0.102]
GR	0.112***	0.105***	0.112***
	[0.003]	[0.004]	[0.003]
HU	0.049	0.053	0.048
	[0.236]	[0.203]	[0.242]
(continues from previous column)			
IE	0.057*	0.050	0.057*
	[0.072]	[0.138]	[0.069]
IT	-0.038*	-0.022	-0.041***
	[0.051]	[0.239]	[0.005]
LT	0.143***	0.152***	0.143***
	[0.000]	[0.000]	[0.000]
LU	-0.282***	-0.289***	-0.283***
	[0.001]	[0.001]	[0.001]
LV	0.196***	0.166***	0.200***
	[0.000]	[0.000]	[0.000]
MT	0.130***	0.135***	0.128***
	[0.000]	[0.000]	[0.000]
NL	0.017	0.048***	0.012*
	[0.191]	[0.000]	[0.092]
PL	0.048	0.046	0.047
	[0.347]	[0.349]	[0.364]
PT	0.244***	0.239***	0.243***
	[0.000]	[0.000]	[0.000]
RO	0.282***	0.295***	0.280***
	[0.000]	[0.000]	[0.000]
SE	0.022	-0.045***	0.032**
	[0.508]	[0.000]	[0.044]
SI	-0.010	0.017	-0.014
	[0.638]	[0.349]	[0.375]
SK	0.206***	0.303***	0.189***
	[0.004]	[0.000]	[0.000]
UK	-0.020*	-0.040***	-0.018*
	[0.069]	[0.000]	[0.099]
Constant	0.804***	0.718***	0.814***
	[0.000]	[0.000]	[0.000]
Observations	266	266	266
R-squared	0.827	0.813	0.826

Notes: Robust p-values in brackets. All standard errors are clustered at the Country level. Omitted country is Austria.

*** p<0.01, ** p<0.05, * p<0.1

Source: our calculations on Eurostat and CE data.

Table 3: Regression Results

The correlation with migration rates is not statistically significant, while long and short term unemployment rates are significant but highly correlated. Country fixed-effects are informative as an average of conversion factors, after controlling for the same variables used for the clustering. On average, the lowest conversion factors compared to the omitted country (Austria) are estimated for Luxembourg and Germany, while the highest are for Romania, Bulgaria and Portugal.

6. Conclusions

In this paper we develop a new simple framework for the empirical computation of shadow wages and conversion factors at the regional level, accounting for structural characteristics and labour market conditions, which is of paramount relevance for public project evaluation.

After a brief review of earlier literature, we have provided the analytical foundations for our empirical exercise. Linking the literature on shadow prices in a general equilibrium setting with easily implementable formulae, we provided a set of shortcut shadow wage formulae based on solid theoretical grounds, that are easily implementable with regional and national statistical data, moving away from the more precise but cumbersome and costly approaches based on project-specific micro-data.

What has emerged from our analysis is that the EU regions are not homogeneous with respect to structural and labour market features, and that they can be classified in four broad classes. We have considered regional GDP, unemployment rates, both short and long term, migration flows and rurality to account formally, with a robust multivariate cluster analysis, for these differences.

In a nutshell, we suggest that the market wage is the best proxy of the shadow wage in the average "Fairly Socially Efficient" labour market; a discount of around 10% of the market wage is the average correction under "Urban Dualism"; a discount of around 46% of the market wage is suggested in "Quasi-Keynesian Unemployment" regions and of approximately 38% in "Rural Dualism" regions.

The main lesson learned from this exercise has been to highlight the importance of regional heterogeneity and disparities both across and within countries in the evaluation of public investment projects and to show how this can be linked directly to underlying, observable, regional characteristics. We believe that the benefit of relying on official statistics is worth the cost of a less precise computation of the shadow wage rate. We regard this as a first step in order to provide project evaluators, particularly in the NMS of the EU and in the context of regional policy, with a range of indicative values.

Annex 1: SWR Formulae in the Drèze and Stern framework

Shadow prices arise as the solution to the optimization of the Social Welfare Function (SWF) in a model with consumers, producers and a benevolent social planner. Agents react to signals $s \in S$ (including producer and consumer prices *p* and *q*, taxes *t*, consumption or production quantity constraints $\bar{x}_i$ and $\bar{y}_i$, lump sum transfers to consumers r^h and consumers' shares in firms' profits θ^{gh}), and to exogenous parameters ω[14]. The planner has control over signals in order to determine the optimal demand compatible with the exogenous public production plan *Z*,[15] therefore controlling the environment to which private agents respond to. Formally, the planner maximizes a SWF subject to scarcity and side constraints:

$$\text{(A.1)} \quad \max_{s} W\left(V^{1},...,V^{h}\left(p+t,\bar{x}^{h},m^{h}\right),...,V^{H}\right)$$

$$s.t.\begin{cases} \sum_{h=1}^{H} x^{h}\left(p+t,\bar{x}^{h},m^{h}\right)-\sum_{g=1}^{G} y^{g}\left(p,\bar{y}^{g}\right)-Z=0 \\ s \in S \end{cases}$$

with $E=\sum_{h=1}^{H} x^{h}\left(p+t,\bar{x}^{h},m^{h}\right)-\sum_{g=1}^{G} y^{g}\left(p,\bar{y}^{g}\right)$

where *h* denotes households, *g* firms, *p* are producer market prices, *t* indirect taxes, *y* and *Z* are private and public supplies, *x* is a vector of consumer demands, *v* are the Lagrange multipliers of the side constraints (which coincide with shadow prices in the model without side constraints), *V* is the individual utility, barred variables represent quantity constraints or rations and income $m^{h}=r^{h}+\sum_{g}\theta^{g}\pi^{g}\left(p,y^{g}\right)$ is the sum of lump sum transfers and consumer *h*'s share of profits of firm *g*.

The shadow price vector is the gradient of the maximum value function *V**. The corresponding Lagrangean is:

$$\text{(A.2)} \quad L=W\left(V^{1},...,V^{h}\left(p+t,\bar{x}^{h},m^{h}\right),...,V^{H}\right)-\upsilon\left(\sum_{h=1}^{H} x^{h}\left(p+t,\bar{x}^{h},m^{h}\right)-\sum_{g=1}^{G} y^{g}\left(p,\bar{y}^{g}\right)-Z\right).$$

The net effect on social welfare of a small shift of any parameter ω is indicated by the gradient of the Lagrangean. *Z* is the net supply of the public sector, which adjusts the net private supply *E(s)*. A change in ω influences private agents' economic behaviour. Formally, for any parameter ω_k,

[14] Parameters can be viewed as truly exogenous, and thus outside the control set of the planner, or represent potential policy opportunities available to the planner, or finally be treated as parametric in order to evaluate reforms.
[15] Which can be both optimally or not optimally chosen.

$\frac{\partial V^*}{\partial \omega_k} = \frac{\partial L}{\partial \omega_k} = \frac{\partial V}{\partial \omega_k} - \upsilon \frac{\partial E}{\partial \omega_k}$ is its marginal social value (MSV). The value of a parameter is optimal from the planner's point of view when its marginal social value is zero.

By considering the MSV of a lump sum transfer to consumer h (r^h), we can define b^h (the social value of a lump sum transfer to workers) and β^h (welfare weight of agent h), as follows:

(A.3) $b^h \equiv MSV_{r^h} = \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial m^h} - \upsilon \frac{\partial x^h}{\partial m^h}$ and $\beta^h \equiv \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial m^h}$.

The MSV of an unrestricted production price, optimally set to zero, is equal to the corresponding first order condition of the planning problem:

(A.4) $MSV_{p_i} = -\sum_h \beta^h x_i^h + \sum_g \sum_h \theta^{gh} b^h \frac{\partial \pi^g}{\partial p_i} - \upsilon \left[\frac{\partial x}{\partial q_i} - \frac{\partial y}{\partial p_i} \right] = 0$.

By manipulation of this equation, and using the definition of the MSV of a lump sum tax on profits of the g^{th} firm, $b^g \equiv \sum_h \theta^{gh} b^h$, and the fact that $\frac{\partial \pi^g}{\partial p_l} = y_l^g$, the expression becomes:

(A.5) $-\sum_h \beta^h x_i^h - \upsilon \left[\frac{\partial x}{\partial q_i} - \frac{\partial y}{\partial p_i} \right] + \sum_g \sum_h \theta^{gh} b^h \frac{\partial \pi^g}{\partial p_i} = 0$.

At the optimum, we can therefore breakdown the MSV in the direct effect on consumers of the price increase, the social cost of meeting the induced extra net demands and the social value of extra profits generated.

We shall now turn our attention to the four labour market structures identified in Section 3, and provide formal derivations in the DS setting of the main equations in the text.

a) Fairly Socially Efficient case (FSE)

The marginal social product of labour in private firms is derived from the social planner's maximization problem, and is given by the marginal social value of input labour. More in detail, the marginal social value of the input labour is given by deriving the Lagrangean with respect to the price of labour, p_l.

(A.6) $\frac{\partial L}{\partial p_l} = MSV_l = \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial p_l} + \sum_g \sum_h \theta^{gh} b^h \frac{\partial \pi^g}{\partial p_l} - \upsilon \left[\frac{\partial x}{\partial q_l} - \frac{\partial y}{\partial p_l} \right]$

Making us of Roy's identity, and the definition of welfare weight, we obtain, at the optimum the following First Order Condition (FOC):

(A.7) $MSV_l = -\sum_h \beta^h x_l^h + \sum_g \sum_h \theta^{gh} b^h \frac{\partial \pi^g}{\partial p_l} - \upsilon \left[\frac{\partial x}{\partial q_l} - \frac{\partial y}{\partial p_l} \right]$.

By manipulation of this equation, and using the definitions of b^h, $b^g \equiv \sum_h \theta^{gh} b^h$ and the fact that $\frac{\partial \pi^g}{\partial p_l} = y_l^g$, and assuming that firm g responds to a change in wages as the average of all the firms we obtain:

(A.8) $SWR = m + \frac{D_l}{\partial y_l / \partial w_l}$

where $D_l = \sum_h b^h x_l^h - \sum_g b^g y_l^g$ reflects the allocative and distributional effect of a raise in wages due to the creation of new employment. If $b^h = b^g$ and $x^h = y^g$, the shadow wage formulation in a DS setting is simply $SWR = m$.

b) Quasi-Keynesian Unemployment (QKU)

This labour market is characterized by involuntary unemployment, and clears by rationing of supply because wages are set under the reservation wage. Additional employment in this case requires a release of an additional unit of labour supply, i.e. $\partial \bar{x}_l^h$. The signal changing in this case is the labour supply constraint and the marginal social value of the reform from the Lagrangean is, around the otpimum:

(A.9) $\frac{\partial L}{\partial \bar{x}_l^h} = MSV_{\bar{x}_l^h} = \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial \bar{x}_l^h} - \upsilon \frac{\partial x^h}{\partial \bar{x}_l^h} = 0$.

The marginal social value here is given by a direct effect on the individual utility of marginal supply of labour corrected by a change in the demand, which is the social cost of allowing this additional labour supply.

Further manipulations lead us to:

$SWR = \beta^h \frac{\partial U^h / \partial x_l^h}{\lambda^h} - \upsilon \beta^h w_l + \upsilon \frac{\partial x^h}{\partial r^h} w_l$ where $\frac{\partial V^h}{\partial m^h} \equiv \lambda^h$ which is the marginal individual utility of lump sum income and $\frac{\partial U^h / \partial x_l^h}{\lambda^h} = r_w$. Therefore:

(A.10) $SWR = \beta^h r_w - b^h w_l$, which is equivalent to equation (6) in the main text.

c) and d) Rural Labour Dualism (RLD) and Urban Labour Dualism (ULD)

The shadow wage in the DS setting for this dual labour market condition is the value of the foregone marginal social product in the informal sector minus the social value of the increase of income to the worker:

(A.11) $SWR = m - b^h \left(w_l - MP_l^g\right)$

This self-employment effect can be seen by considering that the worker owns all the shares of the firm for which he is working. In this case, what is relevant is the marginal social value of an increase in labour demand (negative supply) by firms. This is obtained deriving the Lagrangean with respect to the ration $\bar{y}_l^h$.

$$\frac{\partial L}{\partial \bar{y}_l^h} = MSV_{\bar{y}_l^h} = \sum_h \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial m^h} \theta^{gh} \frac{\partial \pi^g}{\partial \bar{y}_l^g} - \sum_h v \frac{\partial x^h}{\partial m^h} \theta^{gh} \frac{\partial \pi^g}{\partial \bar{y}_l^g} + \upsilon \frac{\partial y^g}{\partial \bar{y}_l^g}$$

Using the definition of welfare weights, rearranging and imposing the FOC:

(A.12) $MSV_{\bar{y}_l^h} = \sum_h b^h \theta^{gh} \frac{\partial \pi^g}{\partial \bar{y}_l^g} + \upsilon \frac{\partial y^g}{\partial \bar{y}_l^g} = 0$

The first term in (A.12) shows how the effect of an increase in labour is distributed based on the property shares θ and the distributive coefficient b. The second term is the social value (evaluated at shadow prices) of the increase in labour supply.

As long as the full owner of the firm is the individual himself ($\theta^{gh} = 1$) the extra profits are simply the marginal social value of a lump-sum transfer to consumer b^h. The marginal profits $\frac{\partial \pi^g}{\partial \bar{y}_l^g}$, on the other hand, are equal to the difference between the wage paid and the marginal product of labour ($MP_l = -\sum_{j \neq l} p_j \frac{\partial y_l^g}{\partial \bar{y}_l^g}$).

(A.13) $\upsilon \frac{\partial y^g}{\partial \bar{y}_l^g} + b^h \left(w_l - MP_l^g\right) = 0$

We separate the shadow price of labour from the vector of the other shadow prices and substitute the marginal social cost for the marginal social product. Observing that $\frac{\partial y_l^g}{\partial \bar{y}_l^g}$ can be interpreted as the marginal productivity of labour evaluated at shadow prices (m), the final result is:

$$SWR = m - b^h \left(w_l - MP_l^g\right)$$

The straightforward interpretation of this is the following: the first term represents the social value of the net loss of output caused by a withdrawal of one unit of labour from the agricultural sector to the project; the second measures the marginal social value of the increase in income.

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