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7 Measuring the Benefits of Income Maintenance Programs

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7.1 Introduction

This chapter addresses the following question: To what extent do the payments that households receive from an income maintenance program, such as Aid to Families with Dependent Children (AFDC) or food stamps, measure the benefit or the value of these programs to the household? In a world where households can always achieve their desired levels of work and consumption and where all the relevant economic constraints are known with certainty, it can be shown that these payments will overestimate or be equal to the value of the program to the household as measured by either the equivalent or compensating measure of variation. This result is due to the manner in which all income maintenance schemes compute their payments. Since the payment is designed to decline as the household income rises, the price of leisure (work) is distorted from its market price (the gross wage rate). This distortion, not unlike the effects of the tax rate in the theory of positive taxation, produces a "wedge" between the value the household places on the program and the payment the government makes to the household. This wedge, which could be considered the deadweight loss to society (to borrow a concept from the evaluation of the positive taxation), measures the excess payment that the government makes to the household over the payment the government would have to make if the payment was given in a lump-sum manner.

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The purpose of this chapter is to examine how this conclusion stands up when we abandon the assumption that the household possesses perfect knowledge about its employment prospects and potential standard of living. Thus we are interested in the measurement not only of the value of the income transfer to the household, but also of the insurance value of the program to the household. When factors that reflect uncertainty in the household's future potential standard of living are taken into account, the payment or expected payments from an income maintenance scheme will tend to underestimate the value of the program to the household.

Section 7.2 will present the methodology underlying the measurement of the value of an income maintenance program under the assumptions of certainty. Section 7.3 extends the methodology to the situation where the household faces an uncertain future, the major factor of uncertainty being the possible limitation placed on the availability of work (unemployment). In this section we evaluate the benefits of a hypothetical income maintenance program that pays benefits only to unemployed individuals. In section 7.4 we extend the analysis to consider how the valuation of an income maintenance program would be affected due to uncertainty in the real-wage rate. Here we also introduce a more realistic program that allows transfers to the household as long as its income does not exceed a given level, regardless of the household's employment. In both sections 7.3 and 7.4 we will calculate the value of an income maintenance program, using as an example a female-headed household with children. The final section of the chapter offers a summary and discusses the implications of our findings for the evaluation of income maintenance and transfer schemes in general.

7.2 Measurement of the Value to a Household of an Income Maintenance Program: The Certainty Case

To clarify the various issues in the measurement of the value of an income maintenance program to a household and to simplify the exposition, we abstract from the many complexities of income transfer schemes as they exist today and consider an income maintenance program that can be described by the following relationship:

$$(1) \qquad P = \begin{cases} G - tI & \text{if } I < G/t, \\ 0 & \text{if } I \geq G/t, \end{cases}$$

where

P = the payment the household would receive if it had I amount of income,

G = the maximum payment or income guarantee to the household,

t = the program's benefit reduction rate, and,

I = the household's income from earnings and other nontransfer sources.

In order to further simplify the analysis, we consider female-headed households with children only, thus eliminating the complication of multiple earners. Thus the household's income is equal to

$$I = wh + Y,$$

where

w = the woman's real-wage rate,
h = the hours of work, and,
Y = the amount of nontransfer nonemployment income she receives.

We will also assume that the woman possesses a complete preference ordering over consumption of goods and services purchased in the market (X) and the amount of nonmarket time, leisure (l). This preference ordering will be represented by a real-value utility function;

$$U = U(X, l),$$

where U is concave in X and l, and the marginal utility of X and l is positive for all values of X and l. Let T be equal to the time available to the woman to either work in the market or "consume" leisure, (i.e., $T = h + l$). We will need the following concepts to develop the methodology to measure the value of the program to the household:

$h(w, Y)$ = the woman's labor supply function,
= $\{h$ such that $U(wh + Y, T - h)$ is maximized$\}$,
$V(w, Y)$ = the indirect utility function,
= $\{$the maximum value of U given $X + wl = wT + Y\}$,
$E(w, U)$ = the expenditure (cost) function,
= $\{$the minimum Y such that $U(X, l) = U$ and $X + wl = wT + Y\}$.[1]

In a world without uncertainty about wages and with a complete choice of hours of work, the woman will participate in the income maintenance program (i.e., work a number of hours so that her income will qualify her for a payment) if her utility level as a participant exceeds her utility level as a nonparticipant. Formally, she will not participate if

$$V((1 - t)w, G + (1 - t)Y) < V(w, Y);$$

she will participate, and receives a payment P, if

$$V((1 - t)w, G + (1 - t)Y) > V(w, Y),$$

1. Note that our definition of the expenditure function differs slightly from the standard textbook presentation. It is more common to define $E(w, U)$ as the minimum $wT + Y$ needed to achieve μ if the woman faces a real wage of w. But since we will be more concerned with the amount of nonemployment income, we use this definition of the expenditure function.

where

$$P = G - t(Y + wh)$$

and

$$h = h((1 - t)w, G + (1 - t)Y).$$

Thus, a woman who does not participate should give the program a value zero, otherwise she would have participated. However, a woman who receives a payment must value the program positively, since, by participating, she is better off in utility terms. The question we address is: Is the payment she receives an appropriate measure of the value she places upon the existence of the program?

Traditional benefit analysis would address this issue by asking the woman two alternative questions. First, what would be the maximum lump-sum payment she would be willing to make in order to keep the program in existence? This monetary measure of the program's value is denoted in the literature as the compensating variation (CV), which can be expressed in our notation as

$$CV \text{ such that } V((1 - t)w, G + (1 - t)Y - CV) = V(w, Y).$$

Or equivalently as

$$CV = (G - tY) + E(w, V_0) - E((1 - t)w, V_0) \tag{2}$$

$$= E((1 - t)w, V_1) - E((1 - t)w, V_0), \tag{3}$$

where

$$V_0 = V(w, Y),$$

$$V_1 = V((1 - t)w, G + (1 - t)Y)\ .$$

Alternatively, we could ask the woman the question: What is the minimum lump-sum payment the government would have to make, so that she feels indifferent about the program's existence? This equivalent variation (EV) can be defined using our notation as

$$EV \text{ such that } V(w, Y + EV) = V((1 - t)w, G + (1 - t)Y).$$

Or,

$$EV = (G - tY) + E(w, V_1) - E((1 - t)w, V_1), \tag{4}$$

$$= E(w, V_1) - E(w, V_0). \tag{5}$$

As can be seen from equations (3) and (4), these two approaches attempt to measure, in monetary terms, the distance between the maximum utility achievable with the program (V_1) and the maximum utility achievable without the program (V_0). Each measure utilizes a different price of leisure to measure this distance. The compensating variation uses $(1 - t)w$ while the equivalent variation measure uses the wage rate, w.

Given that the compensating and equivalent variations represent the monetary value of the program to the individual, how does the payment the woman actually receives compare to these other "true" measures of the welfare gain due to the program? Intuition would lead one to conclude that, since the payment, P, reflects a labor supply reduction due to both income and substitution effects of the program, this payment would tend to overestimate the value of the program to the woman. On the other hand, if one computes the payment the woman would receive if she had chosen to work the same number of hours as she did in the absence of the program, then this hypothetical payment, P_0, would underestimate the true welfare measures. In Appendix A we demonstrate that the above intuition is correct and that the four measures can be ranked in the following manner:

$$P_0 \leq CV \leq EV \leq P .$$

In the above discussion we have assumed that the woman is free to work her desired level of hours and that she is not limited in her choice, except by budget constraints. We showed that, in this case, the transfer payment serves as an upper bound of the value of the program to the household. We also obtained a lower bound, thus defining a range within which the true value of the program lies. How would these results change if the woman suffers a spell of involuntary unemployment? If she still decides not to participate, her evaluation of the program does not change, i.e., it remains zero. If, however, she participates, the woman will place a value on the program which is exactly equal to the payment she receives. For example, consider a woman who is participating in the program, becomes unemployed, and can only find $\bar{h} \leq h_1$ hours of work at the gross wage rate, w.[2] Her payment, P, will now equal $G - tY - tw\bar{h}$. In the absence of a program the woman would also work only $\bar{h}$ hours, so the hypothetical payment P_0 also equals $G - tY - tw\bar{h}$. Hence, it follows that

$$P_0 = CV = EV = P .$$

Thus, in this case, the benefit value of the program to the involuntarily unemployed woman is exactly equal to the transfer.

7.3 The Value of the Income Maintenance Program When the Household Faces Unemployment Uncertainty

In the previous section we explored how a woman would value the existence of an income maintenance program when all the relevant economic

2. A woman who, in the absence of involuntary unemployment, chooses not to participate may opt for participation if her working hours are restricted ($\bar{h} < h_0$). If her optimal working hours under participation, h_1, are less than $\bar{h}$, her evaluation would be equal to the certainty case in section 7.2. If $\bar{h} < h_1$, the value of the benefit again equals the payment.

constraints, including the occurrence of a spell of unemployment, are known to her. To a large extent this analysis should be considered an ex post evaluation of the program on the part of the woman. This ex post evaluation ignores an important feature of income maintenance programs: it insures the eligible population against reductions in their real standard of living. In the previous section, we concluded that when a woman suffers a reduction in her standard of living due to a spell of unemployment, she places an ex post value on the income maintenance program equal to the payment she receives.

However, if the woman could have found sufficient employment that made her ineligible for payments, ex post she would not place a value on the program. Obviously, ex post evaluations of income maintenance programs do not capture the insurance aspects that an income maintenance program possesses.

In order to capture this insurance aspect, it is necessary to introduce uncertainty in the decision-making process of the woman. The question now becomes: What is the value the woman places on the existence of the program if she has a probability of becoming unemployed, even though she is currently employed and not receiving a payment? One possibility is to use the expected payment, i.e., the payment she would receive if she became unemployed times the probability of becoming unemployed.[3] In this section we will show that this measure is likely to underestimate the value of the program to the woman.

In order to analyze this proposition, we first need to introduce the concept of unemployment uncertainty into the above framework. We will assume that the woman with a probability, π, will not be able to work any hours at wage rate, w. She will, with a probability $(1 - \pi)$, be able to work as many hours as she wishes at this same wage rate. Further, in order to simplify the analysis in this section, we assume a fairly restricted type of income maintenance program. If the woman is unable to work, she will receive a payment of P dollars from the government. However, she will receive nothing if she is employed.[4] Finally, we assume that she has no sources of income other than earnings, i.e., Y will be equal to zero.

The woman chooses her hours of work, h^*, so as to maximize her expected level of well-being. Formally, she chooses h^* so as to maximize:

$$EU = \pi U(P, T) + (1 - \pi)U(wh, T - h) .$$

3. See Long 1967 for an example. See also Smeeding 1982 for alternative approaches to valuing in-kind transfers.

4. The structure of this program resembles the unemployment insurance program; it could also be considered a description of the program seen in equation (1) where the tax rate (t) is set high enough so that the individual would not participate in the program if she were employed.

As Sjoquist (1976) has shown, the optimal choice of labor supply to the above problem is the same as the optimal solution to the labor supply decision under certainty, i.e., h^* will maximize $U(wh, T - h)$. Thus the optimal amount of labor supply for this problem will be solely a function of the wage rate (i.e., $h^* = h(w)$).

Now let the expected utility in the absence of the income maintenance program be denoted by:

$$EU_0 = \pi U(O, T) + (1 - \pi)U(wh^*, T - h^*) ;$$

and with the program be denoted by:

$$EU_1 = \pi U(P, T) + (1 - \pi)U(wh^*, T - h^*).$$

The question we now raise is how does the woman value the gain in her expected utility that the income maintenance program provides her?

Burton Weisbrod, in a pathbreaking article (Weisbrod 1964; see also Cicchetti and Freeman 1971; Graham 1981) argued that the appropriate measure of the woman's valuation of the program could be constructed by asking for the maximum certainty payment the woman would be willing to make to have the program in existence. He denoted this amount as the option price (*OP*). Using our notation, the option price can be defined such that

$$\pi U(P - OP, T) + (1 - \pi)U(wh^* - OP, T - h^*) = EU_0 . \tag{6}$$

As Graham (1981) has shown, the option price is just one of many measures one can utilize to measure the value of a program that insures the individual against some risk.[5] An alternative benefit measure is the expected surplus that the program yields. That is, if a given state occurs, the program yields a given amount of surplus to the individual. For each state this surplus can be measured by either the compensating variation or the equivalent variation discussed in the previous section. The expected surplus is then obtained by weighting the state-contingent surplus values by the probability that the state occurs. For example, in this section the woman receives no surplus if she is employed because she will not receive a payment in this state. However, her surplus will be P dollars if she is unem-

5. In this paper we have adopted as a measure of value the maximum certainty payment the individual would wish to make in order to have the program in existence. The use of the measure—the option price—is in keeping with the literature. However, upon further reflection, we have concluded that a more appropriate measure in the case of an income maintenance program would be the minimum certainty lump-sum payment the individual would require in order to be indifferent to the program's existence. When stated in this manner, we see that the option price is the uncertainty equivalent of the compensating variation measure, while the above alternative measure would have the equivalent variation as its certainty counterpart. If the relationship that exists between the compensating and equivalent variation holds up in the uncertainty case, then the option price would underestimate the value of the income maintenance program to the individual. Exploration of this issue represents our future work in this area.

ployed. Hence her expected surplus is πP, which in this simple case is equal to her expected payments from the program.

Following the literature, we will define the risk premium a woman places upon an income maintenance program as the difference between the option price and the expected surplus, i.e., the risk premium, RP, is equal to

$$RP = OP - ES,$$

where ES is the expected surplus. Thus in the above example the risk premium is equal to $(OP - \pi P)$.

7.3.1 Numerical Example

If we adopt the option price as our ex ante measure of the woman's valuation of the program, then it remains to explore whether or not the option price will exceed the woman's expected payment (expected surplus) from the program (πP). As Schmalensee (1972) and Henry (1974) have shown, the option price depends upon the individual's preferences and may or may not exceed the expected payment.[6]

Thus, first we have to specify the woman's preferences for income and leisure. One approach would be to specify a direct utility function, $U(X, l)$, and then to make some assumptions about the parameters of the function. Our approach is different. We will assume a given labor supply function and derive the implicit utility function from it. By doing so we can take empirical estimates of labor supply functions that appear in the literature as statements about the "average" woman's preferences for income and leisure. In particular, we assume the linear labor supply function

$$h = \delta + \alpha w + \beta Y, \tag{7}$$

where δ, α, and β are all constant parameters that may depend upon the individual's demographic characteristics. If the labor supply function takes the above functional form, the expenditure function can be written as (Sheppard's lemma):

$$E(w, U) = (\alpha - \beta(\delta + \alpha w))/\beta^2 + U\exp(-\beta w); \tag{8}$$

or in terms of the direct utility function:

$$U(X, h) = ((\beta h - \alpha)/\beta^2)\exp(\beta(\delta + \beta X - h)/(\beta h - \alpha)).^7 \tag{9}$$

For the purposes of this paper, we chose to utilize the estimates of the linear labor supply function from the Hausman study (Hausman 1981). In

6. In Appendix B, we derive a sufficient condition for the option price to exceed the expected value of the payment.

7. It should be noted that the utility function for the linear labor supply function meets our sufficient conditions for OP to exceed the expected payments from the program for all payments P that are less than an amount roughly equal to $15,000 per year.

Table 7.1 **Values of Option Price (OP) and Risk Premium (RP) Computed from Equation (6)**

	Wage Rate					
	$3.00		$4.00		$5.00	
Probability of Unemployment	OP	RP	OP	RP	OP	RP
0.90	$3,786	$186	$3,794	$194	$3,798	$198
0.75	3,404	404	3,440	440	3,449	449
0.50	2,680	610	2,680	701	2,698	698
0.25	1,530	530	1,606	606	1,625	625
0.10	681	281	727	327	738	338

Source: Calculations by authors.

Notes: Figures computed for a female head under forty-five years of age who has one child aged six. P = $4,000.

this study, Hausman has estimated that for female-headed households (i.e., households with children present and only one, female, adult), α equals 0.3509 while an average β is equal to -0.122. The intercept term (δ) in the Hausman study was made a function of several demographic characteristics such as age and family composition. For the numerical example in this paper, we chose a female who is less than forty-five-years-old and has one child under six years of age. A woman with these characteristics has a value of δ of 1.0563. It should be noted that hours of work are measured in the Hausman study in terms of annual hours of work (in thousands), while Y is also measured in thousands of dollars per year.

Finally, we chose to simulate a value of $4,000 for P—the payment the woman would receive if she became unemployed. In order to examine how the risk premium and option price would vary for other parameters of the problem, we computed these variables utilizing various wage rates ($3.00, $4.00, and $5.00) and for various probabilities of becoming unemployed (0.10, 0.25, 0.50, 0.75, and 0.90). The results of these computations, using equation (6) and the above assumptions, appear in table 7.1.

As the numbers in table 7.1 illustrate, the risk premium that a woman places upon an unemployment contingent payment of $4,000 can be quite large. As one would expect, the option price declines as the probability of unemployment declines. However the risk premium does not possess this same monotonic behavior. First, we note that the risk premium actually rises initially with a decline in the probability of unemployment and then starts to decline when the probability of unemployment falls below 50 percent.[8] Second, reading across table 7.1 we see that the risk premium rises with the wage rate of the woman holding the probability of unemployment constant.

8. While the risk premium shows an inverted U-shape pattern, the ratio of the risk premium to the expected surplus is monotonically increasing with the probability of employment. For a similar result, see Freeman 1984.

Maybe the most important result of table 7.1 is that it illustrates the magnitude of the potential error one makes by using either the actual payments received (ex post analysis), or the use of expected payment from the program as the program's value to the household. To illustrate this, consider two women, one with a wage rate of $3.00 and 90 percent probability of becoming unemployed (ex ante) and the other with a $5.00 wage rate and a 10 percent chance of becoming unemployed. For the sake of argument let us assume that the low-wage woman becomes unemployed and the high-wage woman does not. Ex post considerations would indicate that the low-wage woman benefited by $4,000 from the program while the high-wage woman did not benefit at all. Using the expected payments from the program as a measure of the program's benefits we would be led to say that the low-wage woman values the program at $3,600 and the high-wage woman at $400. However, as the calculations in table 7.1 indicate, either one of these measures will tend to impart different kinds of biases into the measure of the value of the program to the individual women. For the low-wage woman who receives a payment, the use of the actual payment received ($4,000) overstates the value of the program to her ($3,786), while the use of the expected payment ($3,600) underestimates the value of the program because it ignores the risk premium. For the high-wage woman a different relationship emerges. Both the actual payment (zero) and the expected payment ($400) underestimate the value of the program to her ($738).

While there are differential effects on the two women, the results in the aggregate are clear. The total value the two women place upon the existence of the program ($4,524) is 13 percent higher than the actual payments (or the sum of the expected payments). The implications for the distributional effects of the program are also quite clear. The use of the actual payments would indicate that 100 percent of the total benefits are received by the low-wage woman, while the use of the expected payments would indicate that 90 percent of the benefits of the program went to her. However, the use of the option price measure of value indicates that only 84 percent of the total benefits would accrue to the low-wage woman. If the results of our example are indicative for the population as a whole, we have to conclude that the use of either the actual or the expected payment would overestimate the redistributive effects of income maintenance programs such as the one we simulated in the above example, and will serve to underestimate the total benefits the group receives from the program.

7.4 An Expanded Notion of Uncertainty

In the previous section we examined the extent to which a woman would place a risk premium on her expected payments from a specific unemployment contingent program. To clarify the issues and presentation we made some admittedly simplifying assumptions. The most crucial one was the way in which we characterized employment uncertainty: Previously, we assumed the woman faced only two states—employment and the ability to work as much as she wishes at a prespecified wage rate that was known to her in advance, or unemployment. In this section we shall expand our concept of uncertainty by treating the real wage as a random variable.[9] This implies a continuum of employment states with hours worked (and corresponding earnings) dependent upon this stochastic wage rate. We shall also introduce a somewhat more realistic income maintenance program: the woman is now assumed to be eligible for payments as long as her income does not exceed a given level, regardless of her state of employment. Thus, this income maintenance program insures the women against a drop in her level of well-being due to unemployment or due to an unlucky draw from the distribution of wages.

In order to measure the value that the woman places upon this insurance protection, we will need to modify equation (6) to reflect the uncertainty about the wage rate. First, let us assume that the woman possesses a subjective probability function over real wages, $f(w)$. Given that we will continue to characterize employment uncertainty as a two-state occurrence (employment at hours desired, given the stochastic wage rate, or no employment at all), we can modify equation (6) to define the option price, OP, such that

$$EU_1 = EU_0, \tag{10}$$

where

$$EU_0 = \pi U(O,T) + (1 - \pi) \int_0^\infty U(wh_0^*, T - h_0^*)f(w)dw$$

with

h_0^* = the hours that maximize the expected utility when there is no program,

and

$$EU_1 = \pi U(G - OP, T) + (1 - \pi) \int_0^\infty U(wh_1^* + P^* - OP, T - h_1^*)f(w)dw$$

with

h_1^* = the hours that maximize the expected utility when there is an income maintenance program,

9. See Block and Heineke 1973 and Cowell 1981 for the treatment of wage uncertainty in the absence and presence of income maintenance programs respectively.

where $$P^* = \begin{cases} G - twh_1^* & \text{if } h_1^* < G/tw, \\ 0 & \text{if } h_1^* \geq G/tw. \end{cases}$$

Before turning to some numerical calculations of the value that a woman might place upon an income maintenance program given the above characterization of the environment, we wish to remind the reader that two important distinctions must be made between the numerical calculations below and the previous ones. First, in the previous example we considered only unemployment contingent payments. In the current example the woman will be eligible for a payment not only if she is unemployed but also if she is employed and her earnings are less than G/t. This "extension" of the income maintenance program is, of course, likely to increase the option price significantly. Second, in the previous example the labor supply decision is made with no regard to the payment she would receive if she became unemployed. However, in the current example her decision of how much labor to supply will depend not only on the distribution of wages, but also on G and t, since she may be eligible for a payment if her real earnings fall below G/t.

7.4.1 Numerical Example

In order to compute numerical values for the option price and other variables of interest, the only additional concept that needs to be quantified from our previous example is the distribution of real wage rates. We have assumed that wages are distributed normally. Note that the symmetry of the normal distribution implies that we implicitly assume that the woman expects her potential real wage rate to remain unchanged. We choose three values for the mean of the distribution, corresponding to the wage rates utilized earlier: \$3.00, \$4.00 and \$5.00. In all cases, we utilize a standard deviation of \$.25.

Table 7.2 presents the numerical values for the option value, expected surplus, expected payment, and risk premium a woman with one child would place upon an income maintenance program as described by equation (1), where G is equal to \$4,000 and t is equal to 0.50. The expected surplus presented in table 7.2 is defined to be the expected compensating variation, i.e.,

$$ES = \pi G + (1 - \pi) \int_0^\infty CV(w) f(w)\, dw,$$

where $CV(w)$ is such that

$$U(wh_1^* + P^* - CV(w), T - h_1^*) = U(wh_0^*, T - h_0^*)$$

for all w. From the above definition of the expected surplus, we note that if h_0^* is equal to h_1^*, the compensating variation given a specific wage rate will be equal to the payment the woman receives. Hence if this condition is met, the expected surplus will be equal to the expected payment the woman

Table 7.2 **Values of Option Price and Risk Premium Computed Using Equation (10)**

Probability of Unemployment	OP	ES	EP	RP
	$3.00 Wage Rate			
0.90	$3,834	$3,761	$3,830	$ 73
0.75	3,565	3,403	3,590	155
0.50	3,014	2,807	3,179	207
0.25	2,333	2,210	2,769	123
0.10	1,831	1,803	2,522	28
	$4.00 Wage Rate			
0.90	$3,795	$3,602	$3,602	$193
0.75	3,441	3,006	3,006	435
0.50	3,682	2,012	2,012	670
0.25	1,607	1,018	1,018	589
0.10	728	403	403	325
	$5.00 Wage Rate			
0.90	$3,798	$3,600	$3,600	$198
0.75	3,449	3,000	3,000	449
0.50	2,690	2,000	2,000	698
0.25	1,625	1,000	1,000	625
0.10	738	400	400	338

Source: Calculations made by authors.

Notes: Figures computed for a female head under forty-five years of age who has one child aged six. G = $4,000; t = 0.50.

receives. However, if h_1^* is less than h_0^* as we would expect in this example, then, as has been shown in section 7.2, the payment the woman receives will always exceed the compensating variation for all wage rates. Hence in the case where there is a labor supply reduction in response to the program, the expected payment will always exceed the expected surplus. Finally, we would like to remind the reader that the risk premium is defined to be equal to the difference between the option price and the expected surplus.

Let us begin by comparing the numerical values of the option price computed here with the ones in our previous example. As expected, the option prices in table 7.2 are much larger than those in table 7.1. For instance, the option prices rose from $681 to $1,831 for a woman with an (expected) wage rate of $3.00 and a 10 percent probability of becoming unemployed. The main cause of the increase in the value of the option price is the extension of the program, which now provides a real-income floor even when employed. This, of course, is especially valuable for a woman with a low expected wage rate, since given her distribution of real wage rates she is most likely to be eligible for payments from the program. For the women with a higher expected wage rate, the option prices calculated in tables 7.1 and 7.2 are essentially the same because if these women are employed they have only a very small probability of receiving a payment, due to their distribution of wages.

As noted above, if a labor supply reduction occurs due to the program, the expected payments will exceed the expected surplus the woman receives from the program. For the low-wage woman (the \$3.00 expected wage rate case), the difference between the two concepts is significant and reflects the effects of a large labor supply reduction in the order of 30 percent. However, for the higher wage women there is no difference between these two concepts, reflecting the fact that for these women a reduction in their labor supply does not occur due to the program.

From table 7.2 we note that the expected surplus never exceeds the option price. Consequently, the risk premium is always positive. Also, the U-shaped pattern of risk premiums that was present in the earlier example is present in this example.

While in general the calculations indicate that the relationships between the various concepts in this example are similar to those in the previous example, one major difference does appear. This difference is between the value of the option price and the expected payments. In the previous example, the option price always exceeded the expected payments to the women in all cases. However, for the low-wage woman, the expected payment exceeds the option price in all cases except when the probability of unemployment is high. A rational for why this reversal occurs and why the difference widens as the probability of employment increases, eludes us at this time and is an area for further examination.

The possibility that the expected payments exceed the option price for some cases in table 7.2 causes us to soften some of our conclusions presented in the previous example. Since the option price always exceeds the expected payments, we could conclude that use of either the actual payments or expected payments would underestimate the aggregate value of the program. Further, either of these methods would tend to overestimate the redistribution that was accomplished by the program. While the second conclusion will remain, it should be noted that since it is possible that the expected payment exceeds the option price for low-wage-rate women, it is possible in the aggregate that the payments made to individuals exceed the sum of individual option prices.

7.5 Conclusions

In this chapter we have examined the relationship between the payment the household receives and the value the household would place upon the program that either transfers or potentially transfers income to the household. In the case of certainty and with benefit payments only in the case of unemployment, we concluded that the payment the household receives provides an upper bound to the value the household places upon the program. Using the option price as the "correct" measure of the value of the program, we showed that the expected value of the payment, i.e., the payment times the probability of being unemployed, tends to underestimate the value of the program to the population in general and to each household individually. In the numerical examples presented, the risk premium, i.e., the difference between the expected value and the option price, ranged from $186 for a low-wage/high-probability-of-unemployment woman, to $698 for a high-wage woman with a 50 percent probability of unemployment. The corresponding values of the expected payments of the program were $3,600 and $2,000 respectively. Consequently, the use of expected payments as the value of the program to the households will overestimate the distributional impact of the program.

We then discussed a more realistic case with wage rate uncertainty, where the program made payments to a woman as long as her earned income did not exceed a certain amount. Given that the program now insures against erosions in a household's real income even when a woman is employed, it came as no surprise to find that for a woman with a low expected wage rate, the option prices were even larger than in the first case. This was almost entirely the result of the extension of the program. For a woman facing a higher wage rate this extension had no effect on the option price. To summarize our results somewhat differently: the difference between the value of expected payments and the option price is large for those cases where large behavioral responses to the program can be expected.

The methodology to measure the value of welfare programs, as developed in this chapter, has a wide range of applications. In principle it is straightforward, once the option price is accepted as the value of the program. In order to calculate this option price, one needs information not only on what benefits are potentially available to the individual, but also on the distribution of real-wage rates, probability of unemployment, and the individual's preferences over the various alternatives, i.e., a utility function. While in principle the first three elements needed to compute the option price can be inferred from various data sources, the individual's preferences are conceptually more difficult to specify. What we have demonstrated in this paper is that observations on labor supply behavior can—through Sheppard's lemma—yield such a utility function.

We should stress, however, that our results are based on one labor supply function (and thus one particular income-leisure preference ordering) only, as applied to a selected set of hypothetical households. As a next step in our research we need to analyze a "real" sample of household data (like a CPS), estimate various specifications of the labor supply function for female heads, and use the observed distributions of the probability of unemployment and the wage rate to estimate the value of, say, AFDC or food stamp programs. As our examples indicate, the differences between the option price on the one hand and such commonly used measures as payment received or expected benefits on the other hand, are large enough to warrant such a study, especially when the focus is on the distributional aspects of the program.

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Appendix A

Demonstration That the Income Maintenance Payment Will Exceed the Traditional Benefit Measures

In order to show that the payment a woman receives from the program exceeds either of the two benefit measures, we will first show that EV will always be as great as CV. Using equations (3) and (5) for EV and CV, we can state that

$$CV \gtreqless EV$$

if and only if

$$E((1-t)w, V_1) - E((1-t)w, V_0) \gtreqless E(w, V_1) - E(w, V_0);$$

or equivalently,

$$E((1-t)w, V_1) - E(w, V_1) \gtreqless E((1-t)w, V_0) - E(w, V_0).$$

Because the woman is participating in the program, V_1 will exceed V_0. If leisure is a normal good (i.e., the marginal utility of leisure is decreasing in l), then

$$E((1-t)w, V_1) - E(w, V_1) \leq E((1-t)w, V_0) - E(w, V_0).$$

Hence

$$CV \leq EV.$$

Now we will demonstrate that the transfer the household receives from the program will exceed EV. First, let the transfer be equal to P, i.e.,

$$P = G - tY - twh_1,$$

where

$$h_1 = h((1-t)w, G + (1-t)Y).$$

Furthermore, from equation (4),

$$EV \gtreqless P$$

if and only if

$$G - tY + E(w, V_1) - E((1-t)w, V_1) \gtreqless G - tY - twh_1,$$

or equivalently,

$$E(w, V_1) \gtreqless E((1-t)w, V_1) - twh_1.$$

In order to determine which condition will hold, first note that if $\tilde{h}(w, U)$ is the Hicksian labor supply function, then

$$h_1 = \tilde{h}((1 - t)w, V_1).$$

Next note that due to the derivative property of the expenditure function (Sheppard's lemma), the derivation of the expenditure function with respect to the wage is equal to minus the Hicksian labor supply function,

$$\partial E(w, U)/\partial w = -\tilde{h}(w, U) .$$

Because the expenditure function is concave in w,

$$E(w, V_1) \leq E((1 - t)w, V_1) + tw(\partial E((1 - t)w, V_1)/\partial w)$$

(this inequality is known as the Könus inequality), or equivalently,

$$E(w, U_1) \leq E((1 - t)w, U_1) - twh_1.$$

Hence the payment P exceeds the equivalent variation measure of a woman's gain in well-being caused by the existence of the income maintenance program. Since we have shown that EV will always exceed CV, this payment will also exceed the compensating variation measure.

Let us now define an alternative payment, P_0, which is the (hypothetical) payment a woman would receive if she worked the same number of hours under the program as she would in the absence of the program. Let

$$P_0 = G - tY - twh_0$$

where

$$h_0 = h(w, Y) .$$

Now by the same line of argument as used above, we can demonstrate that

$$P_0 \leq CV .$$

Hence we can use the two payments, P_0 and P, to bound the appropriate benefit measures, i.e.,

$$P_0 \leq CV \leq EV \leq P .$$

Appendix B

A Sufficient Condition for the Option Value to Exceed the Expected Payments from a Program

While we have not been able to establish necessary and sufficient conditions for OP to exceed πP, we have been able to establish a sufficient condition that we believe is likely and plausible. Formally, for the risk premium to be positive, the marginal utility of income at $(1 - \pi)P$ dollars of income and T hours of leisure must exceed the marginal utility of income at $wh^* - \pi P$ dollars of income and $T - h^*$ hours of leisure.

In order to demonstrate this, note (from equation 6) that if the marginal utility of income (U_X) is positive for all X and l, then

$$OP > \pi P \text{ if and only if}$$

$$\pi U((1 - \pi)P, T) + (1 - \pi)U(wh^* - \pi P, T - h^*) > EU_0,$$

which can be rewritten as

$$OP > \pi P \text{ if and only if}$$

$$\frac{\pi}{1 - \pi} > \frac{U(wh^*, T - h^*) - U(wh^* - \pi P, T - h^*)}{U((1 - \pi)P, T) - U(O, T)}$$

Now due to the concavity of U

$$\pi P\, U_X(wh^* - \pi P, T - h^*) > U(wh^*, T - h^*) - U(wh^* - \pi P, T - h^*)$$

and

$$(1 - \pi)P\, U_X((1 - \pi)P, T) < U((1 - \pi)P, T) - U(O, T)\ .$$

Thus

$$\frac{U(wh^*, T - h^*) - U(wh^* - \pi P, T - h^*)}{U((1 - \pi)P, T) - U(O, T)} < \frac{\pi\, U_X(wh^* - \pi P, T - h^*)}{(1 - \pi)\, U_X((1 - \pi)P, T)}\ .$$

Hence if $U_X(wh^* - \pi P, T - h^*)$ is less than $U_X((1 - \pi)P, T)$ then the option price will exceed the expected payment to a woman, πP. While concavity of the utility function is not enough to guarantee that the above sufficient condition will hold (note that concavity of the utility function is the same assumption as risk aversion), the examples in section 7.4 indicate that this condition is likely to be met for reasonable values of P, w, and π.

It might prove useful to amplify the significance of the above result. Let us consider a population of N female-headed households each facing a prospect of becoming unemployed with probability π. In any given year we would observe that πN of the women were unemployed and receiving P dollars; as presented above, each woman in the population would be willing to pay up to OP dollars each year to have the program in existence. This means that $N(OP)$ dollars can be collected from the population. Thus if our sufficient condition is met, the women in the population will collectively value the program in excess of the payments that are made to the group.

Comment F. Thomas Juster

The Betson/van der Gaag chapter is concerned with assessing the consequences for the evaluation of income maintenance programs of introducing uncertainty both about hours of work and real-wage rates. The chapter has five sections: the first is an introduction, the second examines valuation issues under conventional assumptions of no uncertainty, the third extends the valuation analysis to uncertainty about hours of work, the fourth extends the analysis further to uncertainty about real-wage rates, and the fifth and last section provides a summary and discussion of policy implications.

In section 7.2 the authors demonstrate that alternative measures of program benefits can be derived from a household utility function in which consumption and leisure are the arguments, and that these welfare-oriented benefit measures can be shown to lie between two observable benefit measures. One observable measure is the actual payments received by a female head of household who participates in an income maintenance program, such as AFDC or food stamps, which is shown to be an upper bound. The other is the payment that the woman would receive if she worked the same number of hours in the absence of the program as she chose to work, given the incentive structure contained by the program, which is the lower bound.

Two features of this analysis are worth noting. First, the two alternative welfare-oriented benefit measures, discussed in the literature as the compensating variation and the equivalent variation, require valuation measures based on questions that are not likely to be answerable in any straightforward manner. The welfare measures are obtained from the answers to questions concerning counterfactual situations, and there is no reason to believe that people can provide useful answers to questions of that sort. Second, the analysis makes the conventional assumptions about utility functions—that the arguments are consumption and leisure and that both are decreasing and positive throughout.

In section 7.3 the analysis is extended to a situation where hours of work are uncertain because some probability, π, of unemployment exists. Thus hours of work equal either the preferred amount given the utility function and the opportunity set, or equal zero because of unemployment. It is further assumed that those who become unemployed will participate in the program, while those who do not become unemployed will not be eligible for the program (it ensures only against uncertainty with respect to hours of work, not real income).

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Given that model, the authors argue that the program can be evaluated by finding the maximum payment that those potentially eligible for the program would be willing to make to have the program in existence—this amount is defined as the option price (*OP*). The remainder of this section explores the circumstances under which the option price can be expected to exceed the expected value of the payments to potential participants. The difference between the option price and the expected payment is defined as the risk premium—the value of the hedge against uncertain hours represented by the program's existence.

Numerical estimates of the risk premium are derived in the paper by specifying the parameters of a particular labor supply function, originally estimated for female-headed households with children present. The basic purpose of this exercise is to calculate the distributional consequences of the program by comparing the distribution of option prices (which includes risk premiums) with the distribution of expected payments. The conclusion is that existence of a program that hedges against uncertainty in work hours provides relatively more benefits to higher-wage workers with low probabilities of becoming unemployed than would be inferred from observing the actual distribution of program payments. That is, the distribution of program benefits as measured by the option price suggests that more benefits would go to high-wage workers than would appear to be true from simply observing the distribution of actual payments. Thus a program that hedges against hours uncertainty will be less redistributive than a program in which hours uncertainty is absent.

In the next section, the analysis of uncertainty effects is extended to cover uncertainty about real-wage rates. For this analysis the authors assume a normal distribution of real-wage expectations, with a standard deviation of \$1.00 per hour at alternative specified levels of the mean of that distribution.

Working through the same kinds of numerical example as used in the earlier section, the value of the program to potential participants as measured by the estimated option price is substantially greater, especially for low-wage workers with relatively low probability of becoming unemployed. The reason is not that the hedge against real-wage uncertainty is especially valuable for these workers, but that the basic structure of the program is modified so that people who are employed at low-wage rates become eligible. Thus the substantial increase in the value of the program for some categories of workers is not a consequence of wage-rate uncertainty, but occurs because low-wage workers are covered by the program even if they are employed, while in the analysis in the previous section, coverage was contingent on becoming unemployed.

It should be noted that the higher option prices for most workers in the hypothetical examples provided are seriously overstated because of the assumptions about real-wage uncertainty. A standard deviation of $1.00 with an expected mean of $3.00, $5.00, or $7.00 implies an enormous amount of real-wage uncertainty relative to what one would expect to find in the real world. The authors are not talking here about real-wage uncertainty as reflected by what kind of job people might be able to obtain, but simply about uncertainty as reflected by the difference between rates of price inflation and rates of inflation in nominal wage rates. Uncertainty of this sort is in fact trivial in quantitative terms: under extreme conditions one might visualize a rate of price inflation of 10 percent associated with stability in nominal wages, hence a real wage cut of 10 percent. But that would imply a standard deviation of expected real-wage rates that would be much smaller than any of the numerical examples used in the paper, hence the real-wage effect is seriously exaggerated in the calculations that are shown by the authors.

The principal difficulties with the paper are twofold. First, the calculations are not carried out on a real sample of the U.S. population, thus providing the reader with an assessment of the distributional consequences of these uncertainty considerations by using data that represent the right proportions of individuals with different wage rates, different employment/unemployment experiences, different serial correlation properties in the incidence of unemployment, and so on. In the real world, just how much consideration of the uncertainty issue would modify the distribution of benefits as reflected by the distribution of actual payments is not at all clear from the paper, although I would guess that the two distributions would not differ very much from each other. Since the main concern of the paper is the effect on the benefit distribution of taking account of both hours and wage-rate uncertainty, the importance of these considerations cannot really be assessed without applying the model to real distributions. There are of course numerous bodies of data on which such a calculation could be made.

The more serious problems with the paper are less easily fixed. The authors use a conventional welfare function in which utility is a function of income and leisure. Unemployment affects that welfare function in two ways: by increasing the amount of (valuable) leisure time, which in the model augments welfare, and by reducing income, which lowers welfare. The latter effect is stronger, hence welfare is reduced on balance. While there may be population elements where the increased leisure resulting from unemployment is a welfare-enhancing element, substantial evidence exists in the psychological literature that there are population elements where increased leisure of this form does not create any welfare enhancement at all, and in fact may reduce the value of leisure time generally. Aside from the long-term consequences of unemployment for conventional human capital theory, parts of the population probably assess unemployment-induced increases in their leisure time as a net disbenefit, over and above the real income loss. The principal point I would make is that imposing the same utility function on everyone may not be very good social science, and may be seriously misleading when it comes to analysis of the utility attached to various programs.

The notion that the utility from being unemployed cannot be well represented by seeing it as simply an increase in leisure time is reflective of a more general issue related to the usual form of utility functions in the economic literature. Specifying the utility function as a combination of income plus leisure really amounts to the view that utility is produced by the combination of *ex*trinsic rewards from one kind of activity (work for pay in the market), plus *in*trinsic rewards from other activities (leisure). But work for pay may also carry intrinsic rewards, and the conventional model simply suggests that they are fully accounted for in the equilibrium choice between work and leisure—the marginal intrinsic rewards attached to work being part of the utility obtained from the last hour worked.

The available literature here is concerned with the existence of compensating wage differentials, which equate the mixture of extrinsic and intrinsic rewards from various types of work by providing monetary offsets to any intrinsic rewards differential. Attempts to test that idea have not been notably successful (see Duncan and Holmlund 1983), although some evidence exists that particular kinds of intrinsic differences in work situations are associated with monetary wage differentials.

More generally, recent data obtained in conjunction with research on nonmarket activities have turned up some results that may be fundamentally inconsistent with much of the conventional utility function literature (see Juster, forthcoming; Dow and Juster, forthcoming). As part of a data base focused on the nonmarket activities of households, we obtained direct measurements of intrinsic rewards (not at the margin, but on average), for a variety of activities that included leisure, work for pay, and work in the home. Conventional utility theory would suggest that these intrinsic satisfaction data should show that leisure outranks work and that interesting, challenging, and pleasant jobs outrank dull, routine, and distasteful jobs. But the data do not show these patterns: work outranks leisure with respect to intrinsic satisfactions, and that result is not due to the fact that the intrinsic satisfaction measures for work represent a mixture of intrinsic and extrinsic rewards. Jobs of all sorts appear to provide about the same level of intrinsic satisfactions.

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