6 Valuing Impacts in Input Markets

Public policies usually require resources (i.e., inputs) that could be used to produce other goods or services instead. Public works projects such as dams, bridges, highways, and subway systems, for example, require labor, materials, land, and equipment. Similarly, social service programs typically require professional employees, computers, telephones, and office space; wilderness preserves, recreation areas, and parks require at least land. Once resources are devoted to these purposes, they obviously are no longer available to produce other goods and services. As a result, almost all public policies incur opportunity costs. Conceptually, these costs equal the value of the goods and services that would have been produced had the resources used in carrying them out been used instead in the best alternative way.

The opportunity cost of the resources used by a program or policy equals the change in social surplus in the input markets. Furthermore, this change equals the expenditure on the inputs adjusted, when necessary, by the changes in consumer surplus and producer surplus in the input markets. Analogous to the previous chapter, this chapter first shows how to compute opportunity costs when the market for a resource is efficient and then it shows how to compute the opportunity cost when the market for the resource is inefficient (i.e., there is a market failure). As will be seen, in the first of these situations, budgetary expenditures usually accurately measure project opportunity costs if there are no price effects and will slightly overstate project opportunity costs if there are price effects. In the second situation, expenditures may substantially overstate or understate project opportunity costs. In this situation, analysts often use shadow prices in order to obtain the best estimates of social costs.

Before beginning, it may be helpful to make a general point concerning opportunity costs: the relevant determination is what must be given up today and in the future, *not* what has already been given up. The latter costs are *sunk* and should be ignored. In CBA, the extent to which costs are sunk depends importantly on whether an *ex ante, ex post*, or *in medias res* analysis is being conducted. For instance, suppose you are asked to evaluate a decision to complete a bridge after construction has already begun. The opportunity cost of the steel and concrete that is already in place is the value of these materials in their current best alternative use, which is most likely measured by the maximum amount for which they could be sold as scrap, less the costs of scrapping them. The latter costs may exceed the scrap value of the materials and, therefore, the opportunity cost will be negative when calculating the incremental gain of continuing construction.

6.1 Valuing Costs in Efficient Markets

6.1.1 *Perfectly Elastic Supply Curves*

An example of this situation is when a government agency that runs a training program for unemployed workers purchases pencils for trainees. Assuming an absence of failures in the market for pencils, and that the agency buys only a small proportion of the total pencils sold in the market, the agency is realistically viewed as facing a horizontal supply curve for pencils. Thus, the agency's purchases will have a negligible effect on the price of pencils; it can purchase additional pencils at the price they would have cost in the absence of the training program.

This situation is depicted in Figure 6.1. If a project purchases q' units of the input factor represented in the diagram (e.g., pencils), the demand curve, D, would shift horizontally to the right by q'. As implied by the horizontal supply curve, marginal costs remain unchanged and, hence, the price remains at P_0. The area under the supply curve represents the opportunity cost of the factor and P_0 is the opportunity cost of one additional unit of the factor. Consequently, the opportunity cost to society of the q' additional units of the factor needed by the project is simply the original price of the factor times the number of units purchased (i.e., P_0 times q'). In Figure 6.1, this is represented by the shaded rectangle abq_1q_0. There is no change in consumer surplus or producer surplus in the factor market. Thus, the opportunity cost of the additional pencils used by the agency equals the expenditure it must incur to buy them.

Because most input factors have neither steeply rising nor declining marginal cost curves, *it is often reasonable to presume that expenditures required for project inputs equal their social costs*. This is the case when the quantity of the resource purchased

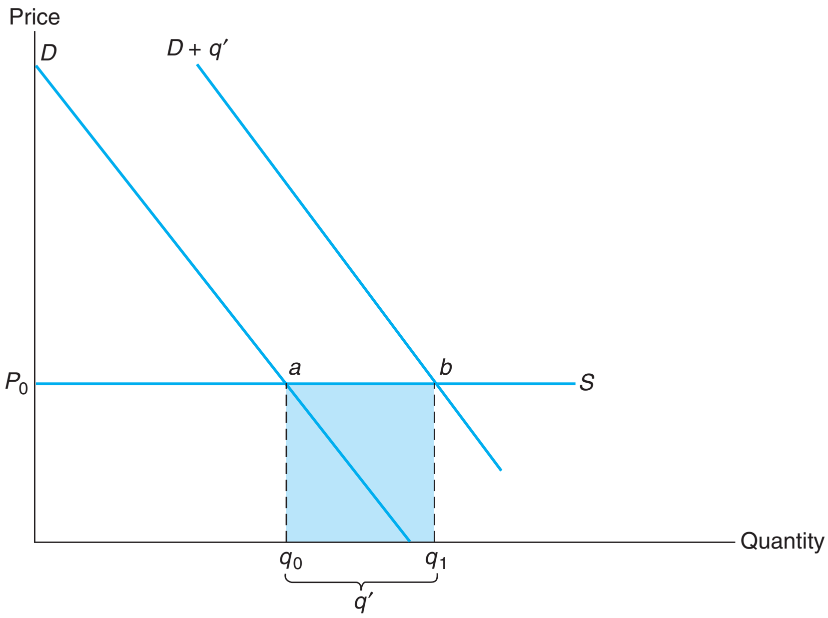

Figure 6.1 Opportunity costs with no price effects.

makes only a small addition to the total demand for the resource, and where, in addition, there is no reason to suspect the existence of significant market failures.

6.1.2 *Perfectly Inelastic Supply Curves*

In contrast to pencils, let us now examine a government purchase of a parcel of land for a park. We assume that, unlike the pencils, the quantity of land in a specified area is fixed at *A* acres. Thus, the government faces a vertical rather than horizontal supply curve. In addition, we assume that if the government does not purchase the land, it will be sold in one-acre parcels to private buyers who will build houses on it.

This situation is represented in Figure 6.2, where *S* is the supply curve and *D* the private-sector demand curve. If the owners of the land sell it in the private market, they receive the amount represented by the rectangle *PbA*0. Now let us assume that the government secures all *A* units of the land at the market price through its eminent domain powers, paying owners the market price of *P*. Thus, the government's budgetary cost is represented in Figure 6.2 by area *PbA*0.

Here, however, the government's budgetary outlay understates the opportunity cost of removing the land from the private sector. The reason is that the potential private buyers of the land lose consumer surplus (triangle *aPb* in Figure 6.2) as a result of the government taking away their opportunity to purchase land, a real loss that is not included in the government's purchase price. The full cost of the land if it is purchased by the government is represented in Figure 6.2 by all of the area under the demand curve to the left of the vertical supply curve, area *abA*0, not only the rectangular area below the price line.[1]

6.1.3 *Efficient Markets with Noticeable Price Effects*

It is possible that even when a resource is purchased in an essentially efficient market its price is bid up. This could occur, for example, if the construction of a very large dam requires massive amounts of concrete. In such a situation, the project should be

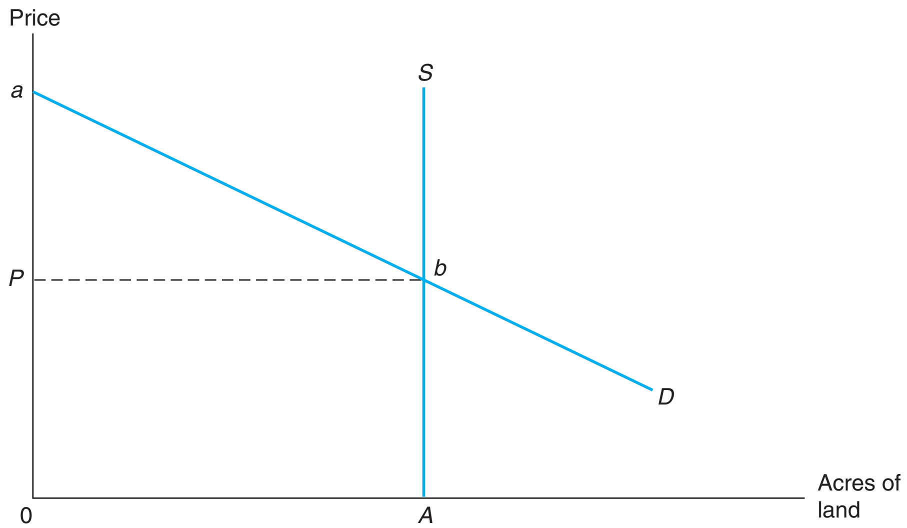

Figure 6.2 Opportunity costs with inelastic supply curve.

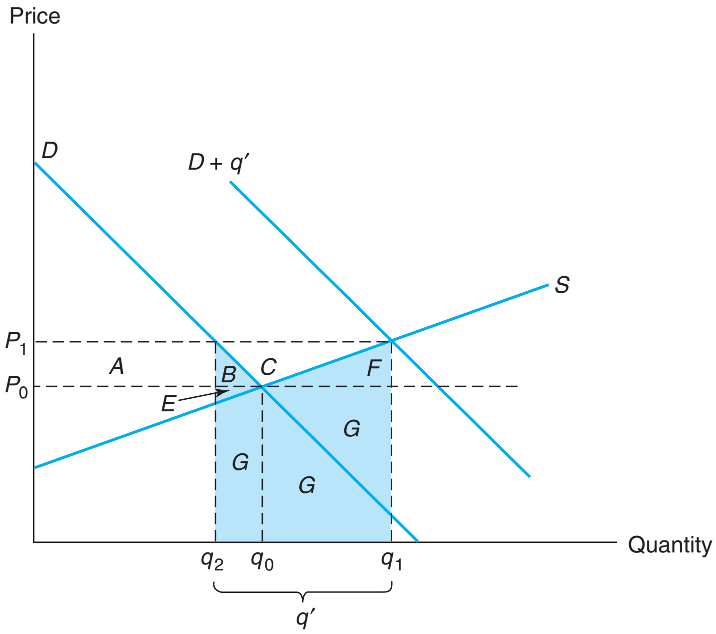

Figure 6.3 Opportunity costs with price effects.

viewed as facing an upward-sloping supply curve for the resource input. Such a supply curve is illustrated in Figure 6.3. In this example, project purchases of q' units of the resource would shift the demand curve, D, to the right. Because the supply curve, S, is upward-sloping, the equilibrium price rises from P_0 to P_1, indicating that the large purchase causes the marginal cost of the resource to rise. The price increase causes the original buyers in the market to decrease their purchases from q_0 to q_2. However, total purchases, including those made by the project, expand from q_0 to q_1. Thus, the q' units of the resource purchased by the project come from two distinct sources: (1) units bid away from their previous buyers, and (2) additional units sold in the market.

Total project expenditures on the resource are equal to P_1 times q'. In Figure 6.3, these expenditures are represented by areas $B + C + G + E + F$, which together form a rectangle. To calculate the opportunity cost we need to add changes in consumer and producer surplus. Area labeled A plus area labeled B in Figure 6.3 represent a decrease in the consumer surplus of the original buyers because of the price increase. However, sellers gain producer surplus as a result of the price represented by areas $A + B + C$. Therefore, the net *increase* in consumer plus producer surplus equals area C. This amount should be *subtracted* from government expenditures to obtain the cost equal to areas $B + G + E + F$. The effects of the purchase are summarized in the following social accounting ledger.

	Gains	Losses	Net gains
Consumers		$A + B$	$-\{A + B\}$
Producers	$A + B + C$		$A + B + C$
Government		$B + C + G + E + F$	$-\{B + C + G + E + F\}$
Society			$-\{B + G + E + F\}$

When prices change, the opportunity cost equals budgetary outlay less an adjustment, which is given by area C. If the demand and supply curves are linear, this adjustment can be readily calculated. It equals the amount of the factor purchased for the project, q', multiplied by $1/2(P_1 - P_0)$, half the difference between the new and the old prices.[2] The social cost of purchasing the resource for the project, areas $B + G + E + F$, equals the amount purchased multiplied by the average of the new and old prices, $1/2(P_1 + P_0)(q')$.[3] The average of the new and old prices reflects the social opportunity cost of purchasing the resource more accurately than either the old price or the new price. It is an example of a shadow price. As an examination of Figure 6.3 suggests, area C will be small relative to the budgetary cost unless the rise in prices is quite substantial. In many instances, therefore, the budgetary outlay will provide a good approximation of the social cost even when there is an effect on prices.

The social cost of using a resource for a project or program does not necessarily depend upon the mechanism that a government uses to obtain it. Suppose, for example, that instead of paying the market price for q' units of the resource represented in Figure 6.3, the government instead first orders supplying firms to increase their prices to the original customers in the market from P_0, to P_1, thereby causing sales to these buyers to fall from q_0 to q_2. Next, suppose that the government orders these firms to supply q' units to the government at the additional cost required to produce them. The social surplus loss resulting from the price increase to the original buyers is area $B + E$, which is the deadweight loss attributable to the increase in price. The social opportunity cost of producing the additional q' units of the resource for the government, which in this case corresponds to the government's budgetary expenditure, is the trapezoidal area $G + F$. Thus, the social cost that results from the government's directive is $B + G + E + F$. This cost is exactly the same as the social cost that results when the government purchases the resource in the same manner as any other buyer in the market. Notice, however, that this time the government's budgetary outlay, $G + F$, is smaller, rather than larger, than the social opportunity cost of using the resource.

6.2 Valuing Costs in Distorted Markets

As indicated in Chapter 3, in an efficient market, price equals marginal social cost. When price does not equal marginal social cost, allocative inefficiency results. A variety of circumstances can lead to inefficiency: absence of a working market, market failures, and distortions due to government interventions (such as taxes, subsidies, regulations, price ceilings, and price floors). Any of these distortions can arise in factor markets, complicating the estimation of opportunity cost.

Because of space limitations, it is possible to examine only five distortions here. First, we consider the situation in which the government purchases an input at a price below the factor's opportunity cost. Second, we look at the situation when the government makes purchases of an input that is in fixed supply. Third, we examine the case in which the government hires from a market in which there is unemployed labor. Fourth, we consider a project in which government hiring for a project induces labor to migrate from rural to urban areas, as often occurs in a developing country. Fifth, we explore the situation in which the government purchases inputs for a project from a monopolist. In each of these situations, shadow pricing is needed to measure more accurately the opportunity cost of the input.

6.2.1 *Purchases at Below Opportunity Costs*

Consider a proposal to establish more courts so that more criminal trials can be held. Budgetary costs include the salaries of judges and court attendants, rent for courtrooms and offices, and perhaps expenditures for additional correctional facilities (because the greater availability of trial capacity leads to more imprisonment). For these factors, budgetary costs may correspond well to social opportunity costs. However, the budget may also include payments to jurors, payments that typically just cover commuting expenses. If any compensation is paid to jurors for their time, then it is usually set at a nominal *per diem* not related to the value of their time as reflected, perhaps, by their wage rates. Thus, the budgetary outlay to jurors almost certainly understates the opportunity cost of jurors' time. Consequently, a shadow price is necessary. A better estimate of jurors' opportunity cost is, for example, their commuting expenses plus the number of juror-hours times either the average or the median pre-tax hourly wage rate for the locality. The commuting expenses estimate should include the actual resource costs of transporting jurors to the court, not just out-of-pocket expenses. The hourly pre-tax wage rate times the hours spent on jury duty provides a measure of the value of goods forgone because of lost labor, although several criticisms of it are discussed in Chapter 15.

6.2.2 *Purchases When Inputs Are in Fixed Supply*

Sometimes the government needs to make a purchase of an input that is in fixed supply. A situation in which supply is fixed is illustrated in Figure 6.4, which pertains to the electricity that would be required for a project. The production of electricity is often characterized as having constant marginal costs up to a capacity constraint. Consistent with this, the supply curve in the figure is perfectly elastic prior to Q_1 and then becomes completely inelastic when the nation's generating capacity is exhausted. Let D_a represent the demand curve for electricity without the project for which the government requires electricity and D'_a represent the demand curve with the project. Under these circumstances, the electricity capacity constraint is not binding. As a result, the project would not affect the current consumers of electricity. However, it would require that additional inputs be used to produce the additional electricity needed by the project. Consequently, the cost of the electricity used on the project would simply be the government's purchase expenditure.

Now assume that without the project the demand curve for electricity is D_b and with the project it is D'_b. Thus, the project would increase the market price of electricity from P_1 to P_2 and reduce the consumption of electricity by current consumers from Q_1 to Q_2. Because of the price increase, current consumers lose surplus, while the producers of electricity gain surplus. As explained earlier in the chapter, these changes in surplus can be appropriately taken into account in determining the cost of electricity to the project by simply using the average of the old and new market prices, $(P_1 + P_2)/2$, as a shadow

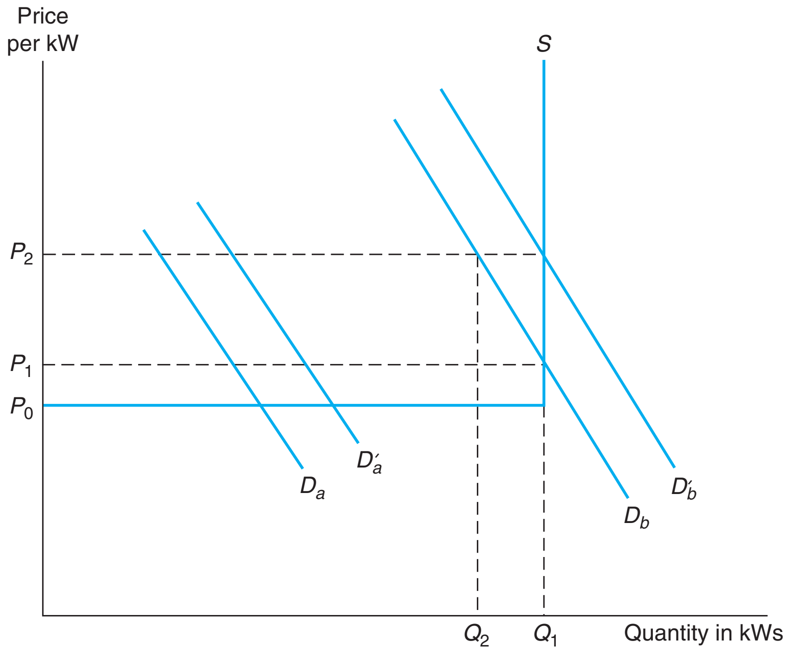

Figure 6.4 Electricity market supply is either completely elastic or completely inelastic.

price. Thus, measured in market prices, the cost of electricity for the project would equal $[(P_1 + P_2)/2](Q_1 - Q_2)$.

6.2.3 *Hiring Unemployed Labor*

We have stressed that assessing opportunity costs in the presence of market failures or government interventions requires a careful accounting of social surplus changes. Analysis of the opportunity cost of workers hired for a government project who would otherwise be unemployed illustrates the kind of effort that is required.

Let us examine the opportunity costs of labor in a market in which minimum wage laws, union bargaining power, or some other factor creates a wage floor that keeps the wage rate above the market-clearing level and, consequently, there is unemployed labor. Notice that we are focusing here on a very specific form of unemployment: that which occurs when the number of workers who desire jobs at the wage paid in a particular labor market exceeds the number of workers employers are willing to hire at that wage.[4] Workers who are unemployed for this reason are sometimes said to be *in surplus*. We focus on surplus workers so that we can examine their opportunity costs when they are hired for a government project. This issue is of particular importance because there are government projects that are specifically designed to put surplus workers to work and numerous other projects that are likely to hire such workers. Of course, there are other forms of unemployment than the type considered here. For example, some persons are briefly unemployed while they move from one job to another.

Before discussing how the opportunity cost of surplus labor might be measured, it may be useful to consider more explicitly the extent to which the labor hired to work on a government project reduces the number of unemployed workers. Consider, for example, a project that hires 100 workers. How many fewer workers will be unemployed as a result? In considering this question, it is important to recognize that the project does not have to hire directly from the ranks of the unemployed. Even if the project hires 100 previously employed persons, this will result in 100 job vacancies, some of which may be filled by the unemployed. If the unemployment rate for the type of workers hired for the project (as determined by their occupation and geographic location) is very high (say, over 10 percent), the number of unemployed workers may approach 100. However, if the unemployment rate for the workers is low (say, below 4 percent or so), most of the measured unemployed are probably between jobs rather than in surplus. As a consequence, the project is likely to cause little reduction in the number of persons who are unemployed. Instead, the project will draw its workforce from those employed elsewhere or out of the labor force. To illustrate, a recent study by Donald Vitaliano found that in July 2009, when the national unemployment rate was 9.5 percent, over half of the workers hired for a government project (55 percent) would have been drawn from among persons who were either unemployed or who had withdrawn from the labor force but stated that they wanted a job. Based on Vitaliano's estimated relationship, the percentage drawn from the ranks of the unemployed would have only been 16 percent in November 2016, when the unemployment rate was 5.0 percent.[5]

Figure 6.5 depicts a situation in which a government project reduces unemployment. In this figure, the pre-project demand curve for labor, D, and the supply curve for labor, S, intersect at P_e, the equilibrium price in the absence of the wage floor, P_m. At the wage floor, L_s, workers desire employment, but only L_d workers are demanded so that $L_s - L_d$ workers are in surplus and thus unemployed. Now imagine that L' workers are

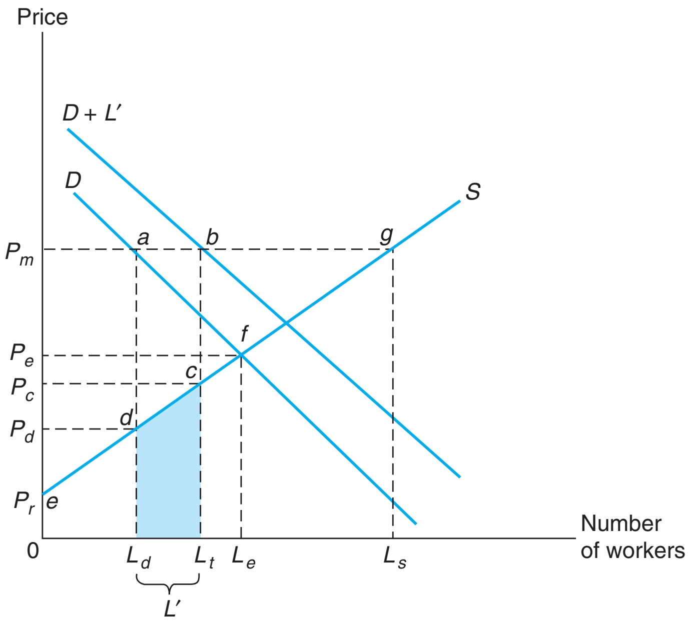

Figure 6.5 Opportunity costs with a price floor.

hired for a government project at a wage of P_m. This shifts the demand curve to the right by L'. As long as L' is less than the number of unemployed laborers, the price remains at the floor.

We now consider five alternative measures of the social cost of hiring the L' unemployed workers. All five of these measures are subject to criticism. Indeed, it is not obvious that, as a practical matter, it is possible to obtain an accurate value of the social cost of hiring the unemployed. However, some of the alternative measures described here are far better approximations of the true social cost than others.

1. **Measure A.** It is sometimes suggested that because the unemployed are not working, there are zero opportunity costs in putting them to work. However, this treats the unemployed as if their time is valueless. This is clearly inappropriate on two grounds. First, many unemployed persons are in fact engaged in productive enterprises such as job search, child care, and home improvements. Second, even if they were completely at leisure, leisure itself has value to those who are enjoying it. Consequently, few, if any, unemployed persons are willing to work at a zero wage. Indeed, the supply curve in Figure 6.5 represents the value that various individuals, both those who are employed and those who are unemployed, place on their time when they are not employed. For example, an individual located at point *f* would only be willing to accept employment at a price of P_e or greater. Thus, P_e provides a measure of the value that this person places on his or her time. In other words, his or her opportunity cost of giving up leisure time to work is P_e. Similarly, individuals located on the supply curve at points *c* and *d* value their time at P_c and P_d, respectively. No individual is willing to work at a price below P_r, and, as P_r has a positive value, Figure 6.5 implies that the opportunity cost of hiring the unemployed must be above zero.

2. **Measure B.** Figure 6.5 indicates that total budgetary expenditure on labor for this project is P_m times L', which equals the area of rectangle abL_tL_d. This budgetary outlay for labor, however, is likely to overstate substantially the true social cost of hiring workers for the project. As implied by the supply curve in Figure 6.5, although employed workers are paid a price of P_m, most would be willing to work for less. This difference between the value they place on their time, as indicated by the supply curve, and P_m, the price they are actually paid while employed, is producer (i.e., worker) surplus, which may be viewed as a transfer to the workers from the government agency hiring them. To obtain a measure of the social cost of hiring workers for the project, this producer surplus must be subtracted from the budgetary expenditure on labor.[6] Measure B fails to do this.

3. **Measure C.** As the project expands employment in the market represented by Figure 6.5 from L_d to L_t, one might assume that the trapezoid *abcd* represents producer surplus enjoyed by the newly hired. Given this assumption, one would subtract area *abcd* from area abL_tL_d to obtain a measure of the social

cost of hiring workers for the project. Thus, the social cost would be measured as the shaded trapezoid cdL_dL_t, the area under the supply curve between L_d and L_t. This shaded area would equal the opportunity cost of the newly hired workers – that is, the value of the time they give up when they go to work.

4. **Measure D.** One shortcoming of measure C is that it is implicitly based on an assumption that all the unemployed persons hired for the project value their time at less than P_c and at greater than P_d. In other words, this approach assumes that these workers are all located between points *c* and *d* on the supply curve. However, there is no basis for such an assumption. Indeed, it is quite likely that some of the hired unemployed persons value their time at well above P_c and that others value their time at well under P_d. In fact, the figure implies that unemployed persons who value their time as low as P_r and as high as P_m would be willing to work on the project because the project would pay them a price of P_m. Thus, perhaps, a better assumption is that the unemployed persons who would actually get hired for the project are distributed more or less equally along the supply curve between points *e* and *g*, rather than being confined between points *d* and *c*. This assumption implies that the unemployed persons who are hired for the project value their time by no more than P_m, by no less than P_r, and, on average, by $1/2(P_m + P_r)$. Thus, the social cost of hiring L' workers for the project would be computed as equal to $1/2(P_m + P_r)(L')$.

5. **Measure E.** One practical problem with using measure D in an actual CBA is that the value of P_r, the lowest price at which any worker represented in Figure 6.5 would be willing to accept employment, is unlikely to be known. Given this, some assumption about the value of P_r must be made. One possible, and perhaps not unreasonable, assumption is that the supply curve passes through the origin and, hence, the value of P_r equals zero. The fact that the probabilities of illness, divorce, and suicide all increase with unemployment, while job skills deteriorate, suggest that P_r could, in practice, be very low for at least some unemployed persons. If we once again assume that the unemployed persons who are hired for the project are distributed more or less equally along the supply curve between the point at which it intersects the vertical axis and point *g*, then this implies that the unemployed persons who are hired for the project value their time by no more than P_m, by no less than zero, and, on average, by $1/2(P_m + 0) = 1/2\ P_m$. Hence, the social cost of hiring workers for the project would be computed as $1/2\ P_m(L')$. Note that the estimate provided by this computation is equal to half the government's budgetary outlay. While this cost estimate would be smaller and almost certainly less accurate than that computed using measure D, it is usually easier to obtain.

Given our preceding argument that non-work time has a positive value, measure E is probably best viewed as providing an easily obtainable lower-bound estimate of the true project social costs for labor, while the project budgetary cost for labor, measure B, provides an upper-bound estimate.

6.2.4 *Hiring Labor when Rural to Urban Migration within a Developing Country is Important*

A substantial fraction of the unskilled workers for a project in a developing country are ultimately likely to be drawn from the countryside. This will be true not only of projects in rural areas, but also of projects in cities, even if the workers who are directly hired by the project currently reside in urban areas. The reason is that as employment increases in urban areas in developing countries, workers in rural areas are induced to migrate to the areas where employment has increased.

Why this migration occurs is suggested by a well-known model developed by John Harris and Michael Todaro.[7] Their model is based on two observations about developing countries: unemployment is often very high in urban areas, and earnings are typically considerably higher in urban than in rural areas. Although Harris and Todaro do not explain the reasons for the higher urban wages, they could be due to minimum wage laws that are enforced in urban areas but not rural areas, the role of unions, decisions by foreign corporations that are under pressure in their home countries to pay wages that exceed subsistence levels, or a belief on the part of employers that higher wages result in higher productivity because higher paid workers are healthier, less likely to leave the firm, and more motivated.[8] The key point for purposes of the Harris–Todaro model is that urban wages are above their equilibrium level and, consequently, result in urban unemployment.[9] Rural wages, in contrast, are at their equilibrium level and, consequently, lower than urban wages.

Harris and Todaro suggest that because of the higher urban wages, workers will migrate from the countryside to the cities, even though some of them will not be able to find jobs. More specifically, they postulate that the probability that a rural worker will obtain employment upon migrating to a city equals $(L - U)/L$, where L is the size of the workforce in the city, U is the number of unemployed persons, and $E = (L - U)$ is the number of employed workers. Therefore, the model implies that workers will have an incentive to migrate from the countryside to the city as long as:

$$RW < UW(E/L) \tag{6.1}$$

where RW is the rural wage, UW is the urban wage, and $UW(E/L)$ is the wage that migrating workers will receive on average (in other words, $UW(E/L)$ is their expected wage). Thus, according to the model, rural–urban migration will cease when:

$$RW = UW(E/L) \tag{6.2}$$

Two important implications of this model are that even when there is no incentive for further migration, urban unemployment may continue to be high, and urban wages may continue to exceed rural wages.

We now use the Harris–Todaro model to examine the effects of locating a new project in a city. Assume that prior to initiating the project the equilibrium condition specified in Equation (6.2) is being met. Now assume that ΔE unskilled workers are hired to work on the project. If ΔE is fairly small relative to the size of the workforce, then wage rates are unlikely to be affected. Moreover, urban wage rates may also be unaffected because they are already above their equilibrium level. However, because of the increase in the number of available urban jobs, the expected urban wage facing rural workers will increase to $UW[(E + \Delta E)/L]$, inducing some rural workers to migrate. Consequently, the equilibrium can only be re-established if:

$$E/L = (E + \Delta E)/(L+\Delta L) \tag{6.3}$$

where ΔL is the number of workers added to the urban labor force.

There are two things to notice here. First, if there are no changes in urban wage rates, then current residents of the city who are presently outside the labor force (that is, not already employed or seeking employment) will not be induced to join it, except perhaps by the increase in the number of available jobs. Therefore, many, if not most, of the workers added to the urban labor force will be migrants from rural areas. Second, according to the model, the number of migrants is likely to exceed the number of jobs created by the project. This can be seen by first rearranging the terms in Equation (6.3) to obtain:

$$L + \Delta L = \mathrm{L}(E+\Delta E)/E \tag{6.4}$$

and then by subtracting $L = L(E)/E$ from Equation (6.4) and rearranging the terms to obtain:

$$L+\Delta L-L = L(E + \Delta E)/E - L(E)/E \text{ or } \Delta L/\Delta E = L/E \tag{6.5}$$

Because the urban labor force consists of both workers and the unemployed (that is, $L = E + U$), the ratio L/E must exceed 1 and, thus, as Equation (6.5) implies, so will the ratio $\Delta L/\Delta E$.

The implications of this simple model can be illustrated with an example. If the urban wage is 50 percent higher than the rural wage (that is, if $1.5RW = UW$), then Equation (6.2) implies that E/L equals 0.67. Hence, one-third of the urban workforce will be unemployed. Moreover, Equation (6.5) implies that for each job created by a project, 1.5 persons will enter the urban labor force (that is, $\Delta L = \Delta E(L/E) = 1(3/2) = 1.5$). For reasons already stressed, many, if not most, of these persons are likely to be rural migrants.

Because most of the unskilled workers added to the workforce as a result of a government project would probably be drawn from the countryside, the output that is forgone is production in rural areas. If the project is located in a rural area, then rural–urban migration is not a consideration, and the shadow wage used in estimating the value of the foregone output would simply be the rural wage. In other words, to determine the cost of labor for the project, the number of workers hired would be multiplied by the rural wage. However, if the project is located in an urban area, then account must be taken of the number of workers who would leave the countryside for each job created. According to the Harris–Todaro model, if *all* the workers added to the workforce as a result of the project are rural migrants, then this can be accomplished by multiplying the rural wage by the ratio, L/E. Alternatively, the urban wage can be used instead, given that Equation (6.2) implies that $RW(L/E) = UW$.[10]

However, the urban wage rate should be viewed as an *upper bound* because fewer than L/E rural workers may actually migrate in response to each job created by an urban project. First, as previously mentioned, some urban residents may be induced into the labor force as jobs are created by the project. Second, the actual number of migrants could be less if workers are risk-averse or there are monetary or psychic costs associated with migrating. Third, if the project is sufficiently large, then the migration of rural workers could cause rural wages to rise, thereby reducing the ultimate number of migrants. If fewer than L/E workers migrate, then the appropriate market wage to use in determining the shadow wage rate would be less than the urban wage. Thus, Caroline Dinwiddy and Francis Teal demonstrate that, under a wide variety of assumptions, the appropriate shadow wage is likely to fall somewhere between the rural and the urban market wage.[11] Consequently, *if large numbers of unskilled workers will be employed on an urban project in a developing country, and there are wide differences between rural and urban wages, a sensitivity test should be conducted in determining the shadow wage rate by first using the rural market wage and then using the urban wage.*

While urban wage rates for unskilled workers can be obtained from survey data – for example, the average manufacturing wage can be used[12] – many rural workers produce crops for their own consumption. Hence, the effective wage rate of these workers is more difficult to ascertain. One way to construct an estimate of the rural market wage is to first determine how a typical rural worker who is likely to be affected by the project being evaluated allocates his or her productive time and then estimate the value of the worker's output. For instance, suppose that the typical worker is employed on a cacao plantation for half the year and receives a daily wage of 40 pesos and food and transportation valued at 10 pesos a day, for a total of 50 pesos. Because the worker is only needed at the plantation for six months, he or she works at home during the remainder of the year, growing corn for three months and bananas for the remaining three months. Although the corn and bananas are mostly grown for home consumption, if they were brought to the local market they could be sold for 910 pesos and 1,365 pesos, respectively. Dividing the market value of corn and bananas by the 91 days during which the work to grow each was performed suggests that the worker earned a daily market wage of 10 pesos from growing corn and a daily market wage of 15 pesos from growing bananas. Given this information, the worker's daily wage can be computed as a weighted average of his or her daily return from each endeavor, where the weights are the fraction of time he or she devoted to each activity. That is:

$$RW = .5(50) + .25(10) + .25(15) = 31.25\text{pesos} \tag{6.6}$$

In principle, at least two additional factors should be taken into account in determining the shadow wage rate of rural, unskilled workers, although in practice they rarely are because of the lack of adequate information. First, it is possible that moving to the city requires the worker to work longer hours, places the worker under greater stress, and results in a less-satisfactory lifestyle. If so, then the shadow wage rate should, in principle, be adjusted upward to account for the resulting loss of utility.

Second, many rural workers in developing countries live in large, extended families. If a project induces a rural worker to migrate to the city, then the effects on the remaining family members should, in principle, be taken into account. The remaining family members lose the migrating worker's output, of course, but they gain because the worker no longer consumes the income available to the family. These two amounts are not necessarily entirely offsetting; it is possible that the gain exceeds the loss. This would occur, for example, if the family shares its income (the total value of the output produced by all family members) equally among its members. Under these circumstances, each family member's consumption level would be equal to the average value of the output produced by the family. The family member's contribution to family output, however, would correspond to his or her marginal product. Because rural families typically produce much of their output at home on a fixed amount of land, it is likely that the family would be producing on the declining segment of its marginal product curve. If so, the value of a family member's marginal product will be smaller than the value of the output that he or she consumes. Thus, if a family member is induced by a project to migrate in such circumstances, the consumption levels of the remaining family members will increase.

Exhibit 6.1

In 1974, the World Bank led an international effort to eradicate onchocerciasis (river blindness) in West Africa. The project, which extended over more than two decades and covered 11 countries, used insecticides to kill the blackfly, the carrier of the parasite that causes onchocerciasis. The benefits of the program stem from the reduction in the number of cases of river blindness. A CBA of a similar program in a developed country would likely have measured benefits by monetizing the morbidity and mortality effects with shadow prices. (See Chapter 17 for estimates of these prices.) However, estimating the necessary shadow prices in these very poor countries was impractical. Instead, the CBA of the project conducted by the World Bank in 1995 measured benefits in terms of the value of increased agricultural output resulting from increased labor and land. As the average person who develops blindness lives with it for 8 years and dies 12 years prematurely, each avoided case adds about 20 years of productive life. Assuming that these years are employed in agriculture, the percentage increase in the rural labor supply resulting from the project was projected and multiplied by an estimated output elasticity of labor of 0.66 to obtain the predicted percentage increase in agricultural output. The value of the increase in agricultural output was in turn estimated by the World Bank. A similar procedure was used to value the additional agricultural land made available through eradication. Overall, the project offered net positive benefits, even when assuming labor force participation rates and land utilization rates of only 70 percent.

Source: Adapted from Aehyung Kim and Bruce Benton, "Cost–Benefit Analysis of the Onchocerciasis Control Program," World Bank Technical Paper Number 282, May 1995.

6.2.5 *Purchases from a Monopoly*

We now turn to a final example of measuring the social cost of project or program purchases in an inefficient market – the purchase of an input supplied by a monopoly. In this circumstance, a government agency's budgetary outlay overstates the true social costs

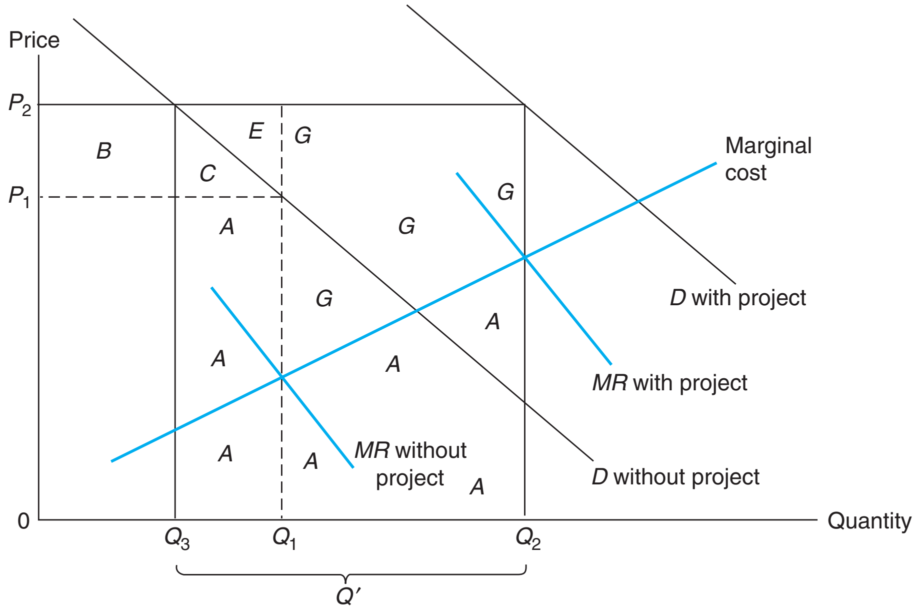

Figure 6.6 Opportunity costs when buying from a monopoly.

resulting from the purchase. This overstatement occurs because the price of the input exceeds the social cost of producing it. As a consequence, a substantial share of the revenues a monopolist receives are transfers or *monopoly rents*. Thus, in principle, a CBA should not use the budgetary outlay as a measure of social cost.

Figure 6.6 illustrates a government agency's purchase of an input from a monopoly. Prior to the purchase, the input is produced at level Q_1, where the monopolist's marginal cost and marginal revenue curves intersect. The price at Q_1, as determined by the demand curve, is P_1. Now, as a result of the agency's purchase of Q' units, the monopolist's demand curve and marginal revenue curve shift to the right. The price of the input increases to P_2 and the quantity sold increases to Q_2. At the new higher price, the agency purchases a quantity equal to the distance between Q_3 and Q_2, while the original buyers in the market reduce the quantity they purchase from Q_1 to Q_3.

As in our previous examples, the direct budgetary cost of the agency's purchase equals the price times the quantity purchased: $P_2(Q_2 - Q_3)$. In Figure 6.6, this is represented by the rectangle between Q_3 and Q_2 and bounded by P_2 (i.e., areas $A + C + G + E$). However, these budgetary costs overstate the true social cost. To find the true social cost of the agency's purchase, one must examine the effects of the purchase on the monopolist and the original buyers of the input, as well as on the agency's revenues.

Because the monopolist sells more of the input at higher prices as a result of the government's purchase, its producer surplus increases. This increase has two parts: (1) that resulting from the higher price the monopolist now receives for the units that it previously sold (which is represented in Figure 6.6 by areas $B + C + E$), and (2) that resulting from the additional units that the monopolist now sells (area G). Thus, as can be seen from the figure, part of the cost to the agency, areas $C + G + E$, is a transfer to the monopolist.

Original buyers in the market are clearly worse off as a result of the agency's purchase because they now have to pay a higher price for the input. In measuring their loss of consumer surplus, it is the original demand curve that is pertinent because this is the curve that reflects the original buyers' WTP for the input. Thus, the original buyers' total loss in consumer surplus, all of which is a transfer to the monopolist, is equal to areas $B + C$.

The following distributional social accounting ledger summarizes the effects of the purchase:

	Gains	Losses	Net gains
Consumers		$B + C$	$-\{B + C\}$
Monopolistic producer	$B + C + G + E$		$B + C + G + E$
Government		$A + C + G + E$	$-\{A + C + G + E\}$
Society			$-\{A + C\}$

The major conclusion from this analysis is that in the case of input purchases from a monopolist, budgetary expenditures are larger than the social costs. The reason is that the price the monopoly charges exceeds the marginal cost of producing the input. Consequently, in conducting a CBA, the government's budgetary cost should be adjusted downward through shadow pricing. In practice, however, the error that would result from using the unadjusted budgetary expenditures would often not be very large. As an examination of Figure 6.6 suggests, the size of the bias, areas $G + E$, depends on the extent to which the price the monopoly charges exceeds its marginal costs – in other words, on how much monopoly power it actually has. This, in turn, depends on how steeply sloped the demand curve is. Thus, before an analyst develops shadow prices, a sometimes difficult undertaking, he or she should ask whether it is really necessary to do so.

6.2.6 *The General Rule*

Other market distortions in input markets also affect opportunity costs in predictable ways. It is useful to summarize the direction of the bias created by some of these distortions. In input markets in which supply is taxed, direct expenditure outlays overestimate opportunity cost; in input markets in which supply is subsidized, expenditures underestimate opportunity cost. In input markets exhibiting positive externalities of supply, expenditures overestimate opportunity cost; in input markets exhibiting negative externalities of supply, expenditures underestimate opportunity costs. To determine opportunity costs in such cases, apply the rule: *opportunity cost equals direct expenditures on the input minus (plus) gains (losses) in producer surplus or consumer surplus occurring in the input market*.

6.3 Conclusions

This chapter has focused on input markets where the government purchases the inputs required by the program or project. It has shown that the government's budgetary expenditure on an input will differ from the social value of the purchase, its opportunity cost, if prices are affected or if, for a variety of reasons, the market in which the purchase is made is distorted. Because data on budgetary expenditures are often readily obtained and estimates of conceptually appropriate measures (which should take account of resulting changes in net government revenue flows, producer surplus, and consumer surplus) are sometimes difficult to make, those conducting CBAs need to consider how great an error results if they rely on budgetary expenditures and if correcting it is worth the cost of the effort. Sometimes upper- and lower-bound estimates are quite possible (for example, in hiring from the ranks of the unemployed). In any event, it is essential to be as transparent as possible about possible errors and their direction in reporting cost estimates of purchases in input markets.

Exercises for Chapter 6

1. Consider a low-wage labor market. Workers in this market are not presently covered by the minimum wage, but the government is considering implementing such legislation. If implemented, this law would require employers in the market to pay workers a \$5 hourly wage. Suppose all workers in the market are equally productive, the current market-clearing wage rate is \$4 per hour, and that at this market-clearing wage there are 600 employed workers. Further suppose that under the minimum wage legislation, only 500 workers would be employed and 300 workers would be unemployed. Finally, assume that the market demand and supply curves are linear and that the market reservation wage, the lowest wage at which any worker in the market would be willing to work, is \$2.

   Compute the dollar value of the impact of the policy on employers, workers, and society as a whole.

2 Assume that a typical unskilled rural worker in a developing country would be paid 2 dubyas a week if he migrates to the city and finds a job. However, the unemployment rate for unskilled workers is 40 percent in the city.

   a. What does the Harris–Todaro model predict the worker's rural wage is?
   b. Assume now that the government is considering funding a project in the city that would use substantial numbers of unskilled workers. Using your answer to part (a), suggest a reasonable upper-bound and lower-bound estimate of the market wage rate for unskilled workers that the government might use in conducting a CBA of the proposed project.

3. (Instructor-provided spreadsheet recommended.) A proposed government project in a rural area with 100 unemployed persons would require the hiring of 20 workers. The project would offer wages of \$12 per hour. Imagine that the reservation wages of the 100 unemployed fall between \$2 and \$20.

a. Estimate the opportunity cost of the labor required for the project assuming that the government makes random offers to the 100 unemployed until 20 of them accept jobs. (First, generate a list of the reservation prices of 100 persons according to the formula \$2 + \$18*u* where *u* is a random variable distributed uniformly [0, 1]. Second, work down the list to identify the first 20 workers with reservation wages less than \$12. Third, sum the reservation wages of these 20 workers to get the opportunity cost of the labor used for the project.)

b. Estimate the opportunity cost of the labor required for the project assuming that the government can identify and hire the 20 unemployed with the lowest reservation wages.

c. Repeat part (a) 15 times to get a distribution for the opportunity cost and compute its standard deviation.

Notes

1. If the government were to purchase only a small part of the fixed supply of land on the open market, its budgetary outlay would very closely approximate the opportunity cost of removing the land from the private sector. In this case, the government's entry into the market would bid up the price of the land slightly, crowding potential private-sector land buyers who are just to the left of point *b* on the demand curve out of the market. These buyers would lose a negligible amount of surplus. In addition, those private-sector buyers who remain in the market would pay a slightly higher price. Hence, surplus would be transferred between these buyers and the sellers of the land.

2. This formula is based on a bit of geometry. The triangular area C equals one-half the rectangular area from which it is formed, $B + C + F$. Thus, area C is equivalent to $1/2(P_1 - P_0)(q')$.

3. This amount is derived as follows:

$$P_1q' - \tfrac{1}{2}(P_1 - P_0)q' = \tfrac{1}{2}(P_0 + P_1)q'.$$

4. For a discussion of various forms of wage rigidity that result in unemployment, see Ronald G. Ehrenberg and Robert S. Smith, *Modern Labor Economics: Theory and Public Policy*, 12th edn (New York, NY: Taylor & Francis, 2015), chapter 13.

5. Donald F. Vitaliano, "An Empirical Estimate of the Labor Response Function for Benefit–Cost Analysis." *Journal of Benefit–Cost Analysis*, 3(3), 2012, Article 1. The relationship that Vitaliano estimated appears below: percentage of hired workers drawn from unemployed = 0.67 – 14.11(vacancy rate). This estimate is based on a time series covering the period from January 2001 to November 2011. "Unemployed" is defined broadly to include those officially unemployed in US government statistics plus those out of the labor force who state that they want a job. The vacancy rate (job openings divided by the size of the labor force) is strongly inversely related to the unemployment rate. The vacancy rate in July 2009 at the height of the Great Recession was .009. In November 2016, it was .037 (www.bls.gov/news.release/pdf/jolts.pdf). The pioneering study of the relationship between government spending and reducing unemployment is Robert H. Haveman and John V. Krutilla, *Unemployment, Idle Capacity and the Evaluation of Public Expenditure: National and Regional Analysis* (Baltimore, MD: Johns Hopkins University Press, 1968).

6. A similar conclusion is reached by Robert H. Haveman and Scott Farrow, "Labor Expenditures and Benefit–Cost Accounting in Times of Unemployment." *Journal of Benefit–Cost Analysis*, 2(2), 2011, Article 7; and Robert H. Haveman and David L. Weimer, "Public Policy Induced Changes in Employment Valuation Issues for Benefit–Cost Analysis." *Journal of Benefit–Cost Analysis*, 6(1), 2015, 112–53.

7. John. R. Harris and Michael. P. Todaro, "Migration, Unemployment, and Development." *American Economic Review*, 60(1), 1970, 126–42. This model is quite simple, making no attempt to capture all important labor market phenomena in developing countries, yet it provides some very useful insights.

8. See Caroline Dinwiddy and Francis Teal, *Principles of Cost–Benefit Analysis for Developing Countries* (Cambridge: Cambridge University Press, 1996), 145–47 and 151. Higher living costs could also contribute to higher urban wages but, unlike the factors listed in the text, would not induce workers to migrate from rural to urban areas.

9. The urban wage is still equal to the marginal product of labor because urban employers hire workers until the point where the marginal product of labor equals the marginal cost of hiring an additional worker.

10. The conclusion that the urban wage should be used was also reached by Christopher J. Heady ("Shadow Wages and Induced Migration." *Oxford Economic Papers*, 33(1), 1981, 108–21) on the basis of a model that incorporated more general and complex assumptions than the Harris–Todaro model. However, Heady also discussed certain circumstances under which a lower wage, but one that is probably higher than the rural wage, should be used.

11. Dinwiddy and Teal, *Principles of Cost–Benefit Analysis for Developing Countries*, chapter 9.

12. This particular measure is suggested by Christopher J. Heady ("Shadow Wages and Induced Migration").