

USE OF SOCIAL AND ECONOMIC MODELING TO PLAN VOCATIONAL EDUCATION AND TRAINING

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Abstract: The Workforce Education and Development program at Penn State University applies input-output and social accounting models to provide information for planning vocational education and training. These models are specified, and several applications of these models to training investment research are described.

INTRODUCTION

Integration of vocational education and training investments with modern social and economic needs requires advanced analytic tools. Reviewed in this paper are uses of analytic tools applied in planning research conducted through the Workforce Education and Development (WF ED) Program at Penn State University. The WF ED program has applied these tools to analyses of the employment outlook in various occupations as an input to training investment decisions.

MODEL

The WF ED program has applied input-output and social accounting models in its research on the implications of employment growth and change for the need for training investment. A hybrid input-output and social accounting model, called the *Pennsylvania REMI Economic Model*, was prepared by Regional Economic Models, Inc. (REMI) from Amherst, Massachusetts, for use in economic and demographic modeling and forecasting by the WF ED program. In 1992, the *International Regional Science Review* wrote that REMI models are one of the “extraordinary successes in the history of regional modeling” and represent the “state of the art in multiregional econometric modeling practice.”

The *Pennsylvania REMI Economic Model* tracks the complex interindustry relationships that deliver industrial output for personal consumption expenditures, government demand for goods and services, fixed investments, and domestic and international exports. It documents the role that these factors play in supporting jobs and income throughout the economy.

In a single source, the *Model* provides information about the performance of the Pennsylvania economy as well as unique information about the relative competitiveness of the Pennsylvania economy with the rest of the United States in terms of prices, costs, productivity, and profitability in 53 industrial sectors. Also available is demographic information about 202 age/sex groups. Detailed information is provided about taxes by source, transfer payments by type, and employment in 628 occupations. Moreover, information is available about the status of small businesses in the Commonwealth.

The *Model* synthesizes information from many sources—to name a few: Bureau of Economic Analysis employment, wage, and personal income series, Bureau of Labor Statistics employment and wage data, and County Business Patterns data collected in conjunction with the Social Security program. The 1996 version of the Model contains historical data from 1969 through 1994 and allows forecasts from 1995 through 2035. Manipulation of several thousand *Model* variables allow simulation of the effects of policy, legislative, and natural changes on the Pennsylvania economy and demography.

Some WF ED applications of the *Pennsylvania REMI Economic Model* include studies of the: sensitivity of the economy of rural Pennsylvania to changing national defense expenditures; employment and income consequences of adopting California pollution standards in Pennsylvania; impact of vehicle emission testing; history and prospects for Pennsylvania manufacturing; economic outcomes of educational reform; economic impact of highway construction and use; structure of the Pennsylvania printing and publishing industry; effects of changing national health spending patterns on Pennsylvania health care and service employment; economic consequences of lowering teenage birth rates; effects of changing national infrastructure spending patterns on Pennsylvania construction employment; Pennsylvania impact of the 1994 baseball strike; and employment outlook for cosmetologists.

Shown in Figure 1 are the major paths of economic interrelationships endogenous to the *Pennsylvania REMI Economic Model*.

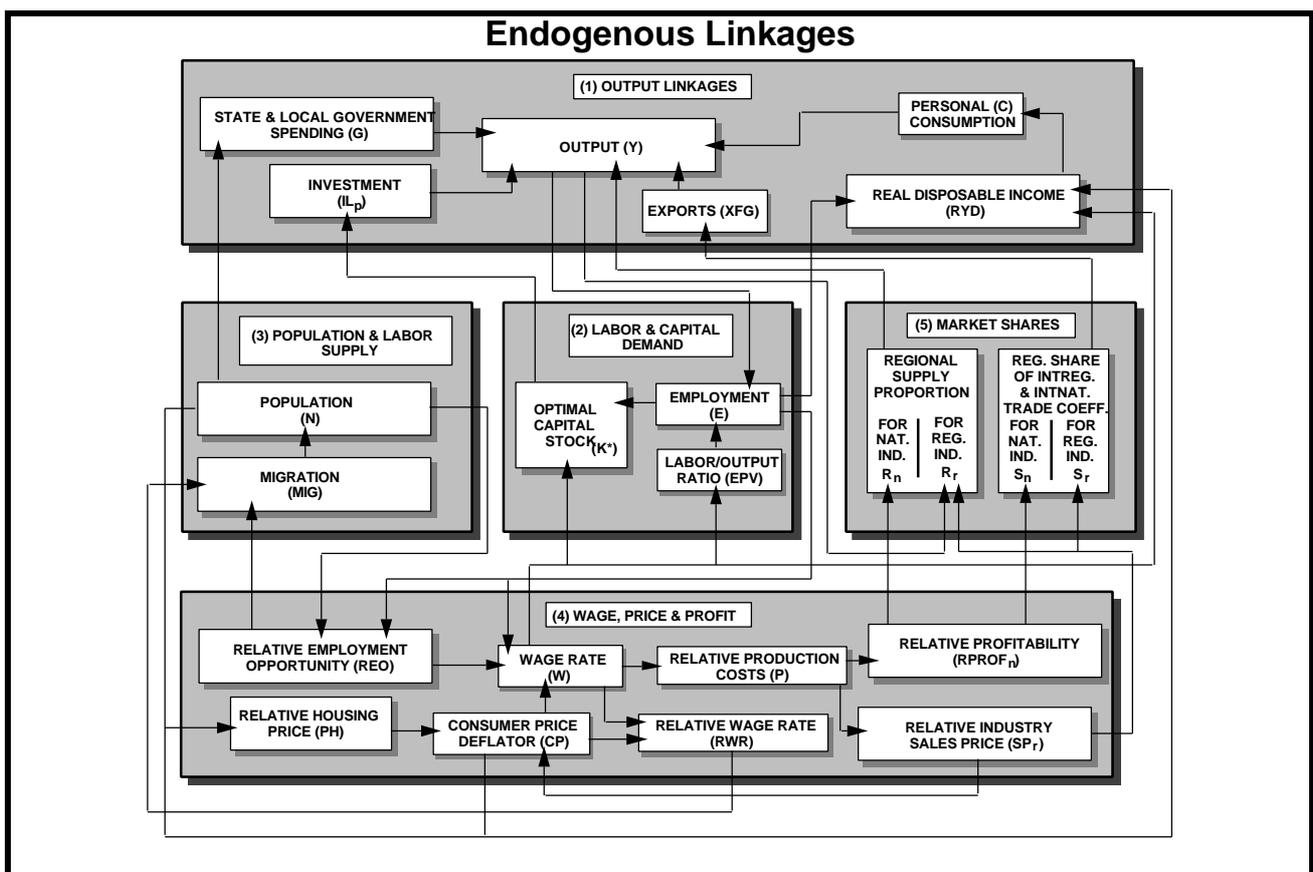


Figure 1. *Endogenous Linkages in the Pennsylvania REMI Economic Model Among Economic Output, Labor & Capital Demand, Population & Labor Supply, Wages, Prices, & Profits, & Market Shares*

This figure summarizes a large number of simultaneous equations that form the mathematics of the *Model*. The *Model* contains five sections of equations:

- The output section of the *Model* (Block 1) accounts for economic output that is created by personal consumption, government spending, and fixed investment in Pennsylvania and net exports from the Commonwealth.
- The labor and capital demand section (Block 2) models demand for nonresidential structures and equipment. Cobb–Douglas production function technologies are used to model substitution between capital and labor and to determine the amount of labor needed to deliver an unit of economic output (i.e., labor intensity). Employment requirements are calculated by multiplying labor intensity by economic output (Block 1).
- The population and labor supply section (Block 3) accounts for ways the effects of demography on the economy as well as the effects of the economy on demography. For instance, the size of the Pennsylvania population affects government spending because many government services (e.g., health, education, and safety) are delivered on a per capita basis. Moreover, the size of the population is affected by economic conditions in Pennsylvania. For instance, migration into and out of Pennsylvania is affected employment opportunities and wage rates relative to the rest of the United States. The *Model* contains detailed algorithms for forecasting births, deaths, and migration due to net immigration, migration of retirees and former military personnel, and economic migrants.
- The wage, price and profit section of the *Model* (Block 4) determines wage rates, prices for regional and national industries, and profits for national industries. Pennsylvania wages relative to the rest of the U.S. are a function of, among other factors, relative employment opportunities and consumer price changes. The *Model* calculates costs of fuel, labor, capital, and intermediate products relative to the rest of the United States. Some business taxes are modeled as capital costs to industries. Profitability is affected by costs and selling prices. Relative profitability of Pennsylvania industries affects regional, interregional, and international market shares held by the industries.
- The market shares section of the *Model* (Block 5) are divided into two types: regional market shares and export shares. Regional shares are the proportion of Pennsylvania demand fulfilled by Pennsylvania industries. Export shares include domestic and international exports and are affected mostly by changes in production costs. Because firms do not move to Pennsylvania instantly as a result of changes in costs, the *Model* contains empirically estimated lags between cost changes and increases in exports shares. Increases in regional shares substitute Pennsylvania products for imports. Export shares include domestic and international exports and are affected mostly by changes in production costs.

These five sections are calculated for all 49 industrial and four governmental sectors of the *Model*.

AN EXAMPLE

The *Pennsylvania REMI Economic Model* is the analytic tool applied in over 20 studies by the WF ED program at Penn State that have implications for planning vocational education and training. One example of these studies, a study of the employment outlook for cosmetologists, is summarized.

Cosmetologists deliver personal services meant to help people appear presentable and attractive according to cultural norms. In this study, we investigated the employment outlook for cosmetologists. First, we forecast employment and job openings for cosmetologists in Pennsylvania

from 1995 through 2005 using the *Pennsylvania REMI Economic Model*. This aspect of our study helps to verify whether jobs are anticipated for cosmetologists. However, employment forecasts are conditional estimates of employment given a particular pattern of economic activity. It is useful to consider whether an employment forecast varies with variations in general economic activity. Therefore, the second purpose of this study is to estimate the sensitivity of Pennsylvania cosmetology employment to changes in consumer spending as well as changes in the business environment as reflected in taxes and costs.

Shown in Table 1 is a forecast of Pennsylvania cosmetology employment from 1995 through 2005. We forecast average annual employment growth of 544 cosmetologists over this period. Not all employment of cosmetologists is in the beauty shop industry. Some cosmetologists work in other industries, including health care (nursing homes, hospitals) and retail stores (beauty shops owned by stores).

Table 1. *Forecast Of Employment Of Cosmetologists In Pennsylvania, 1995-2005*

	1995	2000	2005	Annual Average Change
<i>All Industries</i>				
Workers	49,158	52,226	54,056	544
5-Year Change		3,068	1,830	
<i>Beauty shops</i>				
Workers	45,348	47,997	49,526	464
5-Year Change		2,649	1,529	
<i>Other Industries</i>				
Workers	3,810	4,229	4,530	80
5-Year Change		419	301	

Source: 1995 PA REMI 53 SectorEconomic/Demographic Forecasting and Simulation Model

Displayed in Table 2 is a forecast of job openings between 1995 and 2005 for cosmetologists due to employment growth and need to replace cosmetologists who die, retire, or otherwise leave the occupation. On an annual basis, approximately one of every five job openings for cosmetologists is anticipated to occur because of the need for replacement.

Table 2. *Job Openings for Cosmetologists in Pennsylvania, 1995-2005*

	Total	Annualized Average
Growth	4,898	544
+ Replacement	1,022	114
Job Openings	5,920	658

Source: 1995 PA REMI 53 SectorEconomic/Demographic Forecasting and Simulation Model

Table 3 contains deviations from the baseline forecast of cosmetology employment that are likely to

result from changes in consumer spending and business taxes and costs.

Table 3. *Sensitivity Of Pennsylvania Employment In Cosmetology To Selected Economic Trends & Policy Changes, 1995-2005*

Trend Or Change	1995	2000	2005
<i>Forecast Without Policy Changes</i>			
	49,158	52,226	54,056
<i>Difference from Baseline in Number of Workers</i>			
<i>Consumer Spending</i>			
-1% In Total Consumer Spending	1,502	1,399	1,024
-1% In Other Services Spending	-1,149	-1,647	-2,293
- \$10 MM In Personal Consumption	-1,884	-1,789	-1,443
<i>Business Environment Taxes</i>			
-1% In Total Business Taxes	2,026	1,937	1,591
-1% in Business Tax On Equipment	2,351	2,349	2,004
-1% in Business Tax On Property	2,696	2,730	2,381
<i>Costs</i>			
+1% In Investment Credit	-2,056	-1,981	-1,633
+1% In Total Production Cost	-981	-317	-339
+1% In Personal Service Production Cost	-1,871	-1,641	-1,235
+1% In Non-Wage Labor Cost For Personal Service Industry Only	-1,906	-1,696	-1,273
+1% In Non-Wage Labor Cost For All Industries	-1,616	-1,207	-671

Source: 1995 PA REMI 53 SectorEconomic/Demographic Forecasting and Simulation Model

As might be expected, decreases in consumer spending decrease cosmetology employment. One percent decreases in elements of this scenario are associated with between 2% to 4% reductions in cosmetology employment. Every reduction of \$10 million dollars of personal consumption expenditures results in loss of between 3% and 4% of total cosmetology employment. One percent decreases in various business taxes increase employment by between 4% to 5%. On the other hand, a 1% increase in investment credits increases cosmetology employment between 3% to 4%. Increases in total as personal service industry production costs reduce cosmetology employment, as do increases in non-wage labor costs.

This study, then, demonstrates that approximately 650 annual openings were forecast for cosmetologists between 1995 and 2005. However, cosmetology employment is sensitive to a number of economic factors related to consumer spending as well as business taxes and costs. Caution and attention to economic factors are needed with decisions to enter cosmetology training, to provide cosmetology training, and to fund cosmetology training in Pennsylvania.

USES IN PLANNING

Occupational employment forecasts often are presented to policy-makers as single point estimates of the level of employment at some future date. However, all forecasts are conditional. Therefore, testing the sensitivity of forecasts to variations in their generating assumptions and conditions provides useful information about the risks and uncertainty embedded in using the single point estimates for planning purposes.