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LABOR MARKETS AND EVALUATIONS OF VOCATIONAL TRAINING PROGRAMS IN THE PUBLIC HIGH SCHOOLS - TOWARD A FRAMEWORK FOR ANALYSIS

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ABSTRACT

A simplified model is constructed to analyze the role played by vocational training programs in high schools. The model assumes that there are two kinds of educational programs in high schools, vocational and general. It also assumes that there are two types of jobs for high school graduates. One job requires training that either can be obtained from a vocational program in high school or as general training on the job. The other job has no special training requirements.

The model is used in two ways. First, it is used to examine how the equilibrium outcome is affected by limitations on the number of places in the vocational training program and by the minimum wage. Second, it helps to determine what can be learned from studies that take what has become a standard approach to evaluating high school vocational training programs - attempting to estimate the productivity of these programs by comparing the earnings of vocational and nonvocational program graduates.

We conclude that whether or not limitations on enrollments in vocational programs and minimum wages influence the wage difference between vocational and nonvocational program graduates, findings based on the standard approach to cost-benefit analysis of high school vocational training programs may prove to be highly misleading guides for policy.

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Vocational training is a frequently elected program in high schools. Of the more than 22,000 high school seniors included in the National Longitudinal Survey of the high school class of 1972, fully 24 percent followed this course of study. As may be expected for a large public program, there have been a number of studies attempting to evaluate vocational education programs in the public schools. Commonly, the evaluation consists of measuring the difference in earnings and employment experience between those who enroll in vocational programs and those who do not, and making a comparison of the appropriate differential with program costs. Considerable effort has been made by some researchers to standardize for differences in students' backgrounds, abilities and non-observable characteristics, and for variation in program quality.[1] However, few of these studies question whether earnings or employment differentials are really an appropriate measure of the value of vocational programs.

Presumably, the principal issue is the effect of a vocational program on economic welfare. To measure the effect of a vocational program, one must compare economic welfare in the presence and absence of such a program. It is not sufficient simply to measure the differences in circumstances between those who enroll in the program and those who do not. Indeed, we will show that under some circumstances a program may be associated with a narrow or even no differential, and yet it may have a large positive effect on the overall economic welfare of all students.[2]

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[1] Earlier studies of this type include Taussig (1968) and Corazzini (1968). Meyer and Wise (1979) conclude that high school vocational programs are not productive after finding no difference in earnings or employment experience between those who had enrolled in the program and those who had not.

[2] We do not focus in this analysis on social as well as private returns to vocational programs. Our main focus is on how to measure the benefits from vocational training programs accruing to high school graduates. A complete discussion would consider the effects of the program on the returns to other factors, and would also consider the effects of taxes used to finance any additional costs of vocational training in high schools.

These ideas will be further explored in the remainder of the paper. A simple model with two kinds of jobs and two kinds of high school programs will serve as a basis of analysis. The economic welfare of the students will be approximated by the present value of their earnings. It will be seen how various features of the labor market--e.g., the demand for vocationally trained workers and for other workers, the cost of alternative on-the-job training programs, and the size of the vocational training program itself--all help to determine the level of these earnings. In addition, the analysis will investigate how these same features influence the earnings differentials between those who have completed a vocational course of study and those who have not. This will help to illuminate the relationship between the level of earnings and the earnings differentials measured by many studies. There is also an interesting sidelight to our analysis. Feldstein (1973), Mattila (1978) and Mincer and Leighton (1979) have all noted that minimum wages may limit the extent of general on-the-job training because such training is financed by a reduction in wages during the training period, and a floor on wages limits any wage reduction. An expected result is that jobs will be less available to those who are untrained, opportunities for on-the-job training will be reduced in the face of a minimum wage, and there will be some tendency to prolong schooling.[3] Our model permits an analysis of the impact of the minimum wage in a setting which has not been considered previously. We find that an effect of a successful vocational training program in the high schools would be to mitigate the adverse impact of the minimum wage.

Before turning to a discussion of the basic model, one point should be emphasized. This paper simply assumes that the vocational education program

[3] For evidence consistent with this scenario, see also Gustman and Steinmeier (1979).

is effective and then analyzes its potential impact in the labor market. It provides no evidence on whether the program is actually effective. Such evidence may be provided by subsequent empirical tests of the model. The analysis does imply, however, that negative findings of earlier empirical studies--findings of no difference in earnings between vocational program and other high school graduates (e.g., see Meyer and Wise, 1979)--need not imply that vocational training is ineffective.

Section I explores the impact of vocational education in a model with an inelastic supply of high school graduates and with no effective minimum wage. The possible effects of having the alternative of dropping out of school or continuing beyond high school is introduced in the form of a positively sloped supply curve in Section II. Section III analyzes the effects of a vocational program in the face of a minimum wage. An issue which needs to be considered when estimating the returns to vocational training is discussed in Section IV, while V contains some concluding comments.

I

To keep the model as simple as possible, while retaining essential elements of behavior, we assume that high school students may enroll in only two kinds of programs, called here vocational training and other high school training. Upon graduation, they may work in two kinds of jobs, denoted as T-type and O-type jobs. The T-type jobs require training which may be obtained either on-the-job or by enrolling in a vocational program in high school. The training is general rather than specific--i.e., it is of use to more than one firm (Becker, 1975). The O-type jobs require only a traditional high school education. Young people with similar training are assumed to be equally productive when employed in similar jobs, and on-the-job training and high school vocational training are assumed to be equally effective preparation for T-type jobs.

Consider first a model in which there is a fixed number of students, $\bar{N}$, who will be graduating from high school and entering the labor market. These students are presumed to prefer very slightly nonvocational programs and to be indifferent between the two types of jobs available after graduation.[4] A further important simplification is that the role of uncertainty is ignored. Future wages are known with accuracy, and no account is taken of the possibility that a student might want to change his or her mind after enrolling in one high school program or the other. Thus any difference in the "option" value of the two programs associated with the greater acceptability of graduates of one of the programs to institutions of higher education is ignored. Finally, perfect capital markets are assumed. This implies that students are concerned with the present value of their earnings streams and not with the distribution of those earnings over time.

For students choosing the vocational training program, the present value of their earnings streams is given by

$$W_V = \int_{\Omega} w_T e^{-\gamma t} dt$$

where w_T is the annual wage in T-type jobs, Ω is the time period over which the student expects to work, and γ is the net effect of real wage growth and the discount rate over time. Throughout this paper, upper case W's refer to

[4] We assume the difference in preference is so small it will create an imperceptible compensating differential in the wage. While it would not be difficult to incorporate explicitly a strong differential preference for general or vocational schooling, the presentation would be complicated without changing the thrust of the analysis. The very slight preference is enough to insure that in the model students do not elect a vocational program while never intending to use the training.

discounted earnings streams, and lower case w's refer to annual wages. Defining the constant k as

$$k = \int_{\Omega} e^{-\gamma t} dt,$$

the discounted earnings stream for a student electing the vocational training program is

$$W_v = kw_T.$$

For students enrolled in other high school programs, the discounted earnings stream in O-type jobs is similarly given by

$$W_O = \int_{\Omega} w_O e^{-\gamma t} dt = kw_O,$$

where w_O is the annual wage in O-type jobs.

Students in other high school programs who later engage in on-the-job training for T-type jobs must divide their working life into two parts. During the first part, denoted by Ω_1, they must accept an annual wage below w_T, reflecting both the direct costs of training and the reduced productivity during the training period. If this amount is given by an amount "a" per year, then the net annual wage to these workers during the period of on-the-job training is w_T - a. During the remainder of their working life, denoted by Ω_2, they receive the usual wage for people working in T-type jobs, w_T. Thus, the present value of wages for people electing on-the-job training is

$$W_t = \int_{\Omega_1} (w_T - a) e^{-\gamma t} dt + \int_{\Omega_2} w_T e^{-\gamma t} dt.$$

Defining the constant k' as

$$k' = \int_{\Omega_1} e^{-\gamma t} dt,$$

the present value may be rewritten as

$$W_t = kw_T - k'a = W_v - k'a.$$

Note that, by construction, $k' < k$.

Now consider the determination of the wage levels, w_T and w_O, for the two types of jobs. On the demand side, wages for workers of the generation under consideration are given by the net demand equations

$$w_T = d_T(N_v + N_t)$$

$$w_O = d_O(N_O),$$

where N_O is the number of workers in O-type jobs and where N_v and N_t are the numbers of workers in T-type jobs who have had vocational and on-the-job training, respectively. Lower case d's indicate demand functions in terms of annual wages, while the upper case D's used later represent demand functions in terms of discounted wage streams. On the supply side, workers are presumed to choose their participation in vocational or on-the-job training to maximize the present value of their earnings. This is subject to the constraint that the number of workers who have undergone vocational training cannot exceed the capacity of the vocational training program, given by C.

Let us begin the analysis with two extreme cases. The first case supposes that vocational training is available to all who desire it. Under such circumstances, it is clear that no one will opt for on-the-job training, since the present value for earnings for vocationally trained persons is higher by an amount k'a than for on-the-job trained persons. Students will elect vocational training until wages for vocationally trained persons are driven down to the same level as those for students in the other high school programs.

Figure 1 illustrates the result. $D_O(N_O) = kd_O(N_O)$ is the demand function for high school graduates in O-type jobs, expressed in terms of the discounted earnings stream.[5] With $N_t = 0$, $D_v(N_v) = kd_T(N_v)$ is the corresponding demand function for vocational training graduates. Students elect the vocational training program until wages there are equalized with the earnings of other program graduates. This occurs at a present value earnings level of W**, with a corresponding yearly wage of w**. N_v^{**} students elect the vocational training program and N_O^{**} students the other high school programs, with $N_v^{**} + N_O^{**} = \bar{N}$.

The other extreme case occurs when vocational training is not available at all in the high schools. Under such circumstances, $N_v = 0$, and the demand curve D_v for vocational training graduates is irrelevant. The demand by employers for workers in T-type jobs must be fulfilled by on-the-job training. Expressed in present value terms, the demand for on-the-job trained persons is $D_t(N_t) = kd_T(N_t) - k'a$, which must lie below the corresponding curve D_v for vocational training graduates. Here, workers elect on-the-job training until the earnings advantage for such training is eliminated. This occurs at an earnings level W_O^*, with N_O^* workers remaining in O-type jobs and N_t^* engaging in on-the-job training and going into T-type jobs. In comparison to the unlimited vocational training case, wages and employment in T-type jobs are both less here, and employment in O-type jobs is higher.

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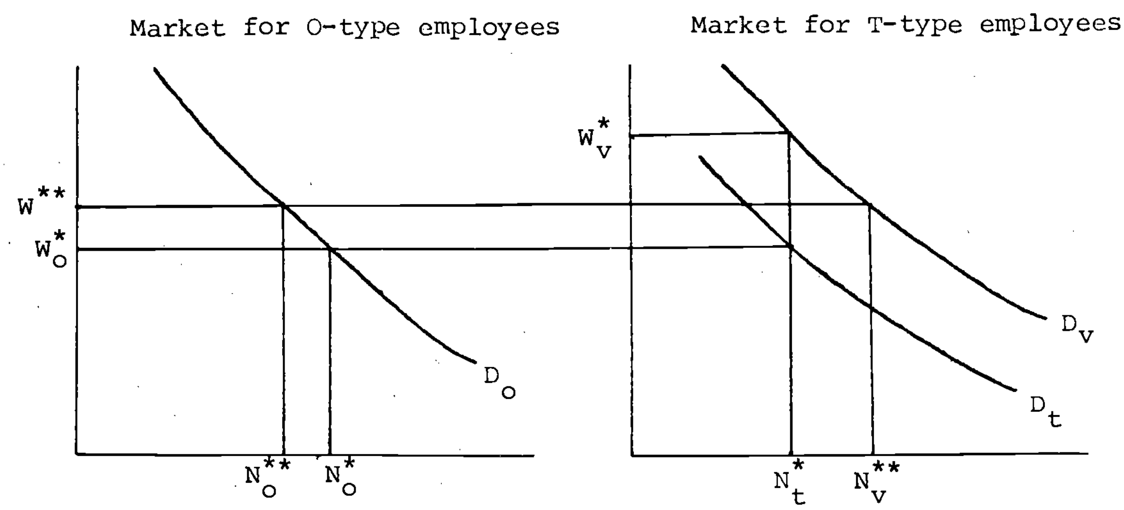
[5] This relationship between yearly wages and discounted earnings streams implicitly assumes that the analysis is of the "steady state" variety.

Figure 1



Now consider the cases falling between the extremes, cases in which the number of vocational places is positive but limited to some number less than the number who would attend if there were no limits.[6] First, let vocational training be introduced in the high schools at any level C between 0 and N_t^*. These C workers will fill T-type jobs, and an additional $N_t^* - C$ other program graduates will undergo on-the-job training to work in T-type jobs. This again equalizes the wages of general training graduates whether they remain in O-type jobs or undergo on-the-job training for T-type jobs. The wages of other program high school graduates remain at W_o^* so long as C is less than N_t^*. The

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[6] Newspapers (e.g., <u>New York Times</u>, Survey of Education, January 6, 1980) and available scholarly material (see the discussion in Nelson [1977]; e.g., pp. 132-133) suggest that there has been a dramatic turnaround in the vacancy-enrollment situation in vocational programs. Instead of vocational programs consituting a lower track to which those at the bottom of the class are assigned, many schools have to contend with excess applications for available places in vocational training programs. It appears in practice that the vocational track in a comprehensive high school may provide a program that is less desirable than the program available in regional vocational centers. The basic organization of these programs differs from state to state.

wages of vocational training graduates are W_v^*, which is higher than W_o^* by an amount k'a. This amount reflects the fact that vocational training graduates need incur no additional training expenses to engage in T-type jobs.

If more than N_t^* but fewer than N_v^{**} vocational training positions are available, then the wage for vocational training graduates will be given along the demand curve D_v and will be less than W_v^*. The number of other program graduates remaining to fill O-type jobs falls below N_o^*, and wages for O-type jobs rises above W_o^* according to the demand curve D_o. The wage differential between O-type and T-type jobs narrows to less than k'a, and no one undergoes on-the-job training if $C > N_v^*$.

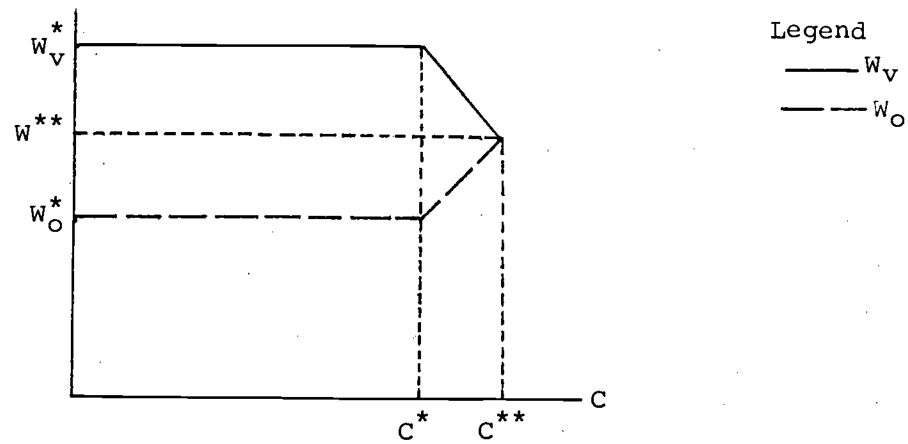
The preceding analysis indicates that there is a relationship between wages for other program and vocational program graduates and the size of the vocational training program. Figure 2 illustrates this relationship. Wages for the two types of graduates are constant at W_o^* and W_v^* as long as the vocational training program has fewer than C* positions, where $C^* = N_t^*$. If there are more than C* positions, the wages for the two groups narrow until equality is reached at C** positions. C** corresponds to the quantity N_v^{**} in Figure 1.

Many studies of vocational training programs seek to establish the differential between the discounted wage streams of vocational and other program graduates. In terms of Figure 2, they seek to establish the difference $W_v - W_o$. This difference is related to the current actual size of the vocational training program, but the possibility of a relationship between the wage differential and the size of the vocational training program is almost universally ignored.

The wage differential found by these studies measures the value of the vocational training program to the marginal enrollee in the program. In other words, it answers the question: If the program were to be cut back (enlarged) by one position, what would happen to the wages of that person dropped from (added to) the program? More importantly, it does <u>not</u> answer the question: What is the effect of the vocational training program on the wages paid to the $\bar{N}$ graduates of both programs?[7]

Figure 2

Wages as a Function of Vocational Program Capacity



This point may be illustrated by referring to Figure 2. If the vocational training program has C** positions, the measured wage differential between vocational training and other program graduates will be zero. And yet with C** openings, wages are W**, versus the figure of W_o^* which would occur in the absence of any vocational training program. Hence, the value of the vocational training program to the $\bar{N}$ workers is W** - W_o^* per worker, in spite of the fact that the measured wage differential between vocational training and

[7] The reader is again reminded that our discussion focuses on the value of private returns to high school graduates rather than social returns to vocational training.

other program graduates is zero.

The effects of the vocational training program on the $\bar{N}$ workers may be summarized by looking at the total wage bill of the workers. Figure 3 depicts the relationship between this wage bill and the size of the vocational training program. The wage bill is found simply by adding the wages of the general training and vocational training graduates separately:

$$WB = CW_v(C) + (\bar{N} - C)W_o(C), \tag{1}$$

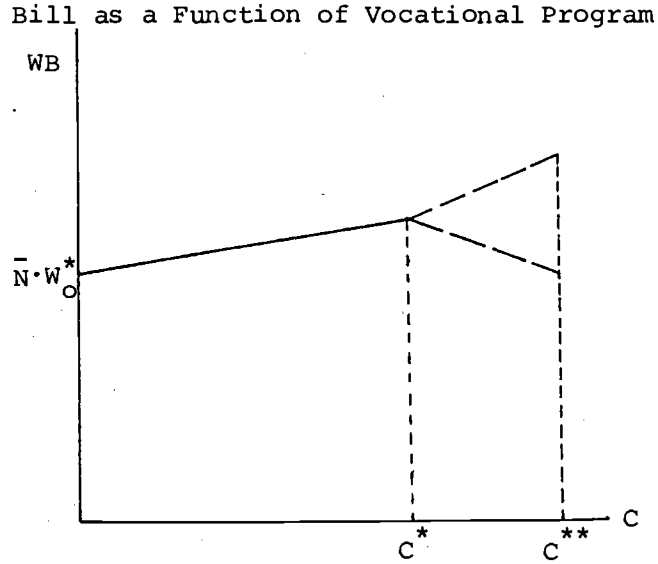
where W_v and W_o are the functions of C indicated in Figure 2.

For levels of the vocational training program less than C*, the wage bill reduces to:

$$\begin{aligned} WB &= CW_v^* + (\bar{N} - C)W_o^* \\ &= \bar{N}W_o^* + (W_v^* - W_o^*)C. \end{aligned}$$

Figure 3

The Wage Bill as a Function of Vocational Program Capacity



This is a straight line with intercept $\bar{N}W^*$ and slope $W_v^* - W_o^*$, as indicated in Figure 3. Note, however, that as the vocational training program is increased in this range, the resulting increases in the wage bill are not being shared equally. Rather, they accrue to the students who manage to win positions in the vocational training program.

Beyond C*, the wages of the vocational training graduates begin to decline, but the wages of the other program graduates increase. The net effect on the total wage bill is indeterminate in this area. The slope of the wage bill as a function of vocational training program size is found by differentiating equation (1), and substituting D_v and D_o for W_v and W_o.

$$dWB/dC = (1 + \frac{1}{\varepsilon_v})D_v(C) - (1 + \frac{1}{\varepsilon_o})D_o(\bar{N} - C).$$

In this equation, D_v and D_o are the labor demand functions in Figure 1, and ε_v and ε_o are the elasticities of these demand functions. Depending upon these values, the wage bill may either rise or fall to the right of C*, as indicated by the alternative functions in Figure 3. In any case, it is clear that the wage bill at C** must exceed that at C = 0, since $W^{**} > W_o^*$.

The principal point of this discussion is that the overall value to the workers of a vocational training program of size C must be found by comparing the wage bill at C with the wage bill which would have been observed in the absence of the program. Merely calculating the difference in present discounted wages between vocational training graduates and other graduates will give the value of the program to the marginal enrollee, but it may give very misleading estimates of the total value of the program.

II

In this section, we drop the assumption that the total number of high school graduates is fixed at $\bar{N}$, thus implicitly introducing the option of selecting some level of schooling other than terminating education after completion of high school. Instead, the amount of labor supplied to jobs requiring a high school degree is taken to be a function of the wage rate available to the workers:

(2) $$N = L(W), \text{ where } L' > 0$$

A new complication arises when a positively sloped supply function is introduced into the analysis because all workers do not receive the same wage. In most cases, the discounted wage is higher for a person enrolling in a vocational training program than for one who does not. Since different individuals have different reservation wages and also receive wage offers that differ, the exact number who choose a high school degree depends on which wage offers those with different reservation wages receive--i.e., on the mechanism which allocates positions in vocational training programs to those with different reservation wages. To pursue the analysis further, we specify the labor supply function in more detail.

Let W_v be the wage prevailing to vocational training graduates, and let $L(W_v)$ be the labor supply that would come forth if everyone were to be paid this wage. Assuming that the probability of securing a position in a vocational training program is independent of the reservation wage, the probability of obtaining a position in the vocational training program (and the wage that goes along with it) is $C/L(W_v)$, and the probability of failing to get into the program is $1 - C/L(W_v)$. Now let $L(W_o)$ be the number of people who would choose exactly a high school education at the lower wage of other graduates. Of this number, $L(W_o) \cdot C/L(W_v)$ of those who apply for admission into the vocational training program succeed in getting in. The remainder, $L(W_o) \cdot [1 - C/L(W_v)]$, apply to the vocational training program and fail to get in, but are willing to work anyway at the lower wage. The total number ending up with a high school degree is this number plus the C persons who did succeed in obtaining positions in the vocational training program:

$$N = C + L(W_o) \cdot [1 - C/L(W_v)] \tag{3}$$

It can be readily verified that at constant levels of the two wages W_v and W_o, participation will increase as the number of vocational training positions C increases.

The effect of substituting this new labor supply equation in the model can be summarized by the wage functions in Figure 4, which is analogous to Figure 2 of the last section. While the detailed derivation of these results below is a little tedious, they can be explained heuristically rather easily. The increasing vocational opportunities tend to draw additional participants into the market for high school graduates, which in turn depresses wages generally in this market.[8] This accounts for the downward sloping segments of both W_v and W_o to the left of C*, whereas in the previous section these segments had been horizontal. To the right of C*, vocational training has expanded to the point where no more on-the-job training takes place, and, as before, further vocational training positions make the two wage rates converge.

To demonstrate these results more rigorously, consider the regions to the left and to the right of C* separately, and construct a simple model for each. To the left of C*, some amount of on-the-job training takes place. In

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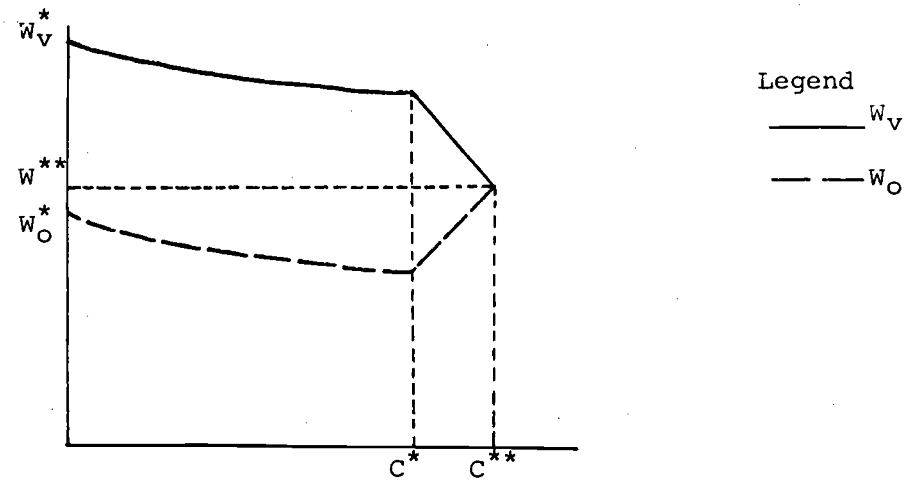
[8] This same effect will raise wages in labor markets for those attaining some level of education other than a high school degree.

this region, the wage differential between W_v and W_o must be just sufficient

Figure 4

Wages as a Function of Vocational Training Capacity



to compensate for the costs of training:

(4) $$W_v - W_o = k'a.$$

The two wage rates are determined by the demand function defined in the previous section.[9]

(5) $$W_v = kd_T(N_v + N_t)$$

(6) $$W_o = kd_o(N_o)$$

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[9] Since a variable N implicitly introduces the possibilities of pursuing higher education after graduation and of dropping out before graduation, and the wages of those in other markets may be affected by their numbers, any changes in wages for these people that do occur may in turn affect the demand for high school graduates. This indirect effect is not treated in the present analysis.

If we now add the labor market clearing equation

(7) $$N = N_v + N_t + N_o$$

the five equations (3)-(7) may be regarded as a simple model with endogenous variables N, N_o, N_t, W_o, and W_v. These equations may be totally differentiated with respect to N_v to find out how the endogenous variables behave as N_v (which is equal to C, the number of positions in the vocational training program) increases. The results, all of which are unambiguous, are as follows:

$$dN/dN_v > 0 \qquad dN_o/dN_v > 0 \qquad dN_t/dN_v < 0$$

$$dW_o/dN_v < 0 \qquad dW_v/dN_v < 0$$

The negative total differentials for W_o and W_v justify the downward slope of the two wage functions to the left of C* in Figure 4. Furthermore, these results show that the number of workers engaged in on-the-job training decreases monotonically as the number of vocational training positions increases. If this number reaches zero at C*, it cannot become nonnegative again to the right of C*, implying that C* is unique and totally separates the region where it does not. Finally, it is of interest to note that the number choosing exactly a high school education increases monotonically as C increases up to C*.

When the number of vocational training positions increases beyond C*, no on-the-job training will occur. Corresponding to this, the wage differential $W_v - W_o$ will narrow to a figure less than k'a. In terms of the model just discussed, these changes to the right of C* require that equation (4) be replaced with the constraint:

(8) $$N_t = 0,$$

which simply asserts that no one is receiving on-the-job training in this case. With this modification, the total derivatives of the model have the following signs:

dL/dN_v indeterminate $\qquad dN_o/dN_v < 0$

$dW_v/dN_v < 0 \qquad dW_o/dN_v > 0$

To the right of C*, wages of vocational training graduates must be declining, simply because there are more of them. The additional vocational training graduates reduce the supply of other program graduates; however, the effect on the number of other program graduates may be partially offset by additions to the labor force. In any case, the reduction in other program graduates raises the wages of those graduates according to the demand schedule, and hence it narrows the wage differential between the two types of graduates.

At C**, the wages of vocational training and general training graduates are equalized, and any further increases in vocational training positions will remain unfilled. It is of interest to ask whether W**, the wage rate associated with C** vocational training jobs, is greater or less than W_o^*, the wage rate that would prevail were there to be no vocational training at all. This question may be answered by a fairly simple argument.

Suppose that $W^{**} \leq W_o^*$. From Figure 1, it is easy to see that this could happen only if the labor supply at C** were greater than at 0. However, by equation (3), the labor supply must be less at C** than at 0 if $W^{**} \leq W_o^*$. This establishes a contradiction and implies that in fact $W^{**} > W_o^*$. Hence, the existence of a vocational training program operating at a level C** increases wages for all workers above the wage level which would prevail if there were no such program. A corollary result is that the labor supply is greater at C** than at C = 0 due to the higher wages there.

As in the previous section, the analysis may be continued by constructing the relationship between the total wage bill and the size of the vocational training program. Since both the wage per worker and the size of the labor force have been shown to be higher at C** than at 0, the total wage bill must be higher at C**. However, it is impossible to establish the slope of any specific segment of this relationship between 0 and C** without specific values for the parameters. Note also that, to use the wage bill as some indicator of the welfare effects of the vocational training program for those who attain a high school degree, explicit allowance should be made for the opportunity wage for those who were attracted into this labor market from elsewhere.

III

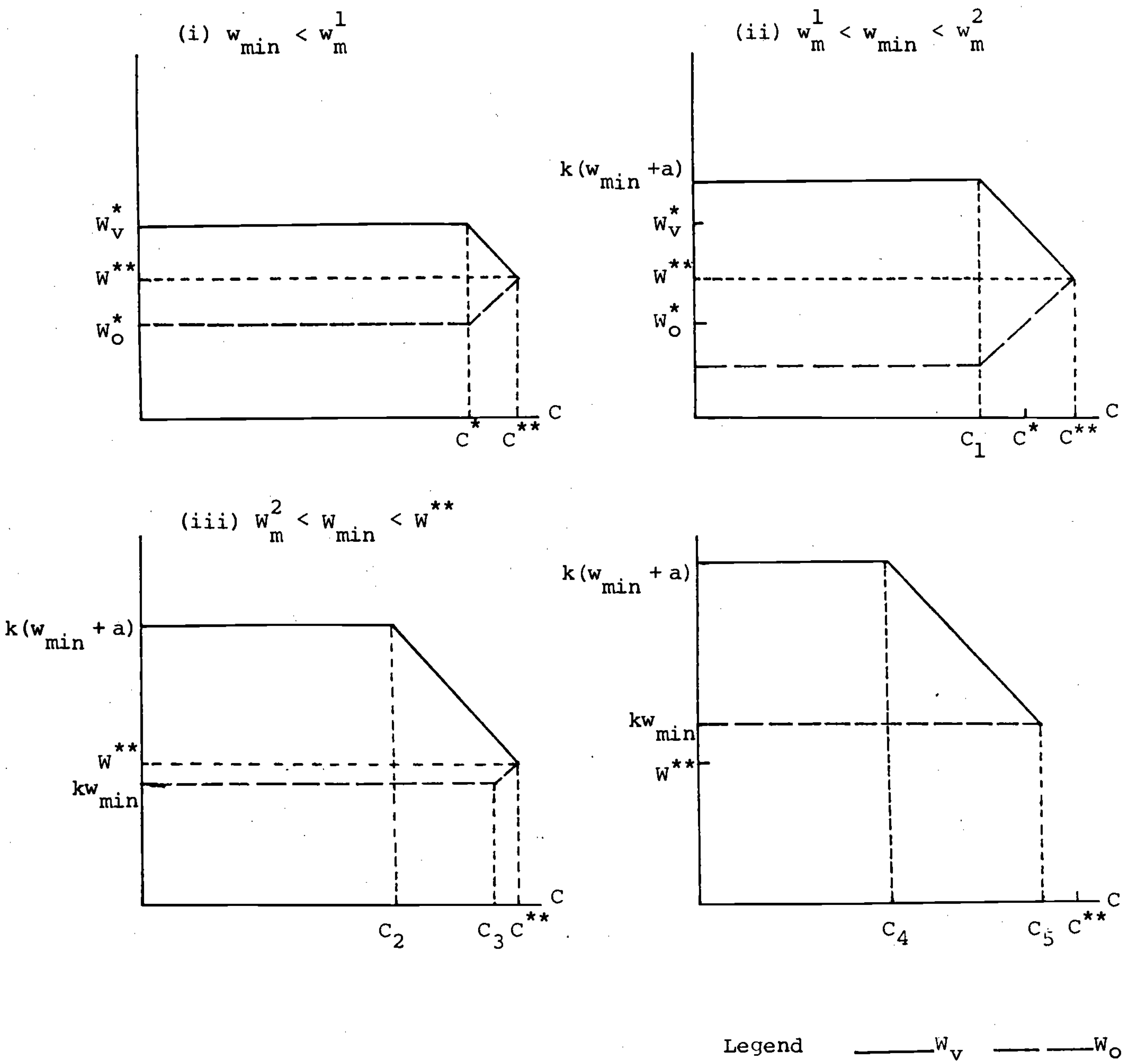
This section extends the analysis of Section I in a slightly different direction by considering how the labor market outcome is affected when there is both vocational training in the high schools and a minimum wage. In this analysis, high school graduates entering the labor force is fixed at $\bar{N}$.

The impact of the minimum wage will be seen to depend on its level and on the enrollment capacity of the vocational education system. In the lowest range, the minimum does not constrain anyone's wage and hence has no effect on the analysis of the first section. The first panel of Figure 5 illustrates the situation in this range; this panel is the same as Figure 2 before. So long as the minimum is below the critical level w_m^1, it doesn't have any impact.

At the critical level w_m^1, the minimum begins to constrain the wage during the period of training for workers engaged in on-the-job training. Where does this impact begin? To answer this question, let w_o^* and w_v^* be the annual wages associated with W_o^* and W_v^*, respectively. Since W_v^* and W_o^* differ by the

Figure 5

Effects of Various Levels of the Minimum Wage



training costs $k'a$, w_v^* and w_o^* must satisfy the relation

$$w_v^* = w_o^* + (k'/k)a.$$

The annual wage during the training period for workers engaged in on-the-job training is $w_v^* - a$. This is the critical minimum wage w_m^1 at which the minimum just begins to constrain training period wages:

$$w_m^1 = w_v^* - a = w_o^* - [(k - k')/k]a. \tag{9}$$

Within the next higher range for the minimum wage, from w_m^1 to w_m^2, the minimum wage constrains training period wages but does not constrain wages generally in either the O-type or the T-type jobs. The situation in this case is illustrated in the second panel of Figure 5.

If workers are trained on-the-job at the minimum wage, then the general annual wage in the T-type jobs must be higher by the training costs a. At this wage level, the firms desire to hire C_1 workers for T-type jobs. If there are fewer than C_1 positions in the vocational training program, then the firms will hire $C_1 - C$ workers for on-the-job training programs, where C is the number of positions in the vocational training program. If there are more than C_1 vocational training positions, then there will be no on-the-job training, and the wages of vocational training graduates will move downward along the demand curve D_v.

If there are fewer than C_1 vocational training graduates, then these graduates must be receiving a discounted wage stream equal to $k(w_{min} + a)$. By using the relationship $w_{min} > w_m^1$ along with equation (9), it is easily shown that this discounted wage stream is greater than the W_v^* that the vocational training graduates would have received in the absence of the minimum wage. Hence, the demand curve implies that the C_1 workers desired by T-type employers will be less at this wage than the C* workers desired at a wage of W_v^*.

With fewer than C* workers demanded by T-type employers at the wage $k(w_{min} + a)$, more of the high school graduates from other programs remain in O-type jobs, and wages in that sector are reduced below the W_o^* that they would achieve in the absence of a minimum wage. Hence, a minimum wage which constrains training for T-type jobs, but which falls below the wage in jobs not requiring such training, increases the wage gap between vocational training graduates and other program graduates working in O-type jobs.[10]

Two other interesting features of the model emerge when the minimum wage lies between w_m^1 and w_m^2, where w_m^2 is the level at which the minimum would just equal wages paid to those in O-type jobs. First, other program graduates may receive different wages depending on whether or not they get into on-the-job training programs. Because the wage differential between O-type and T-type jobs has widened, the higher wages in T-type jobs more than offset the reduced wages necessary during the period of training. Because of this, more people would like to enroll in on-the-job training programs than the firms are willing to take, and positions in on-the-job training programs become rationed in much the same manner as vocational training positions.

Secondly, if the minimum wage is in this range, the effect of the minimum wage may be eliminated if the vocational training program is large enough. If more than C* vocational training positions are offered, then no training would have occurred even without the minimum wage. Since the minimum wage in this range interferes only with on-the-job training, it will have no effect if no on-the-job training would have taken place anyway.

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[10] This type of effect of the minimum wage has been previously noted by Mincer (1976).

If the minimum wage rises above w_m^2, it begins to interfere with wages in O-type jobs as well as with wages for people undergoing on-the-job training. This situation is illustrated in the last two panels in Figure 5. As before, on-the-job training can take place only if W_v is at least $k(w_{min} + a)$, so that wages during the training period may at least be at the minimum. For this to occur, there can be no more than C_2 vocational training graduates in the third panel or C_4 such graduates in the fourth panel. If there are more vocational training graduates than these, then the wages for T-type jobs will fall according to the demand curve D_T, and no on-the-job training will take place.

With a minimum wage above w_m^2, wages in O-type jobs may not be able to fall far enough to create enough demand for all the workers seeking employment. Some unemployment among other program graduates would result. However, if the minimum wage is below w** (the annualized wage corresponding to W**), it is possible for a vocational training program to eliminate the unemployment by providing the training for more people to enter T-type jobs. In the third panel of Figure 5, this occurs if at least C_3 positions are available in the vocational training program. If, however, the minimum wage is at a level above w**, then it is impossible for any vocational training program to restore full employment.[11]

The precise relationship governing wage determination is thus a function of both the size of the vocational training program and the minimum wage. Figure 6 summarizes the manner in which W_v, W_t, and W_o are determined for

[11] It is straightforward but tedious to analyze behavior in the face of queuing and unemployment. We would need to explore the market clearing mechanism in the face of queuing and the labor supply response to lack of job availability. We do not introduce these added complications here. Note, however, that if there is both queuing and relatively free access to vocational programs, overenrollment in vocational programs may become a problem. For related analyses dealing with these issues, see Gramlich (1976), Mincer (1976), Mattila (1978), Leighton and Mincer (1979), and Gustman and Steinmeier (1979).

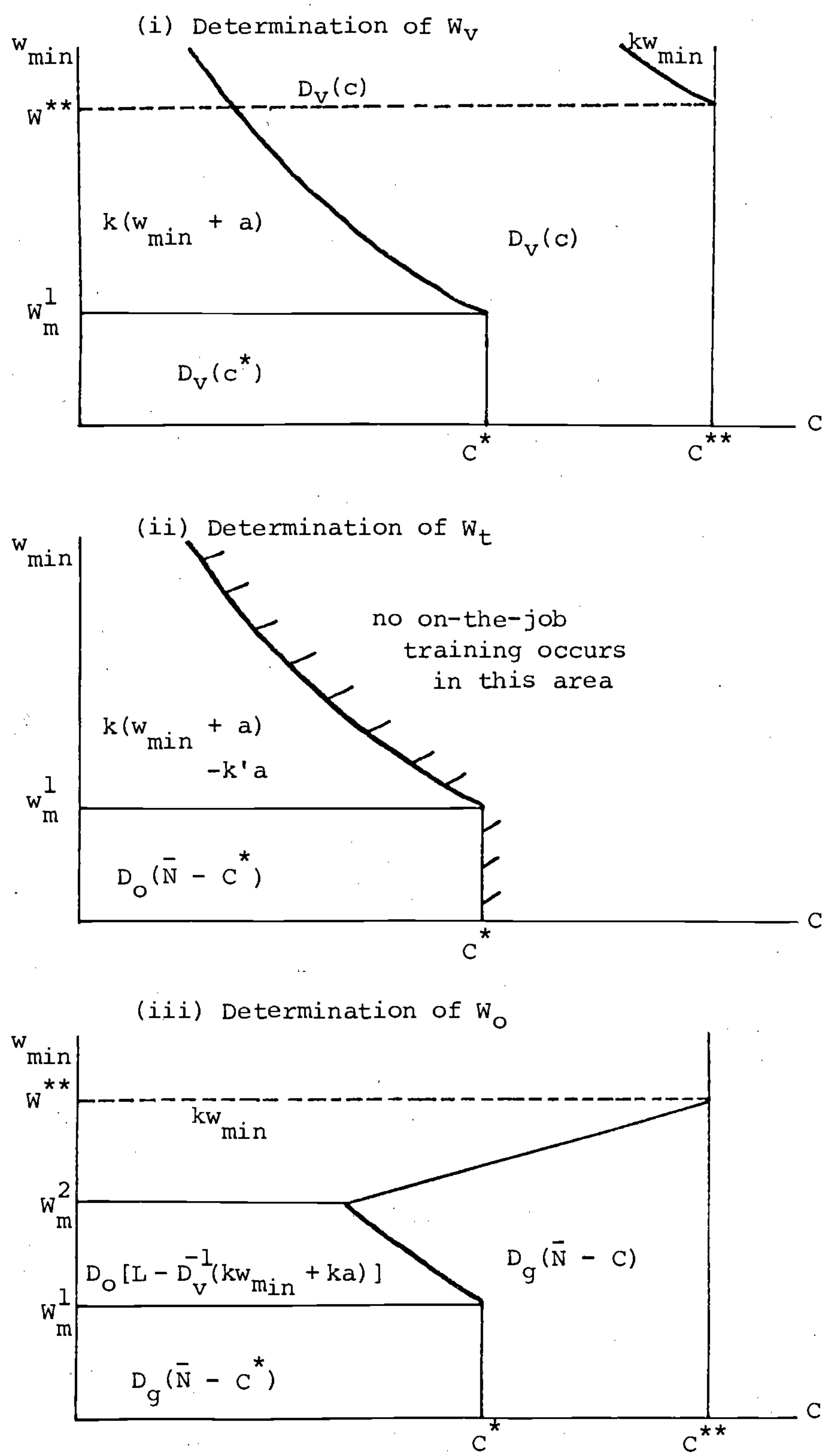
various combinations of vocational program size and the minimum wage. A total wage bill figure could be formed by adding these three figures with the appropriate weights. Note that the functional form in each area of the diagram gives the expression determining the particular wage under consideration for the appropriate combination of vocational training program size and minimum wage.

The principal implication of Figure 6 is that the wage determination is an extremely complicated affair in the face of both a minimum wage and a limited vocational training program. Not only is the function governing wages not the same throughout the diagram, but the functions in various parts of the diagrams have different arguments. Consider, for example, the determination of wages of vocational training graduates in panel (i) of Figure 6. In one of the regions of the panel, the wage depends only upon the size of the vocational training program, while in two other areas it depends only on the minimum wage. In the fourth area, it does not depend upon either C or w_{min}. Similar complexities arise in the determination of wages for on-the-job trainees and for other program graduates who remain in O-type jobs.

In sum, a vocational training program in the high schools which produces a substitute for training on the job will mitigate and in some cases overcome the adverse effects of the minimum wage on on-the-job training and in creating unemployment. The exact effects depend upon the size of the vocational education program and the level of the minimum wage. To evaluate benefits from vocational education programs that arise because the program overcomes some adverse impacts of the minimum wage, we would need to make strong assumptions about whether constraints resulting from a minimum wage can, realistically, be removed--e.g., by instituting a youth sub-minimum wage. Such an analysis would place us well within the world of second-best.

Figure 6

Wage Determination



IV

The previous results have strongly suggested that to estimate fully the impact of a vocational training program, it is necessary to include the size of the program as an explanatory variable. Even here, one must be extremely careful about the functional form of the relationship between the size of the program and the wages, especially in the presence of a minimum wage. Most studies, however, have not considered the size of the vocational training program in assessing the impact of the program. What have these studies actually measured?

Consider a study which draws a random sample from a population scattered over several labor markets. The labor markets themselves differ in the size of the vocational training programs serving them. Let the size distribution of these programs be given by $f(C)$. For simplicity, we will assume that all the labor markets are of equal size $\bar{N}$, but it would be straightforward to allow for varying labor market sizes too.

The probability that a randomly drawn individual will be a vocational training graduate from a program of size C is given by

$$p_v(C) = (C/\bar{N})f(C)dC.$$

The $f(C)$ is the probability of finding a program of the specified size, and $C/\bar{N}$ is the probability of finding a vocational training graduate within the specified labor market. The expected wage in a randomly drawn sample is found by weighting the wages by the probability of finding graduates with those wages:

$$E(W_v) = \frac{\int W_v(C)\,p_v(C)\,dC}{\int p_v(C)\,dC}$$

$$= \frac{\int W_v(C)\,Cf(C)\,dC}{\int Cf(C)\,dC}$$

The denominator of this express is the mean size $\bar{C}$ of the vocational training programs. Hence, the expected wage may be rewritten as

$$E(W_v) = \int W_v(C)(C/\bar{C})f(C)dC. \tag{10}$$

A similar procedure finds the expected wage for other program graduates to be

$$E(W_o) = \int W_o(C)[(\bar{N} - C)/(\bar{N} - \bar{C})]f(C)dC. \tag{11}$$

A note of caution is in order about these expected wages. There wages represent the average wages for the two groups in a random sample of individuals. They may not, however, be used to measure the size of the wage differential which might be associated with an "average" or "typical" labor market.

To measure the differential in an average labor market, it would be appropriate to weight the differentials in specific labor markets by the relative frequencies of those markets:

$$\begin{aligned} E(W_v - W_o) &= \int [W_v(C) - W_o(C)]f(C)dC \\ &= \int W_v(C)f(C)dC - \int W_o(C)f(C)dC. \end{aligned} \tag{12}$$

In comparing equations (10), (11), and (12), it is evident that $E(W_v)$ in equation (10), by virtue of the factor $(C/\bar{C})$, gives more weight to labor markets with large vocational training programs than does the corresponding quantity in equation (12). Similarly, $E(W_o)$ in equation (11) gives more weight to labor markets with small vocational training programs. Hence, neither $E(W_v)$ in equation (10) nor $E(W_o)$ in equation (11) uses weights that are appropriate for finding wages in an "average" or "typical" labor market. In other words, in ignoring the effect of the size of the vocational training program on the wage differential between vocational and other high school program graduates, the typical study oversamples wages from vocational graduates from cities with large vocational programs and oversamples wages for nonvocational graduates from those with small vocational programs.

V

The basic message of this paper is that a proper evaluation of vocational training must do more than simply look at earnings differentials between vocational training and other high school program graduates. These earnings differentials indicate the value of the program to the marginal person, but they do not indicate the overall value of the program to all high school graduates, or even to all vocational training graduates. Even worse, it is possible that the earnings differential may give very misleading indications of the value of the program, indications that are the opposite of the truth. For instance, we have seen that a vocational training program may produce maximum benefits to the workers at precisely that point where earnings differentials are narrowed to zero.

A proper evaluation of vocational training will encounter several difficulties. Two sections of this paper have explored the complications introduced by a consideration of minimum wages and of a variable labor supply. These complexities imply that great care must be taken if estimates of wage relationships are to be accurate and unbiased. Otherwise, the estimates may confound the effects of the programs under varying circumstances and make it difficult if not impossible to reach conclusions about the impact of the program.

In addition, we have examined how the impact of the minimum wage is affected by the existence of vocational training in the high schools. After exploring the relation between the level of the minimum wage, the capacity of the high school vocational training program, and wages, employment, and training of high school graduates, we conclude that vocational training programs may reduce or eliminate any adverse impact of the minimum wage, both on the level of training and on unemployment.

As the title of this paper suggests, we believe the preceding material constitutes only a framework for analysis. This framework may be expanded in a number of ways.

1. The model assumes that vocational training in the high schools substitutes completely for general on-the-job training. Implications of the existence of some general on-the-job training not provided in public schools, specific training which may or may not be complementary with general training, and private vocational training should be explored.[12]

2. Vocational training programs differ in quality. The analysis may be modified to consider the role that the quality of vocational programs plays.

3. The model specifies a particular role for vocational training--namely, as a substitute for general on-the-job training. By introducing into the analysis federal subsidies to on-the-job training, wage rate subsidies, and other related policies, one can explore the interrelations between labor market programs typically supervised by the Department of Labor and vocational education programs which are the responsibility of the new Department of Education.

As we noted at the outset, we have assumed throughout the paper that vocational training provided in the high schools is indeed useful on the job. While in the absence of an empirical analysis, we cannot tell whether this assumption accords with the facts, our analysis has indicated that current

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[12] For an analysis of private vocational training, see Freeman (1974) and Olson (1977).

approaches for evaluating the contribution of vocational training programs in the high schools may be seriously flawed. Our discussion suggests an approach to estimation which should remedy these shortcomings.

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