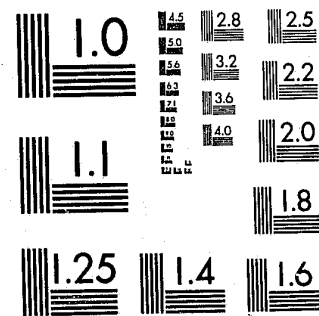


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by

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ECONOMIC ASPECTS
OF PEACE OFFICER TRAINING

81599

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ACQUISITIONS

I. INTRODUCTION

This report projects police training needs in Minnesota over the period 1980-2000 and makes cost comparisons for two training delivery options. Economic techniques are employed in the analyses.

Within a labor market context, monetary and personal incentives encourage individuals to undertake training and thus to become part of the trained personnel supply; while within a budget restraint context, political and public safety considerations encourage law enforcement agencies to demand such trained personnel. Since it can take up to two years to train a peace officer, a market projection will enable individuals and agencies to plan their respective educational, budgetary, and capital needs so that changes in public safety wants are met with minimal delay. A complete market projection is not attempted because future supply of trained personnel depends on a forecast of peace officers' wages as compared to wages in other occupations. Such a wage forecast is extremely difficult over a long time period. However, the trained personnel market components examined are as follows:

1. Projected demand for peace officers,
2. Determinants of peace officer supply, and
3. Cost comparisons of two future training delivery options.

The entire analysis assumes the relevant market is the state of Minnesota, i.e., trained personnel migration between states is disregarded

given the expectation that it is very small. Other factors examined are the geographical location of future training facilities and the financing of training costs.

In particular, cost comparisons are made of training provision through either the community colleges exclusively or the area vocational technical institutes (vo-techs) exclusively. According to these two options, either community colleges alone or vo-techs alone would provide certified law enforcement programs such that their graduates would be licensed to be peace officers. These two alternative means of training delivery are the only mechanisms for which cost estimates and comparisons are reported.

A complete cost-effective analysis of alternative mechanisms for supplying trained peace officers is not attempted. Neither research resources nor data availability permits a comprehensive analysis of all possible training delivery systems. There are innumerable combinations of community college, four-year universities, vo-tech law enforcement programs, and instruction by the Bureau of Criminal Apprehension (BCA) which could be used to train peace officers in Minnesota. All possibilities and their respective costs cannot be anticipated. So comparisons are limited to the cost considerations of two options for providing training, through vo-tech programs exclusively or through community college programs exclusively. Although cost analyses are limited to these two options, there is no implication that training would be limited to students in these two types of programs. There is no reason that a certified community college could not service students enrolled in other institutions or in-service personnel.

The first section deals with the demand for peace officers in Minnesota. The future needs for trained personnel are projected. The second section

discusses supply of trained peace officers and specifically addresses the questions:

- 1) What factors affect trained peace officer supply?
- 2) Who should bear training costs?
- 3) What are the implications of public and private financing?

These questions direct attention to cost considerations of alternative mechanisms for training delivery. The third section reports cost estimates of the training delivery options described above. The appendix describes technical details of the projection methods used.

II. DEMAND FOR LAW ENFORCEMENT PERSONNEL

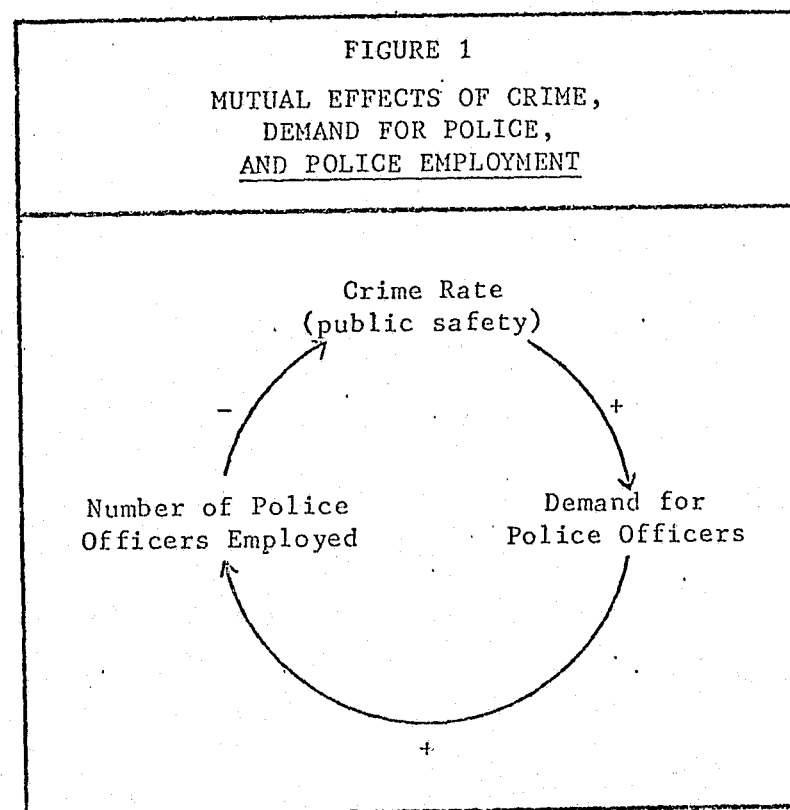
A. DEMAND PROJECTIONS AID TRAINING PROVISION PLANNING

Those providing training for peace officers need to estimate future law enforcement personnel needs. If training is conducted largely at public expense, foreknowledge of the relevant market conditions faced by trained personnel can lead to efficient decision-making in the level of training provision given the expected needs.

B. INTERACTION BETWEEN THE DEMAND FOR PUBLIC SAFETY AND FOR PERSONNEL

In the case of law enforcement personnel, training needs are a function of the demand for services. Peace officers perform a public service. They are intermediate products (or service producing agents) in a process whose outcome can be called "public safety." The demand for such personnel is derived from the demand for the service they provide. Since the demand for this public service is financed by public revenues, response to this demand

is dependent upon political decisions, and not simply market phenomena. But if political decision-makers respond reasonably well to the demands for public safety, it makes sense to use the factors determining citizen demand for public safety to estimate the number of trained peace officers that will be demanded by local agencies. That is, variables that can be expected to affect demand for public safety can also be expected to affect the number of peace officers communities do employ.



C. DETERMINANTS OF THE DEMAND PROJECTION

The variables that affect the demand for public safety and thus the demand for peace officers are:

1. Population size,

2. Crime,¹

3. Assessors' taxable valuation of property, and

4. Time [to capture trends not described by (1)-(3)].

Selection of these variables can be justified. For example, a number of recent studies have discussed the demand for law enforcement personnel and/or law enforcement expenditures.² Most have established that crime and demand for police services simultaneously affect each other. Figure 1 describes visually the mutual effect these variables have upon each other. Higher crime increases the demand for peace officers, and an increase in police services reduces crime. By using the other community characteristics which have been found to be related to demand for police services as well as the community's crime incidence, a demand function for the number of peace officers can be statistically derived.

D. DEMAND FOR TRAINED PERSONNEL ESTIMATION, 1980-2000

Two equations are estimated using the above statistically significant variables; one peace officer demand equation which depends on the crime

¹In analyses reported below, separate regressions were run using violent crime, property crime, and total crime.

²A useful summary is provided by Eric J. Scott, "Determinants of Municipal Police Expenditures: A Review Essay," unpublished technical report, Workshop in Political Theory and Policy Analysis, Indiana University. Donald Genadek and Stephen Coleman, "Costs and Performance of Criminal Justice: A Statistical Analysis of Minnesota Counties," Minnesota Statistical Analysis Center, Crime Control Planning Board: St. Paul, Minnesota, May 1977, finds at the level of Minnesota counties that the relationship between Crime Rate and Police Expenditure per capita is weak. These results should not be read as contradictory to the forecasting attempts to this chapter. The dependent variable is different, i.e., here it is police personnel. Also, forecasting analyses are based on data over time, in contrast to the cross-county data at a single point in time.

rate among other variables, and a second equation determining the crime rate which in turn depends on the number of peace officers and the population. In particular, the following equations are estimated.

$$(1) N = c_0 + c_1Cr + c_2P + c_3V + c_4T$$

$$(2) Cr = d_0 + d_1P + d_2N.$$

The procedure by which the statistically significant right hand side variables were determined is described in the appendix. Equation (1) states that the demand for officers is dependent upon the crime rate (Cr), population (P), assessed valuation in the community (V), and a time trend variable (T). In turn, equation (2) states that the crime rate (Cr) is determined by the population (P) and the number of officers (N). Both of these interdependent equations are used to estimate the demand for peace officers.

The number of trained personnel required over the period 1980-2000 can be determined using these equations. Results indicate an initial decline in the number of new officers requiring training followed by a gradual increase over the period 1980-2000. The yearly projections are included in the appendix. Caution should be used in interpreting the yearly projections, however. First, it is uncertain which categories of personnel to include in the projections. Estimates, for example, do not include part-time personnel.¹ Reliable data are not available on the number of part-time personnel, making it difficult to estimate how much their inclusion would affect training needs. To require training of currently sworn but

¹Part-time personnel are not legally exempt from training but most part-time officers have not been trained since full-time personnel are given priority in the limited BCA classes. Training Board staff suggest that there may be about 300 untrained, part-time officers in the state.

untrained part-time personnel could increase sharply short-term training needs, while to require training of part-time personnel in the future would increase somewhat long-term training needs. Similarly, inclusion of officers from small communities now exempt from training requirements would affect future training needs. Second, all projections involve some range of error, and that error is likely to increase the farther one projects personnel beyond the base period. One should not, therefore, take the yearly projections reported in the appendix too strictly especially those numbers near the year 2000.

On the other hand, readers should not discount the initial decline discovered in the projections. Some of the recent demand for training can be accounted for by the backlog that resulted from mandated training in 1967. For example, data reported in Chapter XV of the Evaluation Unit's *Minnesota Peace Officer Training and Education: Final Report (1977)*¹ indicate that a number of trainees have been in their current positions well beyond the mandated one year, suggesting that some of these trainees were grandfathered and are seeking training by choice or else may be from exempt communities. As this backlog is met, training needs should decline. In addition, the analyses reported in the appendix note a sharp increase in peace officer personnel for the 1965-75 period. This period corresponds to an era of high LEAA funding for law enforcement, the continuation of which is uncertain.

Because of the inevitable methodological and practical problems which subject the estimates to some error, the exact yearly projections are not

¹Hereafter referred to as the REPORT.

reported here but are reserved for the appendix. The major finding to stress in this context is that, barring inclusion of any new category of peace officers requiring training, the number of recruits to be trained in the future is likely to decline from the levels of 1965-75. *A reasonable conclusion would be that after training has stabilized, a statewide capacity for producing approximately 300 newly trained officers annually may be an appropriate estimate of training delivery needs.* Given the human and financial costs of over- or under-supply, training administrators are encouraged to assess continually the short-term demand for peace officers so that training needs can be anticipated.

The cost estimates reported later in this report are based on the above forecast and on the expectation that two options for training delivery would fully meet the state's future training needs. Therefore, costs are estimated for the implementation and operation of law enforcement programs which would produce 300 graduates a year statewide.

III. SUPPLY OF LAW ENFORCEMENT PERSONNEL

A. DETERMINANTS OF PEACE OFFICER SUPPLY

As in most markets, the willingness of individuals to undertake training in an occupation and thereby to become part of the personnel supply in that occupation is determined by three factors:

1. Present and future wages in the occupation as compared to other occupations available to the individual given his/her abilities,
2. Training costs borne by the individual, and
3. Income foregone during the training period.

For example, the higher the training costs paid by the individual and/or the

longer the training period during which the individual is not earning a full-time wage, the higher the expected wage in the occupation must be in order to induce the individual to undertake the training process. Similarly, the lower the training costs and/or the shorter the training period, the lower the wage he/she is willing to accept.

Labor economists would say the notion here is that individuals undertake education or training as an investment in human capital. Their willingness to pay training costs and to forego income during the training period in anticipation of taking a job depends upon the expected value of present and future benefits. This is similar to an investor's willingness to make a particular investment being dependent upon expected returns. Just as an investor is expected to choose the particular investment with the greatest expected net return as compared to other investments, so the individual considering training is influenced by the expected net benefits of other possible occupations. An individual will be willing to pay the costs of training and to forego income during training whenever expected benefits exceed those costs and this difference (expected net benefits) of engaging in other possible occupations.

B. TRAINING COSTS: WHO SHOULD PAY?

This perspective leads to the questions: Who should pay the costs of peace officer training: The trainee, the public, or both? The cost of post-secondary preparation for most professions is usually incurred, at least partially, by the individual. Sometimes specialized training is provided outside the educational system by the employer.

Labor economists distinguish between specific training and general training.¹ Specific training is training in skills that are used only by the employer providing the training. The training cannot be used to obtain employment elsewhere since the employee cannot transfer the skills to another job. The skills are uniquely needed by one employer. General training is training that provides skills useable to many employers. The employee can use the skills to obtain employment from a number of employers. The benefits of training accrue to the individual since he/she has more job options after the training.

Specific training is generally considered the responsibility of the employer since benefits from the skills accrue only to the employer. The trainee cannot use the skills to obtain a higher paying job elsewhere. However, employers are not considered responsible for the costs of general training. There is little economic motivation for the employer to pay the costs of general training. They cannot be sure of getting a return for such an investment in a trainee since he/she can use the skills for employment elsewhere once training is completed. So, employers are usually unwilling to invest resources in general training unless the employer can thrust the training costs back on the individual in the form of wages lower than the typical market wage in the occupation.

Peace officer training falls into the category of general training. Once training is provided, trainees can seek employment with many agencies. In addition, many of the skills can be used to obtain employment with

¹Gary Becker, *Human Capital*, (New York: National Bureau of Economic Research, 1959).

private agencies which have need for police skills. Consequently, if the returns or expected benefits of employment as a peace officer exceed the training costs borne by the individual, then trainees should be willing to incur some if not all the training costs since they will benefit from the skills.

The above statement assumes that public agencies can pay a wage that is competitive with competing private agencies and with the wages in other possible occupations. The source of peace officer wages is a budget determined by political processes. There is no guarantee that the wage level will always be competitive. Too low a wage will deter individuals from entering the occupation. In this instance, a case may be made for the public subsidization of the general training process.

If the public bears partial or full responsibility for the peace officer training costs, local and other governmental units have numerous subsidy options at their disposal. The alternatives are:

1. Tuition subsidies to individuals enrolled in approved programs,
2. Direct subsidization of approved programs, and/or
3. Provision of training by the governmental unit.

Presently the state pays the full cost of training peace officers in the BCA course, as well as partial payment of salary and/or living expenses of trainees who have already been hired by a local agency. Since hiring has occurred prior to training, the supply of newly trained personnel has been generally determined by the number of newly hired peace officers sent to the BCA for training. So, to this point, individuals have not had to expend resources to pay training costs nor have they foregone any salary during the training period.

C. IMPLICATIONS OF ALTERNATIVE FINANCING

Both options for training delivery, through community colleges or through vo-techs, call for partial payment by the trainee and require the trainee to forego income during the training period. But they differ in the degree to which trainees pay training costs. The share of educational costs vo-tech students bear since vo-tech students pay lower tuition costs on the average.¹

For a given salary, the incentive to choose a law enforcement career is higher if training is attained through a vo-tech law enforcement program. Consequently, it may take higher wage scales to attract the same quality of candidates if community college programs or high tuition four-year programs are used in the future as compared to vo-tech programs. This may not be true, however, if other benefits are attributed to a college degree which are not attributed to a vo-tech degree. If an A.A. or higher degree is more attractive perhaps because credits from a college may be more easily credited toward higher degree attainment (and ultimately higher anticipated financial returns), then college law enforcement programs may be more successful than vo-techs in attracting quality students even though the cost borne by the student is greater. The possible range of benefits open to such a student is larger since he/she can move between occupations more easily than a vo-tech student.

¹See Chapters III and IV (REPORT) for descriptions of tuition costs of vo-techs and community colleges respectively. Share of costs borne by the student would be even higher for state four-year institutions and would be highest for private institutions.

In summary, trainees should be willing to pay training costs. The benefits accrue to them so there are incentives to incur training costs and forego income during training. The training costs borne by college students would be higher than for vo-tech students, but alternative considerations besides law enforcement wages may make colleges more attractive to potential students. There are many options at the state's disposal for bearing partial responsibility for training costs. Partial responsibility of training costs may alleviate any need for higher salaries if the present wage levels are not sufficient to attract quality recruits should they have to pay training costs and forego income during training. It is difficult to determine whether the present wage levels are sufficiently high to attract quality recruits if they assume partial or full responsibility for training costs.¹

IV. PUBLIC PROVISION OF TRAINING: ALTERNATIVE COST CONSIDERATIONS

A. COST COMPARISON FRAMEWORK

Future peace officer training may be provided through at least two options: certified community college programs with skills courses or certified vocational-technical programs.² It is possible that four-year state or private programs will be certified as preparatory law enforcement programs but their expansion to include skills training is not considered in this report.

¹However, a recent announcement concerning 2-3 available law enforcement openings in a Twin Cities suburb resulted in 300 applicants. Under the present training system, wage levels appear quite attractive to recruits.

²As mentioned in the Introduction, investigation of these two options does not imply they are the only options not that use of training facilities would be limited to students enrolled at the selected institutions.

Each option involves training costs financed by public funds. This section will compare these public costs and will also compare present program costs.

As stated before, neither a cost-effective nor a cost-benefit analysis will be conducted for these options due to measurement problems. For example, having a better educated citizen confers some indirect benefits on society yet this benefit's measurement has eluded researchers. To conduct a cost-effective analysis, the two programs' output must be similar. Presently, the curricula at the community colleges and vo-techs are not identical and the curricula that would be offered by certified programs under each option is unclear. So, strict cost-effective comparisons of output are inappropriate and possibly misleading since the training of personnel under each option is not identical in form.

B. COST MEASURES

For each option, two cost measures are estimated, total program costs and marginal program costs.

Total program cost has two components: fixed costs and variable costs. Fixed costs are ongoing costs incurred by the school, such as building maintenance costs, whether or not the law enforcement program exists. Administrators often arbitrarily distribute fixed costs to each program depending on its enrollment. Such overall fixed costs incurred by the school do not change if the law enforcement program is expanded. Variable costs are those costs which vary with program size and scope. The largest portion of an existing program's variable cost is instructors' salaries. Calculation of variable costs is sometimes difficult. For example, if a law enforcement program shares faculties or supplemental instructional units providing

elective courses, the program's variable costs associated with these shared services are not easily separable from other programs. This holds true for community college programs. Each such program does not have a separate budget but the Community College Board is implementing a transition to such a budget system. The Division of Vocational-Technical Education maintains a program budget that identifies the program cost components. The total program cost for the present law enforcement program at each institutional type is shown in the next section along with the program cost per student. By dividing total program cost by the number of full time students, the program cost per student is calculated. This is the estimated annual cost of educating a peace officer.

Marginal program cost is the added cost incurred by implementing a new program. The options examined involve supplementing the enrollment of existing community college or vo-tech programs based on personnel demand forecasts. Such options lead to increased variable costs at each institution examined. These increased variable costs are the marginal program cost. By dividing the marginal program cost by the expected enrollment, the marginal program cost per student is calculated.

Training cost estimation requires data from specific institutions. Therefore, five community colleges and five vo-techs are selected for the purposes of estimating costs for each option. All five community colleges presently offer law enforcement programs, and two of the vo-techs have law enforcement programs.

The five institutions of each type are selected on the basis of two criteria. Since the law mandates that skills training at least be made

regionally available¹ and there is strong desire for regional training centers,² the five are selected by providing for one institution in northern, western, and southern Minnesota, and two in the metropolitan area (one east and one west). Second, the locations are selected with the goal of making the programs at the five institutions as comparable in size as possible while still providing for regional availability. The five community colleges represent reasonable choices for locating training programs based on the two goals of serving geographic areas and the state's population distribution.³

For existing law enforcement programs, total program cost components are derived from the existing program budgets of Alexandria and Hibbing in the case of vo-techs, while for community colleges, estimated figures were available from the Higher Education Coordinating Board. These figures attempt to break down the total budget at each community college into variable and fixed costs per student for each type of course. These course costs were then aggregated using the typical curriculum of a law enforcement graduate in each community college program to derive the yearly program cost per student at a community college. The marginal program costs for vo-techs are based upon the cost of the Hibbing program's formation. For community colleges, the marginal program costs are based upon a structured cost survey of the institutions involved.

¹See Chapter II (REPORT).

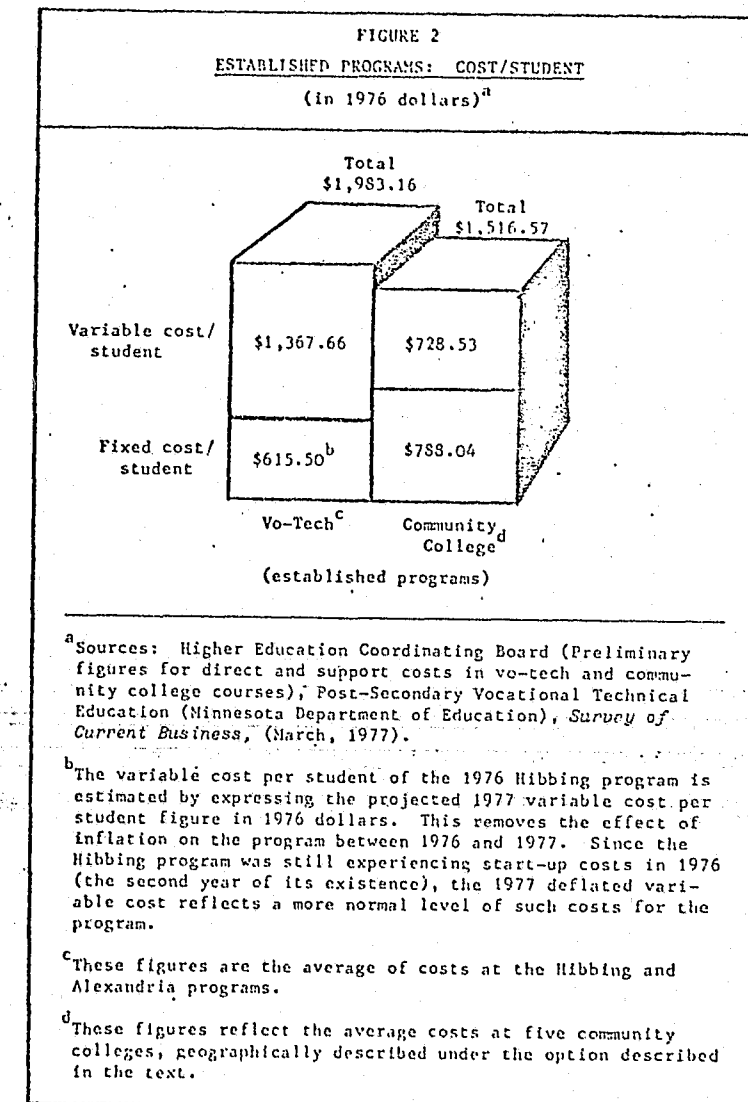
²See Chapter VII (REPORT).

³The size of each hypothetical vo-tech or community college program is determined by assuming each location will draw students in proportion to the population within the geographic area it serves.

The following two sections describe total program costs and marginal program cost of each option.

C. CURRENT PROGRAMS: COST/STUDENT

According to Figure 2, vo-tech programs are more expensive per student than community college programs. In particular, the annual program cost per student is \$1,983.16 at a vo-tech and \$1,516.57 at a typical community college. Annually, it is more expensive, specifically \$466.59 more expensive, to enroll a student in a vo-tech program.



No doubt, it is the strong practical orientation of the vo-tech programs which lead to higher variable costs per student as compared to the variable cost per student at community colleges. Practical curricula may entail higher equipment and supply costs and lower student-faculty ratios (thereby leading to higher personnel costs) than the academic curricula at community colleges.

Having investigated the cost per student under established programs in this section, the next section focuses upon the cost per student under each option.

D. VARIOUS OPTIONS: COST/STUDENT

Even though community colleges experience large initial start-up costs, such schools appear cheaper to operate in the long run. The program cost per student for the first three years of operation under each option is described in Figure 3. The vo-tech figures examine the establishment of these new law enforcement programs and the maintenance of two existing programs. The community college figures describe costs incurred at five on-going community college programs brought up to certified program standards. Hence, the data in Figure 2 (established programs) and Figure 3 (established, modified on-going, and new programs) are not directly comparable.

FIGURE 3
PROGRAM COST/STUDENT^{a,b}

A. COMMUNITY COLLEGE OPTION

	Total \$2,265.06	Total \$1,696.08	Total \$1,595.54
Marginal cost/ student	\$749.84	\$100.54	
Variable cost/ student	\$728.53	\$828.55	\$828.55
Fixed cost/ student	\$786.69	\$766.99	\$766.99
	Year 1	Year 2	Year 3

B. VO-TECH OPTION^c

	Total \$2,262.75	Total \$2,469.00	Total \$1,936.27
Marginal cost/ student	\$299.75	\$532.73	
Variable cost/ student	\$1,367.66	\$1,381.81	\$1,381.81
Fixed cost/ student	\$595.42	\$554.46	\$544.46
	Year 1	Year 2	Year 3

^a Sources: State Board for Community Colleges (estimated cost of new programs) and Figure 2 sources.

^b Estimated enrollment in year 1 is 300 students, in year 2 is 600 students, and in year 3 is 600 students. Remodeling and construction costs occur only in year 1 while equipment and supply costs are spread over the first two years of increasing enrollment.

^c The Hibbing equipment and supply budget over the period 1975-1977 is compared with the 1977-1978 budget in order to derive the vo-tech start-up costs for equipment and supplies.

In the first year of operation, implementing certified programs at community colleges will add \$749.84 per student to their existing cost structure (as described in Figure 2) while it will add only \$299.75 per student to vo-tech programs. Community college programs are slightly more expensive to operate in the first year as compared to vo-tech programs (\$2,265.06 versus \$2,262.75) but are cheaper to operate in the second year as compared to vo-tech programs (\$1,696.08 versus \$2,469.00). Most community colleges had stated that extensive remodeling would be needed in the first year. This is the primary reason for the first year added costs. The large second year vo-tech marginal costs are primarily due to the timing of equipment purchases which fall mainly into the second year program expenditures.

Third year costs can be regarded as typical on-going program costs. Under the options described, an on-going community college program will cost \$1,595.54 per student while an on-going vo-tech program will cost \$1,936.27 per student, thus making community college programs \$360.10 cheaper on a per student basis than vo-tech programs.

However, *the vo-tech costs must be viewed with caution.* Currently, there is a program freeze mandated by the legislature at all vo-techs. Hence, a law enforcement program may be initiated only if another program is phased out. The cost impact of changing each vo-tech's program mix, at an institution without an on-going program, is not estimated but will tend to reduce the stated vo-tech figures sharply.

The figures given in Figure 3 assume that each school makes provision for gym and firing range use. Driver training is not included. Available

estimates for 25 training hours¹ range from \$150.00 to \$427.50. Presently, it is difficult to gauge if the truck driver training facilities at the vo-techs are adequate for police training especially for pursuit driving or whether schools would be forced to rent outside facilities.

Discussion of state funded costs under each option follows in the next section.

E. VARIOUS OPTIONS: STATE SHARE OF TOTAL COSTS

Examining the options of graduating 300 students per year¹ from community colleges alone or vo-techs alone, community colleges are less costly according to Table 1.

Over the first three years of operation, the total cost of operating five community college programs is \$2,654,490 while the total cost is \$3,322,011 at five vo-techs. This means that the vo-tech option is \$667,521 more expensive than the community college option over the first three operating years provided no other vo-tech program is phased out.

¹Recommendation of Police Basic Training Curriculum Task Force, Minnesota Peace Officer Training Board, June 1977.

²Since the cost figures cited are average figures based on an anticipated outcome of 300 graduates per year, adjusted cost figures can be derived from unpublished cost data should outside influences strongly affect the projected graduate figures.

TABLE 1 ^a				
OPTION COSTS: TOTAL COST AND STATE SHARE				
Year	Vo-Tech Option Cost		Community College Option Cost	
	Total	State Share	Total	State Share
1	\$ 678,849.00	\$ 475,194.30	\$ 679,518.00	\$ 516,433.68
2	1,481,400.00	1,036,980.00	1,017,648.00	773,412.48
3	1,161,762.00	813,233.40	957,324.00	727,566.24
TOTAL	\$3,322,011.00	\$2,325,407.70	\$2,654,490.00	\$2,017,412.30
Annual cost after third year:				
	\$1,161,762.00	\$ 813,233.40	\$ 957,324.00	\$ 727,566.24

^aSource: See Figure 3.

Since the state pays for roughly 70% of the vo-tech costs and 76% of the community college costs,² the state share of the first three years' expenses is \$2,325,407 for vo-techs and \$2,017,412 for community colleges. Hence, the state will pay \$307,995 more under the vo-tech option for the first three years.

After the third year of each option's operation the annual state disbursement will be \$727,566 to the five community colleges and will be \$813,233 to the five vo-techs, a margin of \$85,667 between the options providing the number of vo-tech programs remains the same.

Therefore, during the first three years of operation and for each year thereafter, the vo-tech option appears more costly than the community college option assuming new law enforcement programs at vo-techs do not replace on-going programs and assuming reliable cost estimates from the institutions used in this analysis.

V. SUMMARY

This chapter, using a demand-supply framework, presents a forecast demand of law enforcement personnel over the period 1980-2000 by using variables that affect the demand for public safety and from these projections estimates roughly 300 new officers per year. For the state to educate such graduates exclusively at community colleges rather than exclusively at the vo-techs with an expanded number of programs, an annual cost savings of more than \$85,000 would occur.

Estimation of supply was not undertaken since officer's wages relative to competing occupations' wages are difficult to forecast and since uncertainty surrounds the public and/or private provision of training costs. Economic theory predicts that individuals should pay training costs if officers' wages are competitive, but such costs should be shared with the state or local agency if wages are not competitive.

APPENDIX

TECHNICAL CONSIDERATIONS OF PROJECTING TRAINING NEEDS

INTRODUCTION

This appendix provides technical background on the projection of police training needs for Minnesota over the period, 1980-2000. This portion of the report on future police training needs relies heavily upon the economic model of crime, as developed by Becker and others.¹ It uses an econometric model of demand for police, where the selection of explanatory variables is guided by economic theory. The next two sections discuss aspects of the methodology and develop the model. Then there follow the statistical results and, finally, the projections for Minnesota.

ECONOMIC MODEL OF CRIME

Economists generally regard all individuals as behaving in accordance with their perceptions of their self-interest. Thus, the higher are the likely gains from illegal activity, or the lower the losses, the more likely are people to engage in such activity. Likewise, the higher the perceived threat from crime, the more likely is the citizenry to demand crime control. Other community attributes can be identified as influencing the decision to commit crime, or the decision to employ more or fewer resources in crime control.

¹Becker, "Crime and Punishment: An Economic Approach," in *Essays in the Economics of Crime and Punishment*, ed. Becker and William M. Landes (New York: National Bureau of Economic Research, 1974), 1-54.

Since law enforcement agencies are typically viewed as the first line of defense against crime, the demand for law enforcement may be especially responsive to changes in criminal activity. That is, the higher the crime, the higher is the demand for police officers. The demand is also influenced by the costs, that is, the wage of police. The more costly are the police, then the fewer employed.¹ Demand is also constrained by the community's resources as reflected by assessed valuation and/or income levels; a wealthier community can employ more officers than a less wealthy community.

Police effectiveness might also be expected to have some impact on demand. That is, if police are highly productive, fewer will be able to achieve the output of a larger, less efficient force. Thus, the clearance rate, an admittedly rough measure of police efficiency, might be incorporated into an analysis such as this. Finally, a larger population would, on balance, be expected to employ more police officers than a smaller population.

All of these factors can be incorporated into a demand function such as the following:

$$(1) N = f(Cr, P, V, Cl, W).$$

Equation (1) simply states that the number of officers (N) is determined by the crime rate (Cr), the population (P), the assessed valuation in the community (V), the clearance rate (Cl), and the police wage (W). This

¹This implies an assumption that the supply of officers is perfectly elastic at the prevailing wage.

type of equation is quite consistent with a large volume of prior research.¹

The amount of crime occurring in a community reflects the perceived net gains from crime. Thus, a person with lower education and training may perceive the pecuniary benefits from legitimate employment as relatively low. Similarly, a younger person may be more likely to compare immediate benefits of illegal activity to the more distant and uncertain rewards of legitimate employment and select the former. In like manner, minorities may be, or perceive themselves to be, excluded from more remunerative employment opportunities and opt instead for illegal activities. A higher income community may, on balance, present higher rewards for illegal behavior; a larger population will likely experience more crime than a smaller population. Finally, a community with a larger police force should suffer less crime than a similar community with a smaller force.

All of these influences can be incorporated into an "aggregate supply

¹The interested reader is referred to L.R. McPheters and W.B. Stronge "Law Enforcement Expenditures and Urban Crime," *National Tax Journal*, 27 (December 1974): 633-44; Harold Votey and Llad Phillips, "Police Effectiveness and the Production Function for Law Enforcement," *Journal of Legal Studies*, 1 (June 1972): 423-36; P.W. Beaton, "The Determinants of Police Production Expenditures," *National Tax Journal*, 27 (June 1974): 335-49; J.I. Chapman, "An Economic Model of Crime and Police: Some Empirical Results," *Journal of Research in Crime and Delinquency*, 13 (January 1976): 48-63; M.J. Greenwood and W.J. Wadycki, "Crime Rates and Public Expenditures for Police Protection: Their Interaction," *Review of Social Economy*, 31 (October 1973): 138-51; T.G. Bergstrom and R.B. Goodman, "Private Demands for Public Goods," *American Economic Review*, 63 (June 1973): 280-96; T.E. Borcharding and R.T. Deacon, "The Demand for the Services of Non-Federal Governments," *American Economic Review*, 62 (December 1972): 891-901; R.G. Ehrenberg, "The Demand for State and Local Government Employees," *American Economic Review*, 63 (June 1973): 366-79.

of offenses" function such as the following:¹

$$(2) \text{ Cr} = g(P, \text{NW}, A, \text{Ed}, Y, N, \dots),$$

Equation (2) states the crime rate (Cr) is determined by the population (P), the percent of population non-White (NW), the population age distribution (A), the education level (Ed), and income (Y) defined by either the income level or income disparity and the number of officers (N).

The statistical estimation and interpretation of this model are discussed in the next section.

ECONOMETRIC TECHNIQUE

The application of statistical methods to models of behavior based on economic theory is called "econometrics." (Equations (1) and (2) constitute a two-equation model of the demand for police and crime determination.) The first step is to express equations (1) and (2) in linear form as follows:

¹Becker, op. cit. For other applications and verifications of this approach, see John P. Allison, "Economic Factors and the Rate of Crime," *Land Economics*, 48 (May 1972): 193-96; W.C. Bailey, J.D. Martin, and L.N. Gray, "Crime and Deterrence: A Correlation Analysis," *Journal of Research in Crime and Delinquency*, 11 (July 1974): 124-43; B.V. Vechdolt, Jr., "Cross-Sectional Analyses of Socioeconomic Determinants of Urban Crime," *Review of Social Economy*, 33 (October 1975): 132-40; R.A. Carr-Hill and N.H. Stern, "An Econometric Model of the Supply and Control of Recorded Offenses in England and Wales," *Journal of Public Economics*, 2 (November 1973): 289-318; Isaac Ehrlich, "Participation in Illegitimate Activities: An Economic Analysis," in *Essays in the Economics of Crime and Punishment* ed. G.S. Becker and W.M. Landes (New York: National Bureau of Economic Research, 1974): 68-134; M.T. Katzman, "The Economics of Defense Against Crime," *Annals of Regional Science*, 9 (March 1975): 68-76; D.L. Sjoquist, "Property Crime and Economic Behavior: Some Empirical Results," *American Economic Review*, 63 (June 1973): 439-46.

$$(1') \text{ N} = a_0 + a_1 \text{Cr} + a_2 P + a_3 V + a_4 \text{Cl} + a_5 W$$

$$(2') \text{ Cr} = b_0 + b_1 P + b_2 \text{NW} + b_3 \text{Ed} + b_4 A + b_5 Y + b_6 N$$

The objective is to estimate the coefficients (the a's and b's) of the right-hand variables, that is, to measure their separate effects of N and Cr, respectively. This indicated N and Cr, the number of police officers and the crime rate respectively, that can be expected for different explanatory variable values. Equally important is the goal of explaining as much of the variance in N and Cr as possible, that is, including the "correct" variables on the right-hand sides so that reasonable, reliable predictions of N and Cr can be generated.

Multiple regression is the econometric technique used.¹ Since two equations are involved in a mutually-interdependent fashion (i.e., officers partially determine crime and crime partially determines officers), a refinement called "two-stage least squares" is applied. Primary interest here is in equation (1') which, when estimated, can be used to predict the value for N (number of police officers) given values of the explanatory variables. Expected values of the explanatory (right-hand side) variables for future time periods can be inserted in the equation, yielding through simple calculation expected future values of the dependent (left-hand side) variable, law enforcement personnel.

At this point, a major caveat regarding forecasting of this nature is in order. Accurate predictions of demand are restricted under the best of conditions with reliable data to three or four years. For longer projection

¹For a relatively straightforward discussion, see H.H. Kelejian and W.E. Oates, *Introduction to Econometrics* (New York: Harper and Row, 1974), especially 119-44.

periods, the margin of error will be much larger.¹ Despite this problem, many analysts engage in long-term estimates. The reason is that sufficient lead time is required for preparing highly-trained personnel in a number of occupations.² Techniques such as this also have perceptible advantages over such rules of thumb as so many officers per 1000 population. Such rules ignore population characteristics, do not take into account the economies and/or diseconomies of scale, and sometimes become resistant to change as circumstances alter.

STATISTICAL RESULTS

The results of estimating equation (1') are presented in Table A.1. Three different measures of crime (total crime, violent crime, or property crime) are used to estimate the three equations labeled A, B, and C. The variables which generally are significant of peace officer demand are population, total crime, violent crime, property crime, assessors taxable valuation of property, and time. The last variable (time) is included to capture any trends not accounted for by the other independent variables, and turns out to have an interesting implication.

¹Blaug, op. cit., 159-68.

²It remains to be seen that such lead time is necessary in the training of police, especially since current training periods range from 8 to 20 weeks. What may be the case, however, is that if new facilities are required for such training, then the appropriate capacity of such facilities requires estimates of training needs in the future.

TABLE A.1
DEMAND FOR LAW ENFORCEMENT PERSONNEL (1945-1975)^a

	(A)	(B)	(C)
CONSTANT	-6372.4439 (1.560)	-2909.1263* (2.254)	-6274.1363 (1.447)
POPULATION	1.9817 (1.346)	1.1731* (2.414)	1.9010 (1.224)
TOTAL CRIME	.0251* (3.407)		
VIOLENT CRIME		.2644* (9.970)	
PROPERTY CRIME			.0265* (3.132)
TAXABLE VALUATION	.0000* (6.125)	.00000134* (8.522)	.0000* (5.946)
TIME	-210.2779* (2.238)	-81.2196* (3.264)	-211.0235* (2.087)
S.E.E.	284.496	107.9549	298.363
R ²	.934	.991	.928
F	104.364	761.956	94.321
DW	1.989	1.633	1.962

^aData adjusted to include all but part-time personnel.

*Significant at 5 percent level.

If an explanatory variable is statistically significant, variations in the variable do indeed affect the peace officers demanded. In each column of Table A.1, there is a specific number (above each number in parenthesis) denoting each explanatory variable's contribution toward the law enforcement officers demanded. However, tests must be applied to these numbers in order to determine their significance and the whole equation's significance.

The F statistic is an analysis of variance test statistic. It measures the statistical significance of the explanatory variables taken together towards explaining the peace officers demanded. The total contribution of the variables towards explaining variations in the peace officers demanded is evaluated by using the adjusted coefficient of variation (\bar{R}^2). For example, in equation (B), the \bar{R}^2 is .991. This number means that over 99% of the variation in personnel demanded can be explained by changes in population, in violent crime, in taxable valuation, and in the time trend variable. The numbers in parentheses denote t-statistics. The statistical significance of each variable's separate influence on the peace officers demanded is gauged by using this statistic. The Standard Error of Estimate (S.E.E.) evaluates the accuracy of the prediction equation by estimating the variation between the actual and predicted values of the dependent variable, law enforcement personnel. Testing to make certain an important variable has not been omitted is done by using the Durbin-Watson Test (DW).

The results generally support the economic model. As is suspected, population expansion calls forth more police officers. Likewise, the measures of crime, entered separately into three versions of the basic equation, are positively associated with greater demand for police. Taxable valuation, the measure of ability to pay, also has the "correct" sign, i.e., influences the number of officers in the hypothesized way. The greater the community's property wealth, the larger the number of officers employed. The time variable, however, has a negative sign. This can be interpreted as a measure of technical change or automation. That is, over time, capital is substituted for personnel, so that people

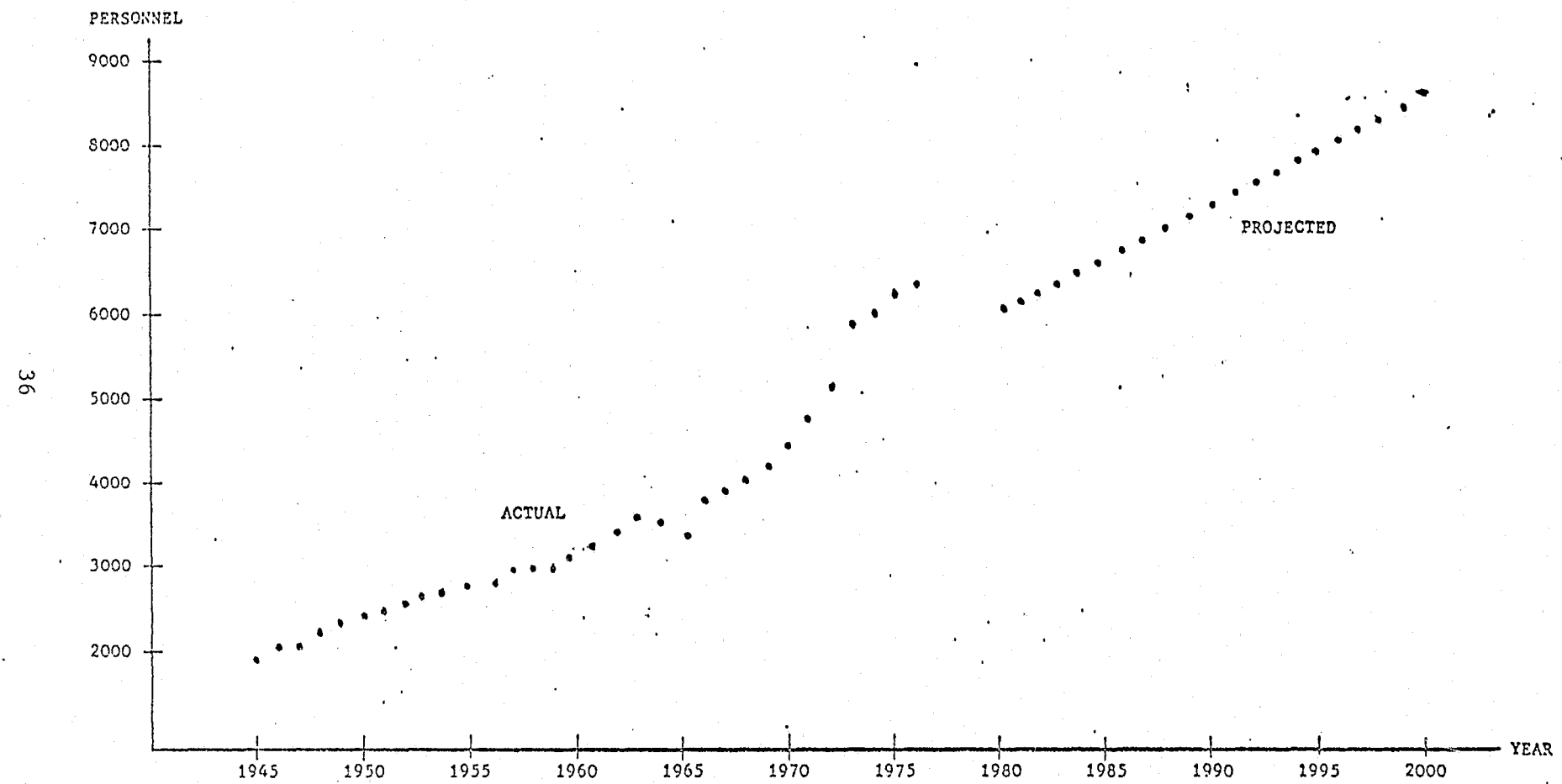
become more efficient and fewer are required. Another interpretation is that over time, more highly skilled people are entering the profession who, in the past, chose other professions.

While all three versions of the equation are acceptable, the second (B) is clearly the "best." It has the lowest standard error of the estimate (SEE), highest adjusted coefficient of determination (\bar{R}^2), and highest F statistic. These measures refer, respectively, to the smallest deviations in the predicted values of the number of personnel from the actual values; the ability of the equation to explain, or predict, the number of personnel; and the significance of the explanatory variables, taken together. These also support the inference that violent crime is far more likely to generate more demand for police than is property crime.

PERSONNEL AND TRAINEE PROJECTIONS

The trend in police personnel is depicted in Figure A.1. The upward trend saw few reversals, but in 1966, there occurred an apparent increase in growth. Perhaps not coincidentally, this follows closely upon the formation of the President's Commission on Law Enforcement and Administration of Justice. Another discontinuity occurred in 1972, when the trend jumped considerably. This may reflect increased availability of federal funding during much of this period.

FIGURE A.1
ACTUAL AND PROJECTED LAW ENFORCEMENT PERSONNEL, 1945-2000



These discontinuities render even more difficult an already challenging task. Using version B in Table A.1, and simply projections of values of the explanatory variables, the results in Table A.2 are obtained.

Year	Personnel	Replace- ment*	Growth- Induced	Total New
1980	5594	84	105	189
81	5699	85	107	192
82	5806	87	109	196
83	5915	89	111	200
84	6026	90	113	203
85	6139	92	104	196
86	6243	94	107	201
87	6350	95	107	202
88	6457	97	110	207
89	6567	99	111	210
90	6678	100	96	196
91	6774	102	98	200
92	6872	103	99	202
93	6971	105	100	205
94	7071	106	103	209
95	7174	108	89	197
96	7263	109	89	198
97	7352	110	91	201
98	7443	112	92	203
99	7535	113	93	206
2000	7628	114	94	208

*Estimated at 1.5% of base.

It is clear that a single functional form applied over the entire period may not be adequate. For example, the projected figure for 1980 is less than the reported figure for 1975 while that for 1985 is only slightly higher. It is tempting to assert that the regression line is the proper basis for an estimate, and that events of the period 1967-1974 represent only temporary aberrations. Indeed, a temporary infusion of federal funds into a field may have dramatic temporary effects on employment and enrollment

in that field. For example, Hansen¹ has documented the rise and fall in engineering employment and enrollment during the 1950's and 1960's. He statistically found defense and space program funding levels to be a major explanatory variable. Similarly, if LEAA funds are decreased and not supplemented by state or local funds, a return to the projected trend line over the period 1980-2000 may be expected.

Observation of Figure A.1 suggests the proper relationship may be linear. However, the model was also estimated in both natural log and exponential equation forms to check for a curvilinear relationship. Generally, the coefficients derived (but not reported here) were statistically not as good as the linear model's coefficients; that is, they did not explain adequately past variations in the demand for police officers and hence would make poor predictors of future demand. So, projections based on the natural log and exponential models were discarded as providing a poorer fit to the data.

If, on the other hand, the events since 1965 represent a permanent structural change and not just an aberration due to funding levels, the model should be estimated for the shorter period and this can be used as a basis for the projected figures. Selected results of this approach are presented in Table A.3. The version entailing the lower SEE and highest R^2 is the second.² In this version, Taxable Value is the only significant

¹W. Lee Hansen, "The Economics of Scientific and Engineering Manpower," *Journal of Human Resources*, 2, (Spring 1967), 191-215.

²See the earlier discussion of these concepts in the Statistical Results section.

regressor. Time does seem to capture some of the technical change, although the coefficient is not significant. The projections in Table A.4 are derived from use of this version.

TABLE A.3
DEMAND FOR LAW ENFORCEMENT PERSONNEL (1965-1975)^a

	(A)	(B)	(C)
CONSTANT	4414.4972 (.543)	2344.2604 (.379)	4546.4449 (.559)
POPULATION	-2.6047 (.849)	-.9012 (.370)	-2.6532 (.865)
TOTAL CRIME	-.0007 (.200)		
VIOLENT CRIME		.3295 (1.657)	
PROPERTY CRIME			-.0008 (.227)
TAXABLE VALUATION	.00000051 (1.172)	.00000088* (2.302)	.00000050 (1.160)
TIME	340.2972 (1.909)	54.4017 (.274)	343.1885 (1.939)
S.E.E.	149.906	137.6216	149.742
R^2	.973	.977	.973
F	81.089	96.445	81.269
DW	2.040	2.087	2.040

^aData adjusted to include all but part-time personnel.

*Significant at 5 percent level.

TABLE A.4				
ESTIMATED NEW PERSONNEL REQUIREMENTS (BASE YEARS: 1965-1975)				
Year	Personnel	Replace- ment*	Growth- Induced	Total New
1980	6163	92	150	242
81	6313	95	154	249
82	6467	97	158	255
83	6625	99	163	262
84	6788	102	163	265
85	6951	104	152	256
86	7103	107	154	261
87	7257	109	159	268
88	7416	111	161	272
89	7577	114	167	281
90	7744	116	158	274
91	7902	118	161	279
92	8063	121	165	286
93	8228	123	168	291
94	8396	126	172	298
95	8568	129	165	294
96	8733	131	167	298
97	8900	134	171	305
98	9071	136	174	310
99	9245	139	180	319
2000	9425	141	184	325

*Estimated at 1.5% of base.

Which projection will be the most accurate depends on whether the base period 1945-1975 or 1965-1975 best describes the trend in personnel needs that is expected to continue over the period 1980-2000. Having no extensive prior knowledge over which base period is best, the final results presented in Table A.5 is the average of figures described in Tables A.2 and A.4. It is from these figures (Table A.5) that the report's estimated statewide capacity for producing approximately 300 newly trained officers annually is derived.

TABLE A.5					
ESTIMATED NEW PERSONNEL REQUIREMENTS ^a (AVERAGE: TABLE A.3 AND TABLE A.4)					
Year	Person- nel ^b	Replac- ment ^c	Growth- Induced	Total New ^d	Smooth Series ^e
1980	5879	88	127	215	216
81	6006	90	131	221	218
82	6137	92	133	225	221
83	6270	94	137	231	223
84	6407	96	138	234	225
85	6545	98	128	226	228
86	6673	100	131	231	230
87	6804	102	133	235	233
88	6937	104	135	239	235
89	7072	106	139	245	238
90	7211	108	127	235	240
91	7338	110	130	240	243
92	7468	112	132	244	245
93	7600	114	134	248	248
94	7734	116	137	253	251
95	7871	118	127	245	253
96	7998	120	128	248	256
97	8126	122	131	253	259
98	8257	124	133	257	262
99	8390	126	137	263	264
100	8527	128	139	267	267

^a Average of two projections. One using a 1945-1975 base (low projection) and another using a 1965-1975 base (high projection).

^b Includes all but part-time personnel.

^c Estimated at 1.5 percent of base and due to resignations, retirements, and deaths. See Minnesota Department of Employment Services, *Minnesota Employment, 1970-1980*, p. 4.

^d Total new personnel demand = Replacement personnel demand + Growth-induced personnel demand.

^e Smoothing based on constant annual rate of change over the period, 1980-2000.

Since the error bound for statistical estimates increases sharply the farther the estimate occurs from the base period (in this instance, either 1945-1975 or 1965-1975), the question is raised as to the magnitude of such error. To answer this question, the forecast error¹ for each equation

¹For the method used, see Jan Kmenta, *Elements of Econometrics* (New York: MacMillan Company, 1971), 374-76.

was estimated at various future time periods using a 95% confidence interval. From these forecast errors for total personnel employed, the error bound on the estimated trainee number of similar years was derived for figures in Tables A.2 and A.4. The appropriate trainee error bounds for each table entry examined were then averaged across the separate tables to find the error bound for Table A.5. For 1980, the trainees needed may be over- or under-estimated by at most 42 recruits given a 95% confidence interval; by 1990, this figure increases to 63 recruits, and by 2000, the error may be at most 88 recruits. However, since the text of this report uses 300 recruits as the statewide capacity for producing newly trained officers and since the error (especially in the next 15 years) is not large, the figures quoted in Table A.5 may be regarded as statistically reasonable estimates.

CONCLUSION

In summary, the figures presented in this report are projections, i.e., they describe what would result if our assumptions concerning trends in variables such as population, violent crime, and taxable valuation prove correct. In order to insulate our figures from the undue influence of federal funding level changes, two base periods are used for the final projected trainee numbers: 1945-1975 and 1965-1975. By averaging the projected figures derived from these two base periods, the situation described best indicates the case in which the state government picks up part of the tab as federal money to the law enforcement area wanes.

END