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Measuring The Social Opportunity Cost of Labor In Mexico

Sylvia B. Guillermo-Peon and Arnold C. Harberger

Abstract

This paper reviews the theory underlying the concept of the social opportunity cost of labor (SOCL), as that concept is used in benefit-cost analysis and in applied welfare economics generally. It then presents in detail the procedures to be followed in estimating the SOCL in real-world cases. Important steps in data processing include calculating gross and net wages from data on "reported" wages. Further economic analysis involves taking account of migration patterns and of labor market duality. Estimates are made for 32 labor market areas in Mexico, covering 21 occupations for males and 19 for females.

Our main results are a) that there are important differences between reported wages and the gross wages paid by employers, and also between both of these and the net wages received by workers, and b) that taking labor market duality into account leads to significant modifications of our SOCL estimates. More important, perhaps, than our specific estimates for Mexico, is the methodological framework that we use. This framework, based on the fundamental principles of applied welfare economics, can serve as a useful starting point for serious estimation of the SOCL for other countries.

KEYWORDS: benefit-cost analysis, project evaluation, applied welfare economics, social opportunity cost of labor

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INTRODUCTION

This paper attempts to help fill a serious gap in the literature on empirical cost-benefit analysis. Although we find many general discussions of the economic or social opportunity cost of labor, there is a notable absence of methodological guidelines as to how precisely to quantify this opportunity cost across occupational groups and different labor markets. In this paper, we use a large sample survey of Mexico's labor force to show how the Social Opportunity Cost of Labor (SOCL) can be quantified in a real-world setting. We focus on two main data problems and two basic economic matters. The data problems concern what has to be done to move from the reported wage for a given occupation in a given labor market area to (a) the gross wage paid by the employer (gross of taxes and fringe benefits) and (b) the net wage received by the worker (net of all taxes but gross of all fringe benefits and any special externalities that might be present). The economic matters we deal with are (c) patterns of migration coming from the 32 labor market areas that we study and (d) the phenomenon of dual labor markets in a number of important occupations in Mexico.

Our main results are (a) that there are important differences between reported wages and the gross wages paid by employers, and also between the latter and the net wages received by workers, and (b) that taking labor market duality into account leads to significant modifications of our SOCL estimates. More important, perhaps than our specific estimates for Mexico, is the methodological framework that we use. The framework is derived from the basic principles of applied welfare economics. Using it, our study provides a concrete example of how to deal with cases where, as in nearly all countries, reported wages differ significantly from both gross wages and net wages. A further step, important for many developing countries, provides an example of how to handle the wage differentials that arise in dual labor markets.

The paper is organized as follows: the first part presents a general overview of the SOCL concept and its measurement. The second part explains the theoretical elements underpinning the concept of SOCL and the methodology used to measure it when migration and the duality of labor markets are taken into account. The third section explains the procedures used to calculate the gross and net wages to estimate labor market distortions and the SOCL for the Mexican market. The fourth section presents the analysis of our results. Finally, concluding remarks are presented in the fifth section. Additionally, Appendix A provides a guide to help the reader understand how the estimates of the SOCL for male and female workers in 21 occupations and 32 Metropolitan Areas of the Mexican Republic were obtained.

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1. BACKGROUND

The postulates underlying cost-benefit analysis are very clear as to how to measure social opportunity cost. If a project adds to the demand for wheat, its impact will be to stimulate (through its effect in price) some new wheat production (along the supply curve for wheat) and to displace (along the demand curve) some demand of wheat that would otherwise be present. When an efficient market for wheat exists, there is no gap between demand price and supply price. In such a case, the economic or social opportunity cost of wheat would be measured by its market price.

If, however, a distortion (say, a tax) is present in the market for wheat, a gap is opened between the supply and demand prices. The economic cost linked to displaced demand is measured by the demand price p^d (gross of tax), whereas that linked to new supply is measured by the supply price p^s (net of tax). The social opportunity cost of wheat is then a weighted average $SOCW = f^s p^s + f^d p^d$. As the size of the tax T is equal to $p^d - p^s$, we can equally well write $SOCW = p^s + f^d T$. The weights f^s and f^d add up to one and their size is determined by the relative magnitude of the supply and demand elasticities for wheat.

Wheat presents us with a very easy case, as it is a substantially homogeneous commodity whose price is set in a well-integrated market. Labor is at the opposite extreme – a factor with such great heterogeneity that it is absurd to even think of something called *the* economic opportunity cost of *labor*. Labor heterogeneity forces us to contemplate different opportunity costs for a whole gamut of different types – discriminated by occupation, education, age, sex, etc. Luckily, most of these characteristics are reflected in the market wages that apply to the different qualities of labor at any given time and place. This permits us to use the market wage w^m as our entry point into the determination of SOCL. Sadly, however, the market wage that is typically reported is neither the effective demand price of the employer nor the effective supply price of the employee. In Mexico, as well as many other countries, the cost of labor to employers (and therefore their demand prices) exceeds the stated wage due to a series of taxes plus the cost of fringe benefits that are provided on top of the stated wage.

To obtain estimates of the SOCL, we should seek ways of estimating these elements, which generate a gap between the "market wage" and the demand price for labor. In addition, we should try to identify elements of taxation (income taxes plus payroll taxes and similar taxes) which reduce the benefit perceived by the employee below the stated market wage. Also, fringe benefits (which are not reported as part of the stated wage) should be counted as part of the worker's net wage.

Making these corrections, we can at any place and time quantify the demand price for labor as the gross wage that employers really incur as labor

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costs, and the supply price as the net wage that employees really get after all taxes, fees and fringe benefits have been accounted for.

Readers will soon see that still further complications also enter the picture, at least for a country such as Mexico. Hence, to keep our story simple without seriously violating reality, we from the outset make the underlying assumption that the supply of labor is inelastic over the relevant range. A new project or program is thus assumed to draw its labor from alternative employments, here (in the labor market where the project is situated) or elsewhere (from other labor markets around the country). We do not assume that any (significant) part of our project's new demand is met by people entering the labor force *simply because of* our project's new presence in the market.

1.1 Dealing with Migration

There is a big intellectual hurdle that practitioners and users of cost-benefit analysis have to overcome before such work can be properly done or interpreted. Everyone – practitioners and users alike – seems to be tempted to look on the analysis as a comparison between the "with project" scenario and the "before project" starting point. It is natural for them to ask, in a post-project analysis, "where were the workers in this project before they joined it?", and consider the answer to this question to tell them the effective sources from which the project's labor force was drawn.

The correct comparison, however, is between a "with project" and "without project" scenario. In the without project scenario the capital funds invested in the project would instead have been invested somewhere else (as the capital market dictated), and the economy would be put on a new equilibrium path following this alternative allocation of capital. The correct comparison is then not between the project's history and the initial starting point. Rather, it would compare two moving pictures of the economy, one tracing its experience with the project, and the other tracing what would have been the economy's experience without the project but with an alternative market allocation of its capital funds. Thus, the fact that a project located in Monterrey hired workers away from a competitor in the same city does not mean that this was the relevant "source" of that labor. Very likely the competitor simply hired a new worker to replace the one who left. Our procedure assumes that the market determines how the "with project scenario" differs from the "without project" picture. The issue of sourcing also arises when one deals with the question of migration. Our study is fortunate in having data on the state of origin of the sampled workers. Accordingly, we treat migration as a steady flow. Our assumption is that an increment in labor demand in Monterrey will be met by migrants from Coahuila in the same proportion as people born in Coahuila represent in the actual labor force of Monterrey. Thus, if

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5% of Monterrey labor force has come from Coahuila, we assume that 5% of the project's demand will be met by migrants from Coahuila.

The above example gives us a good start on a second issue connected with migration. Wages in Coahuila are lower than those in Monterrey; the question therefore arises of how this phenomenon affects our measure of SOCL for Monterrey. The answer is that, as good economics dictates, the *marginal migrant* from Coahuila to Monterrey is taken to be on the borderline of indifference between the two locations. Thus, even though his wage might have been 3,000 pesos per month net of all taxes while he stayed in Coahuila, and is instead 4,000 pesos per month in Monterrey, the incremental 1,000 pesos is considered not to represent increased utility for the worker, but instead to reflect compensation for the location costs and other inconveniences linked to this migration[1].

Thus, pursuing our example, the social opportunity cost of labor in Monterrey would be based on a wage of 4,000. However, the gross wage (labor cost to the employer) might be 4,500 and the net wage received by the worker might be 3,700 in Monterrey. The corresponding prices for Coahuila might be 3,300 for the gross wage and 2,800 for the net wage. Thus, when we calculate the SOCL for labor of this type and quality in Monterrey, we would start with the gross wage of 4,500 (the "financial cost to the employer") and correct it by subtracting 800 (here assumed to be taxes) as a gain to the government. This leaves us with 3,700 (the true supply price of labor to the project). However, for the labor whose alternative would be Coahuila, there is an externality (a loss to the government there) of 500 (that is 3,300–2,800). Thus, the final SOCL for such workers would be 4,200, equal to 3,700 (true supply price in Monterrey) plus 500 (lost taxes in Coahuila). We also get to 4,200 starting from the gross wage of 4,500. Here, we have to deal with two externalities (not considered by the employer). The first is a benefit for the government of 800 of taxes newly paid in Monterrey; the second is a loss to the government of 500 in taxes that in the alternative scenario would have been paid in Coahuila.

In a real-world example we would have to deal with migration into Monterrey from a number of alternative localities. Thus, in this case we would have to deal not just with 500 of lost taxes in Coahuila, but with a weighted average of say, 500 in Coahuila, 300 in Tamaulipas, 600 in Veracruz; the weights being the relative number of migrants from these sources that are present in the Monterrey labor market.

[1] This is the standard treatment of geographical wage differences as compensating differences from the point of view of the marginal migrant. If there were a big gap, from a worker's point of view, we would observe a huge Niagara of migrants trying to take advantage of it. It is the absence of such floods of migrants, with the pace of migration being linked mainly to labor demand in the destination, that underlies the treatment of geographical wage differences (for the same type and quality of labor) as compensating differentials.

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1.2 The Informal Labor Market

There is a large body of economics writings that discusses the phenomenon of the so-called dual labor markets. Different writers give different names to the duality – formal versus informal sectors, modern versus traditional, protected versus unprotected. In the survey from which our data were obtained, workers in the informal sector were identified. The distinguishing feature of the informal sector is the absence of a series of fringe benefits and legal mandates (e.g., access to the social security system and medical benefits). Also, workers in the informal sector typically pay no income tax. This gives rise to a situation (not out of any theoretical necessity but as revealed by the actual data) in which the net wage received by workers in the informal sector is significantly lower than the corresponding net wage received by apparently equivalent workers in the formal sector[2].

In the face of this evidence it would be wrong to treat (as we do for inter-regional wage differences for the formal sector) the gap between formal and informal sectors as an equalizing difference. We feel impelled to consider that when informal sector workers move to formal sector jobs in the same region, they perceive a gain in utility that is measured by the corresponding wage gap. But how should we treat workers who move, say, from the informal sector in Coahuila to the formal sector in Monterrey? Here, we have already indicated that we would treat the wage gap between one formal sector and another as representing an equalizing difference (because we do not see the migratory floods that would otherwise be present). Thus, let us assume, using the previous example, that informal sector workers of similar characteristics earn a true net wage of 2,400, compared to 2,800 in the formal sector of Coahuila. If such a worker moves from the informal sector to the formal sector in Coahuila, we attribute a gain to the worker of the full difference of 400. But if that same informal worker in Coahuila migrates to Monterrey where he works in the formal sector at a true net wage of 3,700, we do not consider the full difference of 1,300 (that is 3,700–2,400) as a measure of the worker's gain in utility. Instead, we treat the worker's move as a two-stage operation – first a (virtual) move from informal-Coahuila to formal-Coahuila, entailing a utility gain of 400; followed by a second move from formal-

[2] Table A1 in the Appendix reports the summary statistics for the ratios of estimated median Net Wage received by a worker in the formal sector in location *k* to the corresponding median Wage received by a worker in the informal sector. These ratios provide evidence of the important difference between formal and informal net wages. The main sources of those differences are taxes (not withheld in the informal sector) and medical and retirement benefits (not provided there). The statistics were calculated over the ratios of the 32 metropolitan areas as defined in Table A2, and we report them for those occupational groups where informality is important.

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Coahuila to formal-Monterrey, entailing a financial gain of 900, but a utility gain of zero because the differential of 900 is treated as equalizing.

In the next sections of the paper we give a more detailed explanation of our methodology, show how we calculate gross and net wages, starting from data on market wages, and explain how we deal with migration and dual market issues when estimating the SOCL.

2. METHODOLOGY – THE GENERAL FRAMEWORK

The methodology employed in this paper is derived directly from the fundamentals of applied welfare economics. This branch of economic analysis is built on the following postulates[3]:

1. Competitive demand price measures the benefit of each marginal unit to the demander.
2. Competitive supply price (or marginal cost) measures the opportunity cost of each marginal unit from the standpoint of the suppliers (factors of production).
3. To measure the benefits and costs to a society as a whole, one adds up the excess of benefits over costs for all individuals (or relevant entities) in the society.

These three postulates provide the basis for measuring how social welfare changes when some policy or project is implemented. Following these postulates it is easy to understand that if demand price (as seen by demanders) is equal to supply price (as seen by suppliers) in a competitive market, marginal social benefit will always be equal to marginal social cost. Hence, in the absence of any distortions in the economy, the social opportunity costs of goods and services would equal their market prices. However, when distortions (such as taxes, subsidies and minimum wages) and externalities (such as those generated by dual labor markets) are present in the economy, marginal social benefit as measured by the price paid by demanders differs from marginal social cost. Under these circumstances, market prices no longer represent the social or economic prices of goods and services because, as shown above, a tax causes the demand price to differ from the supply price. In such a case, the social opportunity cost becomes a weighted average of the two prices (demand and supply), with weights being the proportions of a new demand which are met (a) by displacing other demanders and (b) by attracting additional supply.

[3] Harberger, 1971a.

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The concept of economic or social opportunity cost of factor inputs is derived from the recognition that when resources are used for one project, other opportunities to use these resources are sacrificed. For the specific case of the labor input, any time a vacancy is filled, workers are either sourced from a set of alternative employments (displaced demand) or newly drawn into the labor force (newly stimulated supply).

…when workers are hired by a project, they are giving up one set of market and non-markets activities for an alternative set. The economic opportunity cost of labor is the value to the economy of the set of activities given up by the workers including the non-market costs (or benefits) associated with the change in employment. Jenkins (1995)

In line with the three basic postulates of applied welfare economics, the SOCL has two main components. First, the cost of attracting a worker to the job in question (labor supply price). Second, the welfare effect that results from disturbing any related markets which are subject to externalities or distortions. These elements represent the difference (usually taxes) between competitive demand price for labor and the net-of-tax supply price of labor in the markets from which the labor for a given project is "sourced". The supply price of labor to a project is the net-of-tax market wage rate the project needs to pay to obtain sufficient supplies of labor with the appropriate skills. Typically, so long as the relevant labor market is competitive, the net-of-tax wage at destination accurately reflects this marginal supply price of labor to a project. It is, of course, independent of the source of origin of new workers. The market wage at destination then is the labor price that must be adjusted to allow for prevailing distortions to obtain the SOCL.

In general, taxes affect both labor demand (private cost of labor) and workers´ income through income taxes, social security contributions and other levies. These distortions generate a difference between labor costs for the employer (gross wage) and the income workers receive (net wage). The gross-of-tax market wage guides hiring decisions for the employer, net income guides workers' decisions to supply labor and to choose among jobs. Fringe benefits, by contrast, are a component of both the gross and the net wage. They may present a measurement problem, however, in cases where they are not counted in the wage as it is reported by workers or employers.

When migration between cities or regions is considered, the size of distortions and wage differentials must also be taken into account in measuring the SOCL. To the extent that migration is important, the calculation of the SOCL for a given occupation in one region will have to take account of regional wage differentials and distortions between that region and the relevant sources of

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migrants. In particular, when demand for skilled labor in one area increases it is not unusual for workers from other cities and regions to migrate to help meet that demand. As living costs, weather and other amenities differ substantially among labor markets, the standard assumption is to consider that the marginal migrant from source *s* to destination *k* is on the borderline of indifference between the relevant net wage at the source and the corresponding net wage at the destination. That is to say, as far as net wages are concerned, wage differences among labor markets are treated as "equalizing differences".

2.1 Methodology – Migration Issues

Under the standard case, when a project is undertaken in a particular location or region, a reasonable and realistic assumption is that regional labor markets are linked in such a way that an increase in labor demand in a particular region will displace labor of the same type of occupation not only in that region itself but also in other regions from which labor might be attracted. For example, a new oil refinery project located in Hidalgo state (Mexico) adds demand for mechanical and industrial engineers in this state. It could be the case that 60% of these engineers might come from the same state (who in turn leave their last jobs to fill the new demand at the refinery's location) and the rest from contiguous states, say 20% from Estado de Mexico, 10% from Puebla and the other 10% from Veracruz (all of them leaving their last jobs at the origin).

The pioneering study of SOCL in Mexico was that of González (1995), on which Harberger was the principal external advisor. González dealt with the problem of migration by a very simple set of assumptions. In all cases he assumed that half the jobs created in a given area were filled by net migration. He then employed two alternative assumptions for dealing with the geographic sources for this migration. The first assumption (called "the donut") treated these migrants as coming from labor markets that were contiguous to the destination market. They were assumed to be drawn from these markets in proportion to the current labor force in each source's market. The second assumption (called "all Mexico") assumed that the migratory half of a new project's labor force came not just from contiguous markets but from all other markets in Mexico, again being drawn in proportion to the current labor force in each source's market. These assumptions were recognized by González as being extremely crude, and were defended as short-cuts referred necessary by the time and budgetary constraints under which his study was carried out (under the official sponsorship of Banobras, Mexico's top project evaluation agency).

One of our objectives in the present study was to make what we felt were useful improvements to González's methodology. Our study makes two main contributions in this direction. First, we were able to obtain data on the number of

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people born in each source who were economically active in each destination during the second quarter of 2010. On the basis of these data we were able to make the assumption that increments to a destination's labor force could be sourced from different origins in the same proportions as people from each origin who were present in that destination in the same period. Second, and perhaps more important, we were able to do this for nine occupational groups or categories and for each of the 32 locations. Our procedure, based directly on real data (that were not available to González), is clearly preferable to the much cruder "donut" and "all Mexico" treatments used in his study.

To illustrate our (and González's) method of adjusting the gross wage to obtain the SOCL for a given occupation, consider workers to be drawn from a set of sources *s* for new employment (in occupation *j*) at destination *k*. The employer at *k* will be paying a gross wage GW_j^k which is the private cost per worker hired. The social cost is lower, however, because taxes T_j^k are going to be paid on the basis of this wage. Additionally, each of these workers is presumed to come from some source[4], either from area *k* itself or from other parts of Mexico. It is presumed that taxes T_j^s would be paid on the basis of these source wages, in the absence of the project being analyzed. Hence, these taxes are "lost" as a consequence of the project. The adjustment in this simple case is:

$$SOCL_j^k = GW_j^k - T_j^k + \sum_s \alpha_j^{sk} T_j^s \quad (1)$$

where α_j^{sk} represents the fraction of *k*'s relevant labor force which comes from source *s* (note that the largest source in each case is likely to be the "own location", represented by α_j^{kk}). Thus, the government perceives an external gain of T_j^k, thus reducing the social cost below the private cost GW_j^k. But this external gain is somewhat (maybe even fully) offset by the taxes T_j^s that are being forgone in the various sources. For the case of Mexico, Equation (1) should be modified to refer to a more inclusive concept of distortions (D_j) rather than just taxes (T_j). The reason is that the contributions that workers and employers make for the workers medical care and life insurance function more as a tax rather than as a component of the worker's income[5]. Thus, we have:

[4] Readers should always keep in mind that in all cost-benefit analysis we are not telling a historical story. Instead, we are comparing two "moving pictures", one representing how the economy would evolve in the presence of our project and the other representing a similar evolution in our project's absence. Market equilibrium is assumed to prevail both in the presence and the absence of our project. The resources used in our project are assumed to come at the expense of other alternative uses (in the alternative scenario).

[5] The difference between D_j and T_j in this particular case stems from the way medical care is provided through Mexico's Social Security System. Contributions to medical care vary with hours

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$$SOCL_j^k = GW_j^k - \left(D_j^k - \sum_s \alpha_j^{sk} D_j^s\right) \quad (2)$$

where D_j^k is the distortion for occupation j at the project's location and D_j^s is the corresponding one in each labor source s (including the project's location k). Given that we are comparing the new project with the alternative use of the resources it employs, Equation (2) basically tells us to take as a benefit the taxes and other contributions associated with the labor factor which are to be paid by workers and employers in the project, and as a cost those taxes and contributions that would have been paid by them in their alternative employment if the new project in question did not exist.

2.2 Methodology – Dual Labor Markets

When estimating the SOCL for a project, care must be taken to ensure that all relevant market distortions and externalities are properly accounted for. The externalities associated with the phenomenon of dual labor markets can be important under this framework, especially when measuring SOCL in developing countries where dual markets often prevail. In Mexico, for example, we observe the coexistence of two types of labor markets. They are sometimes called formal and informal, sometimes modern and traditional, and often in the technical literature, protected and unprotected (Harberger, 1971b). The net wage a worker receives in the formal sector is usually higher than the corresponding wage in the informal sector. Sometimes the wage differential is reflected purely in workers' cash receipts in the two sectors, but often part or even all of the differential is accounted for by fringe benefits offered in the formal sector. This is the case in Mexico, where formal work carries with it other monetary and non-monetary benefits that must be taken into account as part of wage income (retirement fund, housing, Christmas bonus, vacations, etc., which of course are included in our measurement of both the gross and the net wages). Also, informal sector workers in Mexico typically pay no taxes on their wages and do not enjoy social security and other non-wage benefits. Hence, in the informal sector, gross, net and market wage rates are all the same. We maintain this assumption in the present example and throughout this paper.

Therefore, if for a given occupation a difference in net wages between the two labor markets exists (that is, if $NWF_j^k > WI_j^k$ where NWF_j^k is the net wage

of work and rate of pay, but the benefits offered are the same for all members of the system. We therefore treat medical contributions as if they were a tax. D_j thus includes all genuine taxes T_j and also the quasi-tax covering medical care. In addition, we consider all workers with social security to be receiving an expected monthly medical benefit equal to the per worker average of national medical contributions by both employers and employees.

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received by a worker in location *k* and occupation *j* in the formal sector and WI_j^k is the wage received by a worker in the informal sector) when a worker moves from a job in the informal sector to a job in the formal one, there is a positive externality (welfare gain) associated with this change. This can be considered as an external benefit of the project. It is a gain going to the worker because the market net wage is above his or her supply price of labor (wage in the informal sector), and is equal to the wage differential plus the benefits of healthcare[6] services to which a worker gains access by moving from the informal to the formal labor market and which we call $\overline{HC}$. That is:

$$E_j^k = (NWF_j^k - WI_j^k) + \overline{HC} \tag{3}$$

Now, a new project in the formal sector can draw some of its labor from the informal and some from the formal sector in each of the different locations from which the project is likely to be sourcing labor. We must therefore take account of externalities such as E_j^k in our estimation of the SOCL[7].

Consider the following example. Assume a new project to be located in metropolitan area *A* in Mexico, which can attract workers from a nearby metropolitan area *B*. Assume also that there are formal and informal labor markets in each area, and finally assume that workers that might be attracted by the project are either employed in the formal sector or employed in the same occupation in the informal sector, implying no change in the level of employment due to the project. Let us then assume the following wage schemes for the two metropolitan areas: GWF_j^A= 8,000; NWF_j^A = 7,200; WI_j^A= 5,000; GWF_j^B =6,500; NWF_j^B= 6,000 and WI_j^B= 4,000; where GWF_j^A and GWF_j^B are the gross monthly wages paid by formal sector employers (demand prices for labor expressed in Mexican pesos) in metropolitan areas *A* and *B*, respectively, NWF_j^A and NWF_j^B are the net monthly wages received by formal sector workers in metropolitan areas *A* and *B*, respectively, and WI_j^A and WI_j^B are the monthly wages received by workers in the informal sector in the corresponding metropolitan area. Finally, assume that the average monthly healthcare benefit per worker in the formal labor market is $\overline{HC}$ =

[6] Given that social security benefits associated with healthcare services (hospitalization, medical assistance and consultation, laboratories, pharmacy, etc.) must be the same for all workers affiliated with the Mexican Institute of Social Security regardless of their work location, gender, wage level and occupation, the amount $\overline{HC}$ represents the nationwide average of social security-healthcare (non-wage) benefit for a worker in the formal sector.

[7] We can find no reason to treat the difference between formal and informal wages as an equalizing difference for a given occupation, gender and location. One might imagine the difference to be equalizing if the informal workers were self-employed. But our data specifically exclude the self-employed and refer only to hired workers.

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1,000. Given that distortions in each location are defined as the difference between gross and net wages, and externalities are as shown in Equation (2), the size of distortions and externalities for each metropolitan area in our example are the following: D_j^A = 800; E_j^A = 2,200 + 1000 = 3,200; D_j^B = 500 and E_j^B = 2,000 + 1000 = 3,000.

To make things simple, for workers with occupation *j* hired in location *A* (destination) from the formal sector in location *B* (source), the social opportunity cost of labor would be:

$$SOCL_j^{ABF} = GWF_j^A - \left(D_j^A - D_j^B\right) = 8{,}000 - (800 - 500) = 7{,}700 \quad (4)$$

For workers hired in *A* from the informal sector in location *B*:

$$SOCL_j^{ABI} = GWF_j^A - \left(D_j^A + E_j^B\right) = 8{,}000 - (800 + 3{,}000) = 4{,}200 \quad (5)$$

Recall that in informal labor markets gross and net wages are the same and that the benefit associated with hiring a worker previously employed in the informal sector is the externality at the source (not at destination), as informal workers at the source have a supply price equal to WI_j^B and the difference between destination and source labor demand prices is treated as a compensating differential (see section 1 above).

Now, if we know that location *B* has a proportion ϕ_j^B of workers employed in the formal sector for occupation *j*, the SOCL in location *A* may be estimated by the linear combination of the SOCL if sourcing from the formal sector ($SOCL_j^{AF}$) and from the informal sector ($SOCL_j^{AI}$), which implies:

$$\begin{aligned} SOCL_j^{AB} &= \phi_j^B SOCL_j^{ABF} + (1 - \phi_j^B) SOCL_j^{ABI} \\ &= \phi_j^B \left[GWF_j^A - \left(D_j^A - D_j^B\right)\right] + (1 - \phi_j^B)\left[GWF_j^A - \left(D_j^A + E_j^B\right)\right] \end{aligned} \quad (6)$$

and it may be re-expressed as:

$$SOCL_j^{AB} = GWF_j^A - \left(D_j^A - \phi_j^B D_j^B\right) - (1 - \phi_j^B) E_j^B \quad (7)$$

Equation (7) tells us that the SOCL is the gross wage at destination minus the taxes (distortion) to be paid and linked to that wage, plus the taxes that would have been paid by the workers at the source if they were drawn from the formal sector multiplied by the proportion of workers in that sector, minus the externality generated by the dual labor market multiplied by the proportion of workers drawn from the informal sector at the source.

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Following our example, if 70% of truckers in Oaxaca work in the formal market (ϕ_j^B= 0.7) then the estimated SOCL for our new project located in Puebla (*A*) and hiring workers only from Oaxaca (*B*) would be:

$SOCL_j^{AB}$= 8,000 – [800 – 0.7(500)] – (0.3)(3,000) = 6,650

We have said that, in general, workers for a new project are drawn from many different sources, including the place where the project will be located. Hence, the general expression for the SOCL in the presence of dual labor markets, for occupational category *j* and located in region *k*, and many labor source locations becomes:

$$SOCL_j^k = GWF_j^k - \left(D_j^k - \sum_s \alpha_j^{sk} \phi_j^s D_j^s\right) - \sum_s \alpha_j^{sk}\left(1 - \phi_j^s\right)E_j^s \quad (8)$$

where ϕ_j^s is the proportion of workers with occupation *j* in the formal sector at location *s*. The convenience of Equation (8) relies on the fact that we can clearly identify what benefits (costs) are going to the government (taxes) and what benefits (costs) are going to workers (externalities) as result of changing jobs from the informal sector to the formal sector. In other words, Equation (8) gives us a stakeholder approach providing a means of allocating gains and losses among different groups in the economy. Equation (8) also shows that costs associated with taxes not paid in source locations occur (in Mexico) only if we draw workers from formal labor markets in those locations. Thus, when we multiply D_j^s by ϕ_j^s we are accounting for the likelihood that workers in location *s* might be attracted from the formal sector in that location. By the same reasoning, benefits associated with dual labor market externalities in each location only occur if we draw workers from the informal sectors in those locations. Therefore, when multiplying E_j^s by $\left(1 - \phi_j^s\right)$ we account for the likelihood that a worker might be drawn from the informal sector in each source location. Note also that the larger is the informal labor market at the source, and the lower is the informal sector wage there (relative to the formal sector), the lower will be the SOCL. Equation (8) also shows that if $\phi_j^s = 1$ for all *s* (implying no duality in the labor market) then we end up with the same expression given by Equation (2), the standard case of SOCL measurement.

2.3 Methodology – From "Market Wages" to "Gross Wages" and "Net Wages"

It is utterly essential for researchers to approach wage data with a great deal of caution. More than most, this is an area where things are very likely not what they

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seem or purport to be. Market wages are a very obvious case in point. In the US and most other advanced countries, market wages are quoted gross of personal income tax and of the worker's portion of the payroll tax. And they are obviously net of the employer's contributions to worker medical plans, retirement plans, the incidence of vacation pay and other fringe benefits (per hour actually worked). US market wages should accordingly be grossed up to cover all fringe benefits and all wage-oriented taxes that the employer pays, in order to reach the gross wage. To get at the net wage, the market wage must be grossed up to cover fringe benefits perceived by the worker (medical plans, vacation pay, etc.) and diminished by the payroll and income taxes paid by the worker.

Mexico's legislation and practices differ from those of the US, but this only means that different adjustments have to be made to go from "market wages" to "gross wages" or to "net wages". In Mexico's case the full personal income tax paid by the typical worker is withheld by the employer, so in this respect the market wage reported by the worker is already a net wage[8]. This is also the case for the worker's contribution to the public healthcare (HC) system. However, the retirement scheme in Mexico is one of individual accounts (similar to TIAA-CREF for US academics). Contributions to these plans are withheld by the employer but must be considered as part of the worker's net wage. In Mexico's formal sector, there is also a special housing fund in the worker's name, plus fringe benefits, consisting mainly of vacation pay plus a Christmas bonus that typically amounts to 15 days of wages.

As will be shown later in our study, for Mexico's case the magnitudes of the differences between gross wages and reported wages, as well as the difference between net wages and reported wages, are very important. Hence, carrying out a project appraisal based on the reported or stated wage as the price of labor would be a big methodological mistake, leading to a significant underestimation of the project's costs.

3. ESTIMATION OF THE SOCL FOR MEXICO

The data source for our estimates of social prices of labor in Mexico is the National Survey of Occupation and Employment (ENOE[9]), published quarterly by the National Institute of Statistics and Geography (INEGI[10]). Information at the

[8] Workers with very high incomes may have to file separate declarations and may end up paying modest amounts of additional tax. Also, workers with very high eligibility for special deductions may end up claiming a tax refund. But neither of these conditions has a significant effect upon the median wage, which was used as the basis for our calculations, and applies to what we refer to as the typical worker.

[9] Encuesta Nacional de Ocupación y Empleo.

[10] Instituto Nacional de Estadística y Geografía.

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micro level on subordinate and remunerated workers[11] for the second quarter of 2010 was used. These data were sorted into 32 groupings, one for each of Mexico's 32 states. Most states are represented by a single Metropolitan Area (MA). MAs were grouped together in states with more than one MA. Finally, states without an official MA were represented by urban data from their leading city. By contrast, for those states having more than one designated MA but each one with a small sample size, the calculation was done by pooling the data (see Table A2 in the Appendix).

3.1 Use of the Median Wage

To compute the SOCL we start with the median wage income that workers earn as a result of their activity in a particular job location and occupation. Why do we use the sample median wage and not the sample mean wage? As summary statistics the sample median and sample mean are both measures of central tendency and both have advantages and disadvantages. The sample mean is easy to calculate but is also very sensitive and easily influenced by outliers (extreme sample values). Such outliers are likely to stem from causes that are quite unrelated to the expectations of a typical worker in a given MA. For example, the son of the owner of a business might get a salary that is out of line with the wage for the occupation in which he is classified. Or workers might be misclassified into a higher-paying or lower-paying occupation or some may greatly exaggerate their actual earnings. Using medians minimizes the influence of anomalies of these types. This is the reason why the sample median has a well-known reputation as a *robust statistic*, and is well suited for skewed distributions (like that of wages in an occupation). This was evidenced in the data used in this paper, which showed positively skewed wage distributions.

3.2 Classification of Occupations

Classifying workers into occupational categories is a key task because labor is an extremely heterogeneous factor of production. In general, the ENOE classifies labor into ten categories; however, because our interest focuses on SOCL for urban areas, we omitted agricultural workers, leaving us with nine occupational categories. The survey also provides codes to disaggregate labor information and identify occupational subgroups within each occupational category. Using these

[11] The ENOE uses the term *Subordinate and Remunerated Worker* to refer to those receiving wages or salaries. It specifically excludes the self-employed.

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data we were able to define and work with 21 occupations[12] grouped into nine occupational groups (see Table A3 in the Appendix).

Now, when calculating the SOCL under a dual labor market framework, we work with three basic elements (for each gender): the median wage by occupation and location as reported in the survey (w_j^k), the median of distortions by occupation and location (D_j^k) which are defined as the difference between gross and net wages in the corresponding labor market, and the median of externalities by occupation and location (E_j^k), defined in Equation (3). The first element is needed to estimate gross (GWF_j^k) and net (NWF_j^k) formal sector wages. The next step is to calculate distortions and externalities. To do so, we must consider the different circumstances under which workers are likely to be receiving non-wage income; that is, we must consider whether they have access to healthcare services or not, and whether they receive other benefits associated with salaried work or not. Access to benefits associated with salaried work defines the size of distortions for a particular occupation j and labor market location k. For the Mexican case, the data reveal important differences (among occupations and locations) in the proportions of workers having access to health services and other salaried work benefits[13]. This fact was taken into account when estimating the median gross wage for each such category (see Equation 9 below).

On the other hand, the importance of distortions and externalities associated with sourcing labor from different locations is also related to the proportion of workers in the informal labor market (as shown by Equation 8). The ENOE survey allows us to identify (by occupation, location and gender) workers

[12] Identifying the relevant level of disaggregation on occupations is not an easy task. It would be desirable to have information on median wages for typists, bookkeepers, lawyers or pediatricians in the Monterrey metropolitan area, for example. But taking data to such a disaggregation level for the information provided in ENOE data set and for each metropolitan area, leaves us with too few and sometimes even zero observations to be used for estimation purposes. Also, working with more disaggregated data on occupations will be desirable if it reduces the dispersion of the distribution of wages by occupation. This occurs for low-skilled workers when separating them out from high-skilled workers within an occupational group. Therefore, when defining a set of groups within an occupational category, we aimed at concentrating into each subgroup occupations paying similar wages. For female workers in our sample, there were a few occupations for which data were very scarce and estimation of the median wage was not performed. These categories were transportation workers and army and police workers, which are occupations rarely chosen by women in Mexico.

[13] For example, on average, for male workers in our sample of 32 MAs, 90% of college and university teachers and professors have access to health services (as a benefit associated with salaried work). This is a relatively high proportion compared to say, the 60% of male personal service workers. For female workers, these proportions are 90.4% and 35.8%, respectively. Given the importance of these proportions in estimating the size of distortions, we carried out similar calculations for each MA, occupational group and gender.

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under informality[14]. The sample data show that informality is relatively important among industrial, commerce and transportation workers. The percentage of informal workers also varies across metropolitan areas, thus contributing to regional differences in the distortions and externalities which enter into the calculation of SOCL.

3.3 Estimating the Gross Wage

Distortions are the difference between gross and net wages. If we aim at estimating distortions in labor markets (by occupation and location) we must clearly define how gross and net incomes are calculated. Gross wage income GWF_j^k represents the full labor cost as seen by the employer, so it must account for all tax withholdings that are not included in the worker's reported wage, as well as those employer disbursements that cover worker's healthcare, retirement and other benefits. As has been mentioned above, the data from the ENOE survey show that not all subordinate and remunerated workers in the formal sector report having access to health services and/or other benefits. Thus, the estimation of the median gross wage must take into account the proportion of workers receiving healthcare and other benefits.

Let us define:

a_j^k = proportion of formal workers with access to healthcare services in occupation *j* at location *k*.

b_j^k = proportion of formal workers receiving fringe benefits (retirement, housing and other fringe benefits) with occupation *j* at location *k*.

Therefore, for occupation j and metropolitan area k and taking into account all costs associated with hiring a worker in the formal market, GWF_j^k will be given by:

$$GWF_j^k = w_j^k + T_j^k + a_j^k \cdot HC_j^k + b_j^k \cdot FB_j^k + PRT_j^k \quad (9)$$

where w_j^k is the monthly wage reported by the worker in the survey (which does not include taxes, union fees or deductions associated with contributions to social

[14] Following ENOE's glossary, the informal sector is defined as all economic activities carried out with home resources, but without being constituted as a business, independent from the home's assets. The criterion to determine whether a production unit is independent from the home's assets is the absence of conventional accounting practices. That is, there is no possibility to identify and separate out the home endowment from the business endowment, and there is no distinction between the home and the business cash flows and expenditures. We may add to this definition the fact that informal economic activities do not pay taxes, nor provide benefits to their workers as established by law.

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security[15] nor other fringe benefits), T_j^k is the amount of tax withheld on the median taxable wage for occupation j, location k; HC_j^k are the payments associated with healthcare; FB_j^k is the amount of other fringe benefits associated with salaried work and PRT_j^k is the state payroll tax paid by the employer. A more detailed explanation for each of these elements (constituting the difference between GWF_j^k and w_j^k for the Mexican case) is given in the Appendix. On the other hand, given that workers in the informal labor market do not pay taxes nor receive any benefits associated with salaried work, the median of the gross and net wages in the informal labor market are the same, and are estimated by the wage reported in the survey w_j^k.

3.4 Estimating the Net Wage, Distortions and Externalities

The Net Wage is taken in this paper to represent the supply price of labor at the margin. It aims at measuring the market wage rate a project needs to pay to obtain sufficient supplies of labor with the appropriate skills. This wage reflects workers' preferences regarding location, working conditions or any other factors that affect the desirability of working for a project[16].

In the formal labor market, the net wage (NWF_j^k) must be defined as the monthly income effectively received by the worker plus the value of those benefits (vacations, Christmas bonus, retirement fund, contributions for housing, etc.) that are not included in the monthly payment and that represent a direct individual benefit. The employer disbursements for healthcare are not considered as an individual benefit for the worker. Rather they are considered as contributions to collective services whose quantity and quality are not proportional to the amounts disbursed per worker under that concept. In this sense, the worker does not fully internalize benefits of the contributions for healthcare services. They therefore cannot be considered (in full amount) as part of the wage income received by the worker. However, the worker internalizes part of the benefits associated with those contributions to healthcare services because he/she and his/her family can enjoy public medical services. But these benefits ($\overline{HC}$) are the same regardless of location, occupation, gender or income level. Thus, when a worker leaves an alternative job in the formal sector to work for a new project also in the formal market, the healthcare benefits that he/she can internalize are the same. In this sense, we cannot add $\overline{HC}$ to the supply price of labor. If a worker is attracted from the formal labor market, $\overline{HC}$ would be a benefit that cancels out when doing the calculation of $\left(D_j^k - \sum_s \alpha_j^{sk} \phi_j^s D_j^s\right)$ in the

[15] See INEGI. Glosario de la Encuesta Nacional de Ocupación y Empleo
[16] Jenkins et al. (2011), chapter 12, pp. 3–4.

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SOCL equation (he or she receives the same $\overline{HC}$ benefit in the old and new jobs). However, if a worker is attracted from the informal labor market, $\overline{HC}$ is an additional gain to the worker that needs to be accounted for when calculating SOCL, and we explicitly do so in the definition of the dual labor market externality (Equation 3). Therefore, the net wage in the formal labor market for occupation *j*, location *k* can be defined as:

$$NWF_j^k = w_j^k + b_j^k . FB_j^k \tag{10}$$

Having all elements estimated, the distortion for occupation *j* and location *k*, D_j^k can be calculated by taking the difference between the corresponding gross and net wages. The externality E_j^k is calculated as specified in Equation (3), where the informal sector wage for occupation *j* and location *k* is the median of the reported wage w_j^k and $\overline{HC}$ is the estimated overall (for all MAs, all occupations and both male and female workers) average of payments for healthcare, and whose estimated monthly value was 1,032 Mexican pesos of 2010. Hence:

$$D_j^k = GWF_j^k - NWF_j^k \tag{11}$$

$$E_j^k = (NWF_j^k - w_j^k) + \overline{HC} \tag{12}$$

The final step in estimating the SOCL in the presence of dual labor markets as specified in Equation (8) is to estimate the proportion of labor in occupation *j* that might be attracted from each sourcing location *s*, which we have called α_j^{sk}. As previously mentioned, these proportions were estimated with the same ENOE survey using data for economically active population by state and by occupational group (nine occupational groups). The number of α values estimated for each destination *k* (32 MAs) is related to its migration patterns. For example, in Mexico we have states with very low immigration rates, such as Chiapas where 91.8% of the economically active population was born in the same state. Oaxaca occupies the second place among the less attractive working places with 90.6% of the economically active population born there. By contrast, the state with the highest immigration rate is Quintana Roo (Cancun MA), where only 25.13% of the economically active population is native-born and almost 30% is attracted from the neighboring state, Yucatan. We can also mention the case of Baja California, where only 43.8% of the economically active population was native-born, with the rest coming from several regions of the country. Patterns of migration, however, vary substantially across states. For example, we identified 16 different sourcing locations for Baja California, whereas for Colima we only

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identified five (in both cases including the destination state itself). A summary of the migratory patterns by state[17] is shown in Table A4 in the Appendix.

Regarding the migration evidence presented, one might easily conclude that, because in some locations there is almost no immigration, then SOCL would be the same as the market wage (gross wage). However, this reasoning is far from correct once the phenomenon of a dual labor market is taken into account. We have mentioned that the informal sector is important for some occupations and that its size also varies substantially across locations. This is an issue that must be taken into account when estimating SOCL because hiring workers from the informal sector generates a positive externality consisting of the benefits that workers perceive when moving from informal jobs to formal jobs.

4. ANALYZING ESTIMATION RESULTS

The estimation of the SOCL for each of the 32 MAs, the 21 occupations for male workers, and the 19 occupations for female workers was carried out using the methodology explained in the previous pages. We estimated 619 and 530 social prices of labor for the male and female labor markets in Mexico[18].

The resulting estimates of gross and net wages revealed that the gaps between gross and reported wages and between net and reported wages are too large to be neglected. To give the reader an idea of the magnitude of these gaps, we calculated ratios of the estimated (median) gross wages to reported wages and the corresponding estimated net wages to reported wages for all occupations and in both male and female labor markets. The summary statistics of these ratios are presented in Table 1 and the corresponding histograms are shown in Figure 1. As can be seen, the gross to reported wage ratio (GWF_j^k/w_j^k) ranges from 1.13 to 1.65 for male workers and from 1.06 to 1.58 for female workers, whereas the net to reported wage ratio (NWF_j^k/w_j^k) ranges from 1.1 to 1.24 and 1.07 to 1.23 for males and females, respectively.

[17] Complete tables showing the migratory patterns by state (all α values) estimated for this paper can be found at http://www.econ.ucla.edu/harberger/

[18] We have already noted that for a few metropolitan areas there were some empty cells due to too few data points.

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Table 1 Gross Wage to Reported Wage and Net Wage to Reported Wage Ratios[19]

Ratio	Male Labor Market					Female Labor Market				
	Q1	Median	Q3	Mean	Std Dev	Q1	Median	Q3	Mean	Std Dev
Gross to Reported	1.30	1.37	1.46	1.37	0.10	1.28	1.37	1.44	1.35	0.12
Net to Reported	1.15	1.17	1.19	1.17	0.03	1.15	1.18	1.20	1.17	0.04

Source: Estimation results.
Q1 = First quartile; Q3= Third quartile.

As mentioned in the previous section, in Mexico a high fraction of workers report that they do not have access to healthcare and fringe benefits, even when they are working in the formal labor market. This fact was taken into account in Equations (9) and (10) to estimate the gross and net wages, respectively (HC_j^k was multiplied by a_j^k, the proportion of workers with access to healthcare and FB_j^k was multiplied by b_j^k, the proportion of workers with access to fringe benefits). As a consequence, when the fraction of workers not having access to healthcare and fringe benefits is high, the estimated median gross and net wages move closer to the median wage reported by the worker and the ratios (GWF_j^k/w_j^k) and (NWF_j^k/w_j^k) move closer to 1. This is particularly true in the female labor market, where not only are wages lower, but where the proportion of workers without healthcare and fringe benefits is lower than for the male labor market. In addition, these proportions vary across metropolitan areas and occupational groups (see footnote 15). This is the reason why, for the particular case of personal service workers, the wage ratios would be closer to 1, whereas for education workers the wage ratios are very high (reaching up to 1.65).

[19] Our estimates of the gap between net and gross wages include income tax withheld, healthcare contributions, housing fund (INFONAVIT) and the payroll tax. To check on the plausibility of our estimates, we cite here an example presented on the website of ContaMex.com, a Mexican accounting firm that provides information and tools for accountants in Mexico. They report the following breakdown of the gap between net and gross wages (here expressed as percentages of the net wage): income tax 17.2%, healthcare 15.6% (excluding retirement fund), housing 6.4%; and state payroll tax 2%. They sum to 41.2%. These fractions vary for both the income tax (varying income level) and the healthcare contribution (varying with income level) and workmen's compensation (varying by employment risk). Our estimates are on average lower than those of ContaMex, mainly because we take into account that healthcare contributions are made by employers and employees only for a fraction a_j^k of the sampled workers. Because of the heavy cost (15.6% in the example) of HC, employers have a strong incentive to avoid it. We surmise that the market leads such employers to pay higher cash wages, thus attracting those workers who subjectively place the lowest value on the benefits from the government's healthcare services.

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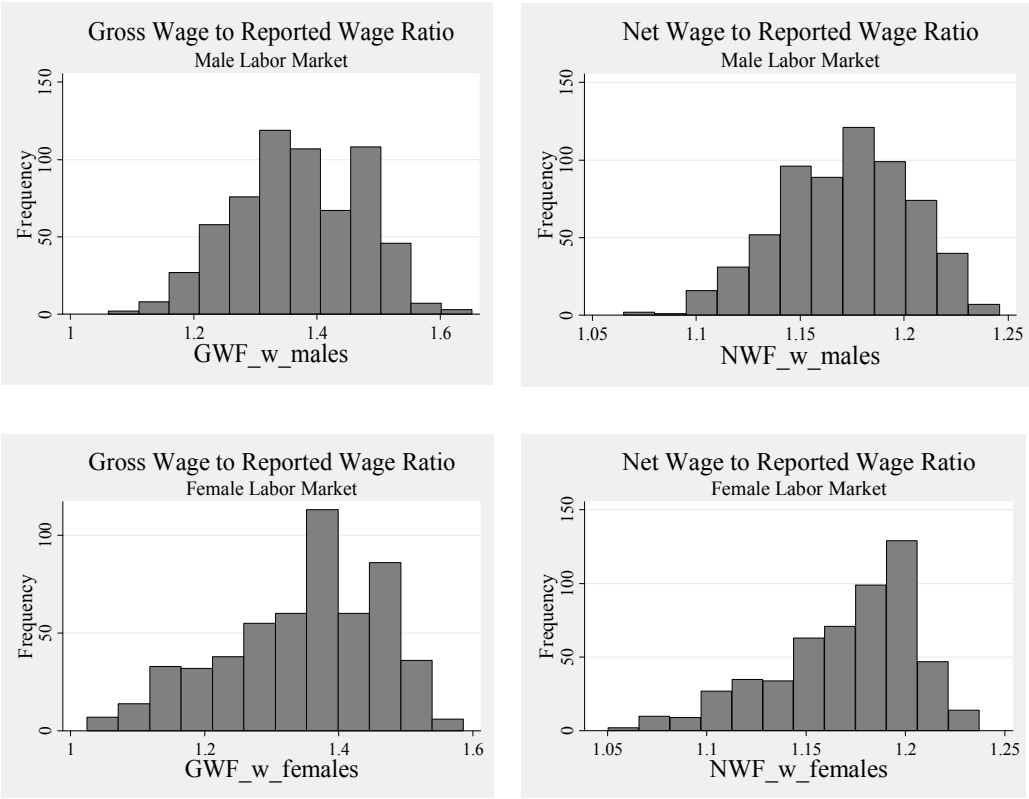
Figure 1



Source: Estimation Results.

These ratios are too important to be ignored. Therefore, for professionals engaged in project appraisal, it is really essential to ensure that the labor prices used capture all major components. Reported wages only rarely are good estimates for either the gross or the net wages.

The estimates of social prices are expressed in pesos of 2010. It would not be worthwhile to go through all this highly time-consuming work if the results could not be applied for other time periods. Hence, to facilitate the use of our results in any current and future project evaluation process in Mexico, we can express them in the form of adjustment rates. That is, we can take the difference between distortions at destination (social benefit) and the weighted average of distortions from all labor sources (social cost), add to this the weighted average of externalities for each location and occupation, and finally express the result as proportion of the corresponding median gross wage (financial cost to the employer). This gives us the rate needed to adjust gross wages to obtain the corresponding social opportunity cost of labor. Algebraically we have:

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$$AR_j^k = \frac{\left(D_j^k - \sum_s \alpha_j^{sk} \phi_j^s D_j^s\right) + \sum_s \alpha_j^{sk}\left(1-\phi_j^s\right) E_j^s}{GWF_j^k} \quad (13)$$

Hence

$$SOCL_j^k = GWF_j^k\ (1 - AR_j^k) \quad (14)$$

where AR_j^k is the rate of adjustment to the gross wage (recall that ϕ_j^s is the proportion of workers in the formal sector for occupation *j* and labor source *s*). Note also that the numerator in Equation (13) is the net social benefit of hiring a worker in the formal market for occupation *j* and location *k*. Also note that if $AR_j^k > 0$, the $SOCL_j^k$ must be lower than the corresponding gross wage GWF_j^k, implying a social benefit, whereas if $AR_j^k < 0$, the $SOCL_j^k$ must be higher than the gross wage, implying a social cost.

Our results show that the majority of adjustment rates are below 5% in absolute value. Those above |5%| are concentrated on industrial workers, commerce workers and transportation workers, and some on personal service workers. The results also show that adjustment rates for the female labor market in general are lower than the corresponding rates for the male labor market. The highest adjustment rate for males was 27.22% for the Acapulco-Chilpancingo MA (in Guerrero state) for transportation workers, where 62.65% of these workers are reported as part of the informal labor market, whereas the highest adjustment rate for females was 14.97% reported in Villahermosa MA (in Tabasco state) for artisans and transformation industry workers[20].

What calls one's attention most in our results is the fact that high adjustment rates are related to high proportions of workers in the informal sector. In other words, the SOCL adjustment rate is closely and positively related to the weighted average rate of informality from all labor sources for the project's location *k*. The weighted average rate of informality is defined as $\sum_s \alpha_j^{sk}\left(1 - \phi_j^s\right)$ and it also determines the size of the weighted average of externalities $\sum_s \alpha_j^{sk}\left(1 - \phi_j^s\right) E_j^s$ for each destination *k*. To make more evident the relationship between the adjustment rate and the weighted average rate of informality, we present scatter plots for male and female labor markets (Figures 2 and 3). The plots clearly show a linear relationship between the two variables, with a little more dispersion when rates of informality are zero or close to zero. Dispersion around the zero rate of informality reflects differences between distortions at

[20] For interested readers, the complete tables of estimated adjustment rates for male and female labor markets per MA and occupation can be also accessed at http://www.econ.ucla.edu/harberger/

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destination and at source. This basically occurs in a very few cases over the whole sample for men (only seven observations show adjustment rates above |5%| when the weighted average of informality is zero) and for women (only one observation). The histogram of adjustment rates previously calculated for those observations where the rate of informality is zero is presented in Figures 4 and 5. Note that these observations are closely clustered around zero with a very low frequency for adjustment rates above 5% (in absolute value) in both male and female labor markets. The estimated adjustment rates for occupations with zero informality are similar to González's results using 1993 data. The big difference in adjustment rates thus stems from the existence of the informal sector in labor markets.

The fact that our estimation results show a linear relationship between the adjustment and informality rates suggests the possibility of devising a shortcut method of estimating the adjustment rate to be applied to the market wage to compute the SOCL. This shortcut is relevant for the bulk of cases examined, i.e., for situations in which regional differences in wages and distortions seem to be not important but where duality of labor markets exists. For the Mexican case analyzed here, the presence and importance of informal labor markets makes the SOCL adjustment rate a key element to be considered when evaluation of public investment projects is carried out.

The suggested method of estimation entails defining the SOCL adjustment rate as a linear function of the weighted average rate of informality and allowing for a gender difference in the slope (to test if there is any difference between male and female labor markets with regard to the change of the adjustment rate as a response to a unit change in the informality rate). In other words, we estimated a linear regression function specified as follows:

$$AR_j^k = \beta_1 + \beta_2 IR_j^k + \gamma(G_j^k \cdot IR_j^k) + e_j^k \qquad (15)$$

where AR_j^k is the SOCL adjustment rate for occupation j and location k, IR_j^k is the weighted average rate of informality observed for occupation j and considering all sourcing locations for the project's destination place k, and $G_j^k = 0$ for the female labor market and $G_j^k = 1$ for the male labor market.

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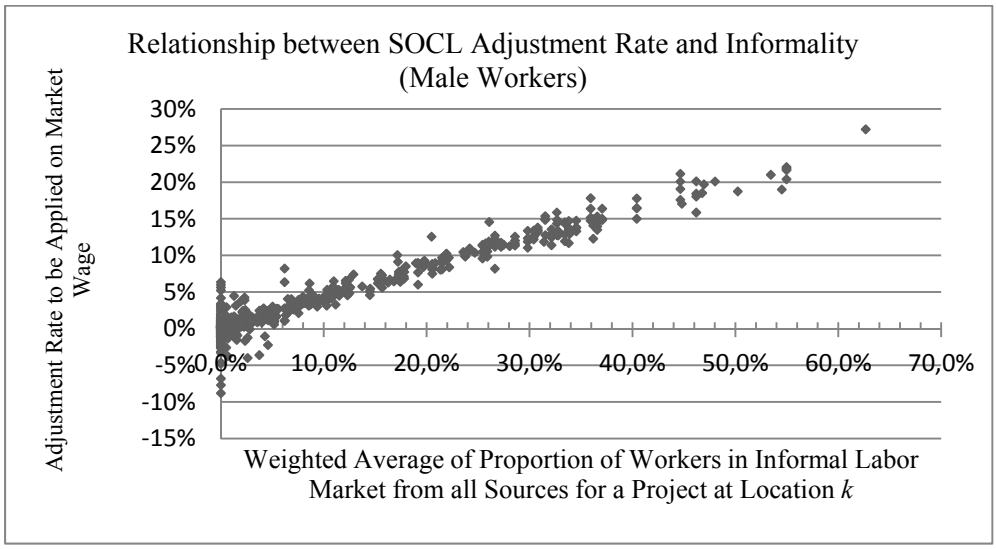
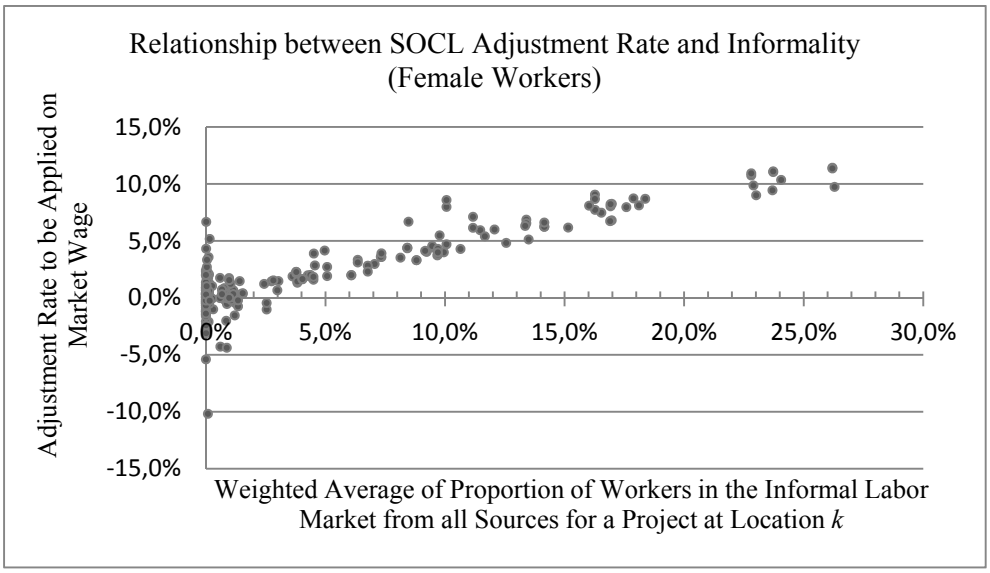
Figure 2



Source: Estimation Results.

Figure 3



Source: Estimation Results.

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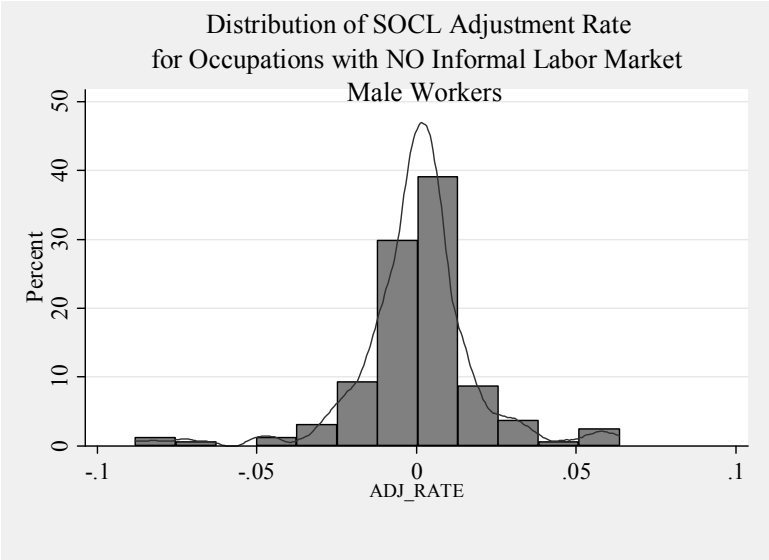
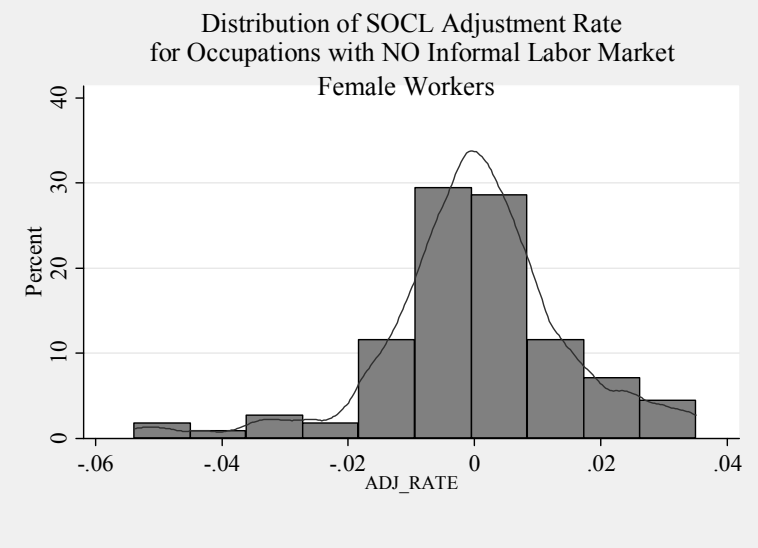
Figure 4



Source: Estimation Results.

Figure 5



Source: Estimation Results.

Using the data obtained from our results, we estimated the regression function (Equation 15) applying feasible Generalized Least Squares (GLS) to account for the heteroskedastic behavior of the error term. In this case, a heteroskedastic partition was found. Observations associated with zero rate of informality showed

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greater dispersion compared to those with a positive rate of informality. In other words, it was observed that:

$$((\hat{e}_j^k)^2 \mid IR_j^k = 0) > \ ((\hat{e}_j^k)^2 \mid IR_j^k > 0) \tag{16}$$

where $(\hat{e}_j^k)^2$ is the estimated residual of the regression function (Equation 15). To test the null hypothesis of homoskedasticity, Breusch-Pagan (Lagrange Multiplier) and Goldfeld-Quandt[21] tests were carried out. Both provided evidence to reject the null hypothesis, as the corresponding sample values of the test statistics were 18.41 and 1.868 with *p*-values of zero in both cases[22]. With these results, we proceeded to estimate feasible GLS assuming a variance function[23] where

$$\sigma_{jk}^2 = \begin{cases} \sigma_1^2 & \text{if } IR_j^k = 0 \\ \sigma_2^2 & \text{if } IR_j^k > 0 \end{cases} \tag{17}$$

With 1149 observations, the estimation results are the following:

Table 2 GLS Estimates

Variable	Coefficient	Std. Error	*t*	*p*> |*t*|
IR	0.4586485	0.0077113	59.48	0.0000
G_IR	–0.0475764	0.0078006	–6.10	0.0000
_constant	0.0007726	0.0005127	1.51	0.1320

Source: Estimation Results.

As we may observe, both the informality rate coefficient (β_2) and the one associated with the gender- informality rate interaction term (γ), are statistically

[21] For the Goldfeld-Quandt test, we partitioned the regression into two subsamples, the first one for those observations with $IR_j^k = 0$, from where we get $\hat{\sigma}_1^2$ and the second for observations with $IR_j^k > 0$, from where we estimate $\hat{\sigma}_2^2$. The null hypothesis is $H_0: \sigma_1^2 = \sigma_2^2$.

[22] We should mention here that the Breusch-Pagan statistic has a χ^2_{p-1} distribution where *p* is the number of parameters in the corresponding auxiliary regression (two in this case). By contrast, the Goldfeld-Quandt statistic $\widehat{GQ} = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_2^2}$ is distributed as $F_{(\upsilon_1,\upsilon_2)}$, where υ_1 and υ_2 are the degrees of freedom for the numerator and denominator, respectively (272 and 873 in this case).

[23] A Goldfeld-Quandt test was also performed to see if the heteroskedasticity problem was linked to gender. The results showed no evidence to reject the null hypothesis of constant variance in this case.

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different from zero[24]; however, the intercept is not. Therefore, predicted values for the SOCL adjustment rates, given the weighted average rate of informality for occupation *j* and destination *k* may be reasonably obtained by using the following expressions:

Male labor market $$\widehat{AR}_j^k = 0.41107\, IR_j^k \quad (18)$$

Female labor market $$\widehat{AR}_j^k = 0.4586485\, IR_j^k \quad (19)$$

Hence, for the Mexican market, we may estimate the SOCL adjustment rate for occupation *j* and destination *k*, by calculating the weighted average of informality rates for that occupation *j*, given all source locations and using Equation (18) if hiring male workers and Equation (19) if hiring female workers. When the informality rate is zero, our results tell us that the gross wage is an adequate measure of the SOCL. In particular, this occurs for occupational categories 1 through 4, which can be considered as occupations with high and middle income levels. These results basically tell us that we only need to concentrate efforts on calculating migration and informality rates by occupation using ENOE's data which are published quarterly. The fitted regression lines for both male and female markets are shown in Figure 6.

4.1 A brief note on Hiring Workers for a Project in a Protected Sector

In addition to the duality of labor markets generated by the existence of formal and informal sectors, in many developing countries we can also observe the existence of other protected sectors such as the case of government enterprises (e.g., Pemex in Mexico), or large transnational firms (e.g., Volkswagen) and jobs with strong labor unions (e.g., in the public education system in Mexico). The way we can visualize these protected sector jobs is to think of all workers wanting to have a job there because they pay higher wages and benefits are usually also higher compared to regular formal sector wages[25]. Thus, it is not surprising to find out that all mechanical engineers in Tabasco and Veracruz, for example, want to get a job in one of the Pemex facilities. It is not even surprising that many professionals want to get a job at Volkswagen in Puebla, Mexico. How can we estimate the SOCL in these cases?

[24] "Statistically significant" does not necessarily imply "economically significant". The reader may think that the size of the estimated γ is relatively small, hence for practical purposes, when prediction of the SOCL adjustment rate is carried out, we may decide not to make any distinction between male and female labor markets with regard to the estimated regression slope.

[25] Harberger (2008), Edwards (1989).

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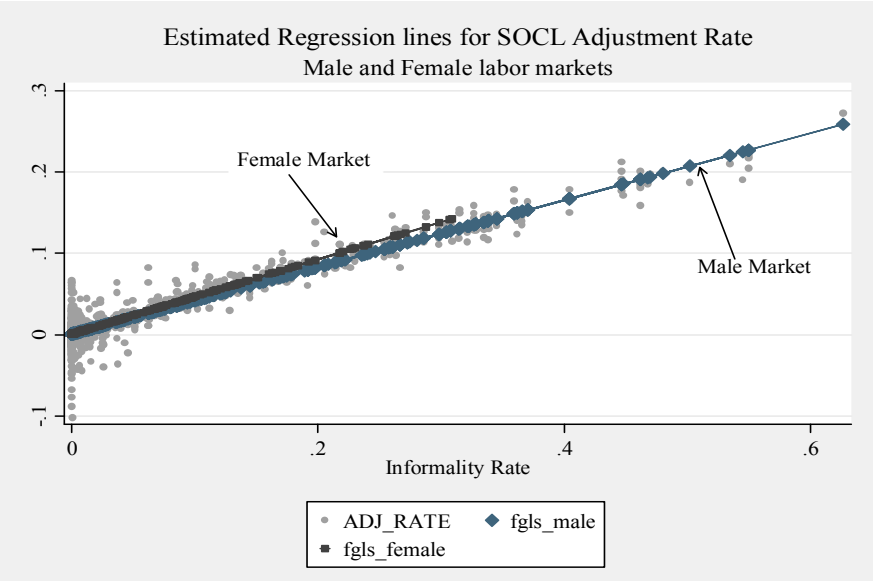
Figure 6



ADJ_RATE refers to the SOCL adjustment rates estimated following Equation (13); fgls_male and fgls_female are the predicted SOCL adjustment rates for male and female labor markets respectively, using the estimated regression function specified in Equation (15).

Let us start with a simple example, again by assuming that we want to hire engineers for a project in the regular formal sector (which we may call the free sector) in metropolitan area *A* and assume also that the source of workers are the formal and informal labor markets in location *B*. If the median of the monthly gross wage for this occupation in location *A* is, say GWF^A =10,000 pesos and the corresponding distortions are D^A = 1,500, and if source distortions and externalities are D^B = 1,000 and E^B = 2,500, respectively, and also considering that the proportion of workers in the formal market is ϕ^B= 0.8, then the SOCL for engineers in location *A* will be:

$$SOCL^A = 10{,}000 - [1{,}500 - 0.8(1000)] - (0.2)(2{,}500) = 8{,}800 \qquad (20)$$

This implies that an adjustment rate of 12% should be applied on the median of the gross wage to obtain our estimate of the SOCL. Next, we assume that the project of interest is situated in a protected sector (e.g., Pemex) in the same location *A*. The gross wage in this protected sector is GWF^{AP}= 16,000 and associated taxes (distortions) are D^{AP}= 2,400. Considering the same source of workers, then the SOCL for engineers in the protected sector will be:

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$$SOCL^{AP} = 16{,}000 - [2{,}400 - 0.8(1000)] - (0.2)(2{,}500) - [(16{,}000 - 2{,}400) - (10{,}000 - 1{,}500)] = 8{,}800 \quad (21)$$

That is, the SOCL is the same for workers going to the protected sector with higher wages. The only difference is that all workers hired in the protected sector, regardless of source, get an extra benefit of the difference between (16,000 – 2,400) and (10,000 – 1,500) which is the difference between net wages in the protected and the regular formal labor sectors ($NWF^{AP} - NWF^{A}$). Therefore, the adjustment rate to be applied on the protected gross wage will be (16,000 – 8,800)/16,000 = 45%.

Another special case for SOCL estimation arises when the project in question requires a worker with special skills to be hired. In this particular case, we may assume that the median market wage at destination for occupation *j* (e.g., artisans) is 10,000, but as workers with a special skill are needed (e.g., diamond cutters), then the market wage (say 15,000) will be above the market wage for the artisan category. In this case, a rough estimation of the adjustment needed on distortions and externalities to calculate the SOCL is 50% (the percentage by which the specialist's gross wage [15,000] exceeds the standard gross wage [10,000]).

5. CONCLUDING REMARKS

In this paper, the social opportunity cost of labor for the Mexican market was estimated using the methodology originally suggested by Harberger. This approach takes the gross wage GWF_j^k (project's financial labor cost) in the project's labor market area as the starting point and then adjusts it to account for market distortions and externalities in that market as well as in other sourcing points for project labor. The methodology required detailed calculations to account for several conditions (some of them specific to the Mexican labor market) needed to move from reported wages to gross and net wages (from which market distortions can be quantified). Our results revealed very large differences between reported, gross and net wages, which highlights the necessity of using the correct cost of labor in applied benefit-cost analysis.

The methodology especially dealt with the migration issue by estimating the fraction of relevant labor force which comes from different locations to meet the project's labor demand. These fractions were estimated for each of the 32 metropolitan areas defined and for nine occupational groups. The existence of dual labor markets was also taken into account when defining externalities as specified in sections 2 and 3 of this paper. Both migration and the size of the informal sector in each market were key elements in determining the weighted

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average of distortions and externalities and hence the SOCL adjustment rates (rates applied on the gross wage at destination to estimate the SOCL).

The estimated adjustment rates for occupations with zero informality are consistent with González's results using 1993 data. Roughly speaking, we may say that if market conditions are similar to the ones observed in this study, and if the weighted average rate of informality is zero, then it is adequate to take the gross wage as the SOCL. These cases were basically observed for occupations with high and middle wage income levels. The big difference in comparison with the former estimates, however, arises when we consider the existence of the informal sector in labor markets. In this latter case, we have found a linear relationship between the SOCL adjustment rate and the weighted average rate of informality. This allowed us to suggest a simple alternative estimation method for SOCL adjustment rates that was presented in section 4, and that greatly may simplify work for professionals dealing with public project appraisal.

These results, of course are specific to the Mexican labor market under current legal and institutional arrangements. For other countries and situations, this paper provides an example that can serve as a useful guide for calculating the social opportunity cost of labor.

APPENDIX

Table A1 Formal Net Wage to Informal Wage Ratios

Summary Statistics

	Male Labor Market				Female Labor Market		
	Industrial Workers	Commerce Workers	Transpor-tation Workers	Personal Service Workers	Industrial Workers	Commerce Workers	Personal Service Workers
Quartile 1	1.21	1.40	1.20	1.19	1.27	1.38	1.23
Median	**1.32**	**1.66**	**1.34**	**1.35**	**1.43**	**1.52**	**1.45**
Quartile 3	1.45	1.86	1.59	1.59	1.60	1.71	1.59
Mean	**1.36**	**1.70**	**1.42**	**1.41**	**1.46**	**1.57**	**1.43**
Std Deviation	0.15	0.41	0.26	0.28	0.23	0.34	0.28

Source: Own estimations.

The main sources of differences between informal and formal wage levels are taxes (not withheld in the informal sector) and medical and retirement benefits (not provided there).

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Table A2 Metropolitan Areas or Municipalities included in the Sample per State

State	Metropolitan Areas included
Aguascalientes	Aguascalientes
Baja California	Tijuana and Mexicali
Baja California SUR	La Paz[a]
Campeche	Campeche[a]
Chiapas	Tuxtla Gutierrez
Chihuahua	Chihuahua and Juárez
Coahuila	Saltilllo, Monclova-Frontera and La Laguna
Colima	Colima-Villa de Alvarez and Tecomán
Distrito Federal	Valle de México
Durango	Durango[a]
Estado de México	Toluca
Guanajuato	León
Guerrero	Acapulco and Chilpancingo Municipality
Hidalgo	Pachuca, Tulancingo and Tula
Jalisco	Guadalajara
Michoacán	Morelia
Morelos	Cuernavaca and Cuautla
Nayarit	Tepic
Nuevo Leon	Monterrey
Oaxaca	Oaxaca
Puebla	Puebla-Tlaxcala
Querétaro	Querétaro
Quintana Roo	Cancún
San Luis Potosí	San Luis Potosí-Soledad de Graciano
Sinaloa	Culiacán[a]
Sonora[b]	Hermosillo[a]
Tabasco	Villahermosa
Tamaulipas	Tampico, Reynosa-Rio Bravo, Matamoros and Nuevo Laredo
Tlaxcala	Tlaxcala-Apizaco
Veracruz	Veracruz and Xalapa
Yucatán	Mérida[a]
Zacatecas	Zacatecas-Guadalupe

Source: Own definitions based on designation of Metropolitan Areas, INEGI (2008a).

[a] Data of the main municipality (capital city) of the state is taken due to no delimitation of metropolitan areas in this state.

[b] The designated MA for Sonora (Guaymas) has almost no data sampled for urban localities in the Survey. The information needed for SOCL estimation is taken from the capital city in this case (which is considered by INEGI self-representative).

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Table A3 Definition of Occupational Groups

Group	Occupational Group	Sub-group	Occupation	Codes Included[a]
1	Professionals, Technicians and Art Workers	1-1	Professionals	110 to 119
		1-2	Technicians	120 to 129
		1-3	Art, Shows and Sport Workers	140 to149
2	Education Workers	2-1	College and University Teachers and Professors	130
		2-2	Middle and High School Teachers	131, 132
		2-3	Primary and Preschool Teachers	133, 134
		2-4	Other Education Workers	135, 136, 139
3	Officials and Executives	3-1	Government Officials, Superiors and Legislators	210
		3-2	Executives of Public and Private Enterprises and Related	211, 212, 213, 219
4	Office Workers	4-1	Department Chairs, Control Personnel and Supervisors on Administrative Activities	610 to 619
		4-2	Workers on Administrative Activities	620 to 629
5	Industrial Workers	5-1	Chairs, Control Personnel and Supervisors on Industrial and Maintenance Activities	510 to 519
		5-2	Artisans and Transformation Industry Workers	520 to 529
		5-3	Operators of Machinery and Industrial Equipment	530 to 539
		5-4	Industrial and Artisan Assistants	540 to 549
6	Commerce Workers	6-1	Merchants, Sales Representatives and Assistants	710 to 713 and 719
		6-2	Ambulant Vendors and Ambulant Service Workers and Related	720, 721, 729
7	Transportation Workers	7-1	Mobile Machinery Drivers, Ground Transportation Drivers and Related	550, 551, 554, 555, 559
		7-2	Air Transportation Drivers	553
8	Personal Service Workers	8-1	Personal Service Workers	810 to 819
		8-2	Household Services	820
9	Protection Workers and Security Guards	9-1	Security Guards and Related	830, 839
		9-2	Army and Police Workers	831

Source: Based on ENOE and the Mexican Classification of Occupations (INEGI, 2008b, 2008c).
[a] Codes used in the ENOE survey.

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Table A4 Migratory Patterns of the Economically Active Population in Urban Areas

State	Migrants		
	All Occupations	Range of Individual Occupations	
		Lowest	Highest
Aguascalientes	24.08%	18.94%	31.25%
Baja Calif	56.17%	40.78%	62.87%
Baja Calif S.	38.52%	24.18%	53.33%
Campeche	18.90%	8.80%	25.22%
Chiapas	8.20%	4.57%	19.77%
Chihuahua	12.99%	9.94%	17.16%
Coahuila	17.77%	15.79%	23.21%
Colima	30.19%	21.71%	42.28%
Distrito Fed	23.55%	15.49%	35.38%
Durango	10.06%	7.38%	14.54%
Estado de Mex	37.63%	31.06%	61.94%
Guanajuato	10.14%	6.54%	20.87%
Guerrero	10.46%	9.19%	16.00%
Hidalgo	18.92%	13.59%	27.00%
Jalisco	16.84%	13.31%	27.15%
Michoacan	15.16%	7.80%	30.86%
Morelos	37.02%	23.65%	50.63%
Nayarit	18.93%	14.62%	22.22%
Nvo Leon	26.08%	13.50%	34.83%
Oaxaca	9.40%	6.30%	18.45%
Puebla	13.79%	7.69%	18.70%
Queretaro	33.93%	25.43%	65.22%
Quintana R	74.87%	64.18%	84.75%
San Luis P	16.57%	11.58%	22.09%
Sinaloa	12.32%	10.05%	22.83%
Sonora	15.56%	10.56%	20.00%
Tabasco	20.54%	13.83%	33.33%
Tamaulipas	29.53%	18.85%	36.14%
Tlaxcala	17.17%	13.56%	33.85%
Veracruz	15.16%	10.46%	31.25%
Yucatan	12.45%	7.69%	29.00%
Zacatecas	13.92%	10.00%	26.27%

Source: Based on ENOE (2010), IIQ.

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A. Details of the Methodology applied in the estimation of the SOCL in Mexico

Social security payments (as officially denominated in Mexico) are based on The Mexican Social Security Institute (IMSS[26]) regulations which include several concepts that we may separate out into three categories: (a) Healthcare, life insurance and welfare (which we will call healthcare for short); (b) Retirement (SAR[27]); and (c) Housing (INFONAVIT[28]). Payments also include the accident risk premium associated with the likelihood of accident claims arising from the firm's activity. With regard to other worker's benefits associated with salaried work we assume that employers are paying their employees at least the minimum benefits specified by the Federal Labor Law. These include a private retirement fund (financed by 5.15% and 1.125% contributions from the employer and employee, respectively), Housing (an employer's contribution of 5% of the wage), vacations (which vary with the number of years of employment and must include a 25% premium), Christmas bonus (15 days) and profit participation (10% of distributable income of the firm and proportional to the number of days worked during the fiscal year). It should be mentioned here that estimating profit participation is not a feasible task with the information we have from ENOE and goes beyond the objectives of this paper. However, a sensible assumption (see González, 1995) when estimating the proportion of benefits associated with vacations, Christmas bonus and profits participation is that they all account for approximately one month of the gross-of-tax annual wage income. Hence, when estimating the percentage of benefits we have taken 1/12 = 0.0833 of the monthly gross-of-tax wage (gw_j^k).

A.1 Estimating Tax Withholdings

Benefits associated with salaried work (FB_j^k) and tax withholdings (tax_j^k) are calculated based on the taxable wage income gw_j^k. Both FB_j^k and T_j^k are elements to be added to w_j^k when estimating GWF_j^k. The amount of tax withheld is estimated using w_j^k as a starting point and following the Tax Revenue Law tables for 2010. The monthly tax to be withheld is calculated as follows:

[26] Instituto Mexicano del Seguro Social.

[27] SAR is the abbreviation for *Sistema de Ahorro para el Retiro* (Retirement Savings System). Employer and employee contributions for this concept are placed in a personal account whose beneficiary is the worker or his/her family.

[28] Abbreviation for *Instituto del Fondo Nacional para la Vivienda de los Trabajadores* (Institute for The National Fund of Workers Housing) Mexico's largest issuer of government-backed home mortgages in Mexico designed to finance housing, especially for low income workers. The INFONAVIT mortgage is wage-indexed.

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(T_j^k) = Fixed payment for bracket
+ (gw_j^k - bracket lower limit) τ – subsidy[29] (A1)

where τ is the marginal tax rate levied on the difference between income and the lower limit of the taxable income bracket[30]. Once we have the corresponding average tax rate to be applied on gw_j^k, we get:

$$gw_j^k = \frac{w_j^k}{1-t} \quad \text{(A2)}$$

where t = estimated average tax rate (tax/income) corresponding to the median of taxable wage income in occupation j and metropolitan area k. Then, the amount of taxes to be added in estimating GWF_j^k is just the difference between the median taxable wage income and the median wage reported by the worker or after-tax wage:

$$T_j^k = gw_j^k - w_j^k \quad \text{(A3)}$$

Note that what we call median Gross Wage in the formal market, GWF_j^k, is different from gw_j^k. The former includes personal taxes but also other non-taxable benefits, social security payments (employer disbursements and employee withholdings) and payroll taxes that are part of the labor demand price (labor cost paid by the employer), whereas the latter represents the taxable wage income used to estimate social security payments and other benefits associated with the salary.

A.2 Estimating Healthcare Payments (HC)

As previously mentioned, payments associated with healthcare and life insurance (as well as retirement and housing) are calculated following regulations established by the Mexican Social Security Institute and based on the so-called integrated wage[31], which refers to the taxable (or gross-of-tax) monthly wage increased by the monthly proportion of the mandatory Christmas bonus (15/365 = 0.0411) and vacation premium (6×0.25/365 = 0.0041). Assuming that the

[29] This subsidy amounts to a negative income tax for the very lowest incomes.
[30] Because the taxable wage income is an unknown variable in our story, w_j^k represents the after tax income information that allows us to estimate tax withholdings. We then work with the tax table to find the taxable income gw_j^k and the tax T_j^k necessary to generate w_j^k of disposable income.
[31] See Social Security Law, Art. 27.

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employer pays at least these minimum benefits to the worker as established by law, the integrated wage for occupation *j* in metropolitan area *k* would be:

$$iw_j^k = gw_j^k(1 + 0.0411 + 0.0041) = gw_j^k(1.0452) \quad \text{(A4)}$$

With iw_j^k we are now able to estimate healthcare payments (HC_j^k) attributable to the employer and to the worker using percentages established by the IMSS. It must be mentioned here that the work risk is an element needed to calculate SS, and the work risk premium is determined by Social Security regulations based on the firm's productive activity and its recorded accident incidence. In this paper, work risk premium estimation takes into account IMSS regulations and ENOE classification of occupations. This means that we have estimated a work risk premium for each occupational group[32] (nine groups). Risk premium differences between occupational groups are another element that contributes to our estimated differences in distortions for different labor markets.

A.3 Estimating Fringe Benefits Payments (FB)

These benefits include Retirement Fund (6.28% of integrated wage), Housing benefits (5% of integrated wage), Christmas bonus, vacations and profits participation. As explained above, we take one month of gross wages to account for Christmas bonus, vacations and profits participation (8.33% of gw_j^k).
Hence:

$$FB_j^k = iw_j^k(0.06275 + 0.05) + gw_j^k(0.0833)$$
$$= gw_j^k[(1.0452)(0.11275) + (0.0833)]$$

or

$$FB_j^k = 0.20115\, gw_j^k \quad \text{(A5)}$$

[32] According to the Regulations of Social Security Law in its article 196 (Reglamento de la Ley del Seguro Social, 2005), firms can be classified into five classes depending on their activity and the corresponding risk implied. For each firm-risk class there is an average risk premium specified. Following the definitions of the firm's activity and risk class, we have identified the risk class that might be associated with each occupational group defined by ENOE, which allows us also to estimate an average work risk premium per occupational.

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A.4 Estimating the Payroll Tax Payment (PRT)

Given that this is a state tax paid by the employer and varies by state, we must consider it as an additional source of differences in distortions among different labor market locations (metropolitan areas). The payroll tax is calculated as a percentage of the integrated wage iw_j^k. Hence, PRT for occupation *j* in metropolitan area *k* will be given by:

$$PRT_j^k = iw_j^k * prt^k = gw_j^k(1.0452)prt^k \quad \text{(A6)}$$

where prt^k is the corresponding payroll tax rate levied in MA *k*.

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