GENERAL MOTORS LORDSTOWN: A SIMULATION IMPACT STUDY ON THE YOUNGSTOWN-WARREN ECONOMY

by

Joseph Bartholomew

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Joseph Bartholomew

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Signature: Joseph Bartholomew 5/19/99
Joseph Bartholomew, Student Date

Approvals:

5/19/99
Yih-Wu Liu, Ph.D, Thesis Advisor Date

5/19/99
Dennis Petruska, Ph.D, Committee Member Date

5/19/99
Anthony Stocks, Ph.D, Committee Member Date

5/19/99
Peter J. Kasvinsky, Dean of Graduate Studies Date

Abstract

General Motors' "acceptance" of its recent decline in market shares has prompted the company to make drastic changes in its production methods. These improvements will begin with a change from on-site assembly to modular assembly of certain car components. Along with a new production technique, General Motor's will also build new plants to accommodate modular assembly. These announced plans threaten existing plants, many of which desperately need capital improvements. Ultimately, those locations that are not selected for the new plants will probably witness the closing of their assembly plants. The General Motors plant in Lordstown, in particular, falls in this category. Built in 1966, the plant houses General Motors' small car operations, and, at that time, was the largest and most automated assembly plant. The plant has also become an important manufacturing firm for Mahoning, Trumbull and Columbiana counties. General Motors has not yet confirmed any plans to reinvest in Lordstown; therefore, if a shutdown occurs, the region may suffer serious economic consequences. This paper studies the possible ramifications of both a decision to build and a decision to shut down the plant on the Youngstown-Warren economy. Specifically, a regional econometric model is used in four different scenarios that reflect the two possible decisions. Scenario 1 and scenario 2 focus on the selection of Lordstown for the new plant while scenario 3 and scenario 4 take the alternative view. Regional multipliers and time series graphs then are used to study these effects and draw conclusions for the scenarios.

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Chapter 1 Introduction

General Motors' market share of the domestic auto industry has been slowly shrinking in the last decade, and several elements can explain this fall from supremacy. First, General Motors is far behind Ford and Chrysler in producing and marketing mini-vans and sport utility vehicles, which is now one of the fastest growing segments of the market. Second, their cars lack the engineering quality and designs of their competitors, resulting in reduced sales. Finally, the continued use of traditional assembly methods in aging assembly plants has increased costs and reduced efficiency. In an effort to reverse this trend, General Motors is gearing up for a massive reformation project.

One of the key features of this project rests with the commitment to abandon old production methods and, instead, build cars using modules. With modular assembly, less laborers will be needed to build the cars, and outsourcing to suppliers will result in lower prices for car parts. Since first announcing these changes, General Motors has nearly selected all the locations for the new plants. They have however left the last remaining site unmentioned, responding by only saying that the choice has been narrowed to two possible locations: Lansing and Lordstown. Without hesitation, both cities began local campaigns to help convince General Motors to reinvest in their respective region.

The possibility of Lordstown shutting down has spawned many questions about its impact on the Youngstown-Warren economy in the event of this decision. This paper examines these questions and attempts to put into "prospective" the possible economic consequences of its closure. In the following chapters ahead, four scenarios are introduced relating to the two possible outcomes of a decision. A regional econometric model analyzes these different scenarios and delivers many important conclusions.

Before drawing any conclusions about Lordstown's future, the paper begins with a detailed discussion of its thirty-three year old history.

Chapter 2 History

This section follows the history of the Lordstown's assembly and Fisher Body plant from its rocky beginnings and prosperous years to the present.

The Beginnings

The post World War II automobile industry experienced a steady increase in the demand for its products, and General Motors especially felt this surge. For General Motors, this phenomenon lead to a nationwide investment of new plants, equipping them with the latest automobile technology and assembly line methods (*Vindicator*, 1966, p. E10). One of these sites, Lordstown, Ohio, brought an innovative plant design of a dual Fisher Body and Chevrolet Assembly Plant to advance the process of building automobiles. An official indication of this planned investment came in February, 1956 when General Motors bought 775 acres of land, and, later, in May when they purchased an additional 300 acres (Reiss, 1956, p.1). This location, a mile south of Lordstown at the intersection of Young-Hallack and Bailey-Ellsworth roads, was located in the middle of a quiet farming community of 2,000 residents. Initially, the plant had an estimated employment capacity of 8,000 to 20,000 workers, total area of 2,250,000 feet and estimated costs of $75 million. Preliminary figures indicated that the plant would be the world's largest automobile assembly plant (*Vindicator*, 1956, p. 13).

After several delays in the start of its construction, groundbreaking ceremonies finally commenced on September 30, 1964. With construction finally underway, expectations of the new plant's economical impact on the surrounding area remained high. Former Governor Rhodes, for instance, said, "This is a giant step in the economic growth of the Mahoning Valley " (Jagnow, 1964, p.1). Estimations of its impact concur with his statements as forecasted purchases from suppliers around Mahoning County ranged form $9 million to $11 million and payroll and other estimated purchases reached nearly $45 million (Jagnow, 1964, p.1). These figures then indicated that important secondary effects would appear because of the new plant, including the development of new businesses and expansions of existing businesses.

Construction was expeditiously completed, and the plant produced its first car on March 4, 1966--one year and seven months after initial ground breaking. At this time, only 1,500 workers were employed at the plant, and production rate was only five cars an hour; however, with an expected increase in production, General Motors Lordstown was hiring hundreds of workers a week (*Vindicator*, 1966, p. E5). While General Motors intended on hiring more workers, the list of applicants greatly exceeded the number of jobs available. Astonishingly, personal managers of both the Fisher Body and Chevrolet Assembly Plants received over 35,000 job applications, some as far away as Florida and California but most within the regional area. (*Vindicator*, 1966, p. E5). The expected job opportunities made available by the new manufacturing plant rendered it the title of the area's most important and promising new business of the 1960's.

The 1970's: The Turbulent Years

For the Mahoning Valley, the end of the 1960's were a period of both anticipation and relief as the "world's largest" automobile plant was finally built and producing cars. The 1970's however brought a new set of challenges for the automobile plant. With pollution control issues and rising fuel costs making headlines, the demand for more fuel-efficient cars was rising. Small car imports made deep inroads into the domestic automobile market, reducing the demand for domestic products and snatching profits away from American automakers. General Motors, vowing to reclaim the market for domestic cars, introduced a new small car that had, as the company described, "maximum combination of low pollutant emissions, fuel economy and performance" (*Vindicator*, 1970, p.1). This changing market would soon alter the role of Lordstown in producing cars.

General Motor's ' optimism about a resurgence in demand for domestic cars was attributed to its plan to build its new line of compacts--known as the Vega 2300--at the company's newest and most automated plant in Lordstown. In preparation, General Motors added a new section to its complex: a 2.2 million square foot metal stamping plant. In addition, the company redesigned the assembly line and Fisher Body plant to accommodate the production of the new small car. General Motors wasted no time in equipping the plant for production of the new Vega (*Vindicator*, 1970, p.1).

Within a few months, all necessary preparations for the Vega's arrival were complete; however, production was halted by a two-month strike--the first major work stoppage at the plant. The strike, resulting from a contract dispute, was however settled within two months, and, with production resumed, the first Vega was produced in November, 1970 (*Vindicator*, 1970, p.1). Concurrent with General Motor's pursuit of building small cars, they also saw potential profits in another area of the auto industry: the van market.

To gain a foothold in the market, General Motors once again selected Lordstown as the site to build a new product line. As Reiss (1970) reported, this plan called for the building of a 630,000-foot assembly plant that would ultimately cost $25 million and employ 1,500 workers (p.1). For Lordstown, 1970 brought much promise and success; however, as the years rolled on and production of small cars increased to record levels, problems began to occur.

In 1972, General Motors Lordstown was distinguished with the fastest assembly line (100 cars/hr), and, ironically, this achievement led to the most significant strike in the plant's history. Problems first began to surface when the company hired General Motor's Assembly Division, a new management team, to take over the management of the plant. Specifically, disputes occurred after the new team attempted to increase efficiency and reduce costs by cutting back on jobs; moreover, the remaining workers were responsible to pick up the slack (*Automotive Industries*, 1972, p. 18). Workers, in opposition, retaliated and caused production setbacks through increased absenteeism and number of defects, low productivity and outbreaks of worker sabotage. In fact, workers even publicly admitted to committing sabotaging acts such as failing to do their job, incorrectly installing parts and purposely causing damage to cars (Rothschild, 1972, p18; Given, 1972, p.50). Management, enraged at these actions, developed more strict policies, and eventually the workers went on strike. In response to the strike, Emma Rotheschild (1972) said, "conditions there are bound to be important for years" (p. 18). This statement suggests that even though the strike was brief (three weeks) and did not severely handicap production, the strike's underlying issues would continue to be a source of problems for Lordstown.

Redemption in the 1980's

By the end of the 1970's, General Motors Lordstown's role in producing automobiles was secured. Lordstown had been producing the Vega since 1970, and, just as the car's luster began to disappear, General Motors awarded the plant with a new contract for building compacts. This new group consisted of the Chevrolet Monza, Pontiac Sunbird, Oldsmobile Starfire and the Buick Skyhawk, and this responsibility set company records for the number of models produced at one plant (Reiss, 1977, p.1).

The beginning of the 1980's brought even greater prominence to Lordstown as it again won the bid to produce the next line of compacts, the J cars (Mahoney, 1981, p.3). Once recognized as incorrigible, young and fearless, this now tamer group of employees was again given the task of revitalizing GM's small car market. Also, at this time, General Motors Lordstown's operations were thriving as employment reached its highest levels and demand for its products were strong.

While GM's valley operations remained strong, other businesses were experiencing different economical conditions. For example, Youngstown's industrial foundation, Steel, began its decline in the late 1970's, and the full ramifications did not appear until the early 1980's. As unemployment soared and thousands of jobs were lost, General Motors arguably served as the crutch to a fallen manufacturing sector. It can also be hypothesized that Lordstown's existence aided in an economic rebound years later.

With the decline of the steel industry, Lordstown, now assumed a new identity. As the area's leading manufacturing company, it was imperative that Lordstown cleanup its reputation and avert labor-management problems. Fortunately, the 1980's served as a non-strike era, and some officials gave credit for this accomplishment to the presence and services of Charles Abernathy. A former manager of the assembly plant, Abernathy's friendliness and insistence of open communication among workers and managers won votes among the employees (*Vindicator*, 1976, p. B17).

Although General Motors Lordstown's operations ran smoothly in the 1980's, the plant was struck with an unforeseeable disappointment. The dissatisfying news came in the late 1980's when General Motor's announced that it would shut down the van assembly plant and eliminate 2,000 jobs (Jensen and Livingston, 1987, p. A2).

The van plant however did not officially closed its doors until March 1992, and, importantly, the event jumpstarted questions about the effects of a complete shutdown (Williams, 1992, p. C2). Recently this question has again sparked a lot of interest as GM seeks a new solution to gain profits and regain supremacy in the industry.

These new changes however entail much more severe and complex changes than past attempts. Most importantly, these decisions will create one of the greatest challenges for General Motors Lordstown.

The Fate of Lordstown

In an effort to downsize and reduce costs, General Motor's is restructuring its assembly methods and consequently its family of assembly plants. This new idea, called Project Yellowstone, involves modular assembly or the delivering of completed sections of the car, dashboards and engines for example, to its assembly plants for final production. Therefore, the car will be built by linking or joining together different modules, bypassing traditional assembly techniques. With sections of the car delivered intact, less laborers will be needed and total assembly time per vehicle will be cut; thus labor, material and factory costs will be reduced. The responsibility for building the modular parts will be outsourced, and those suppliers will also be involved with its design. GM vice president Mark Hogan believes that this process will not only greatly reduce costs but also improve quality and efficiency. In fact, he predicts that total factory costs will decrease by 20%, and, most importantly, he believes that this new production method will finally allow GM to earn profits on small cars (Kubik, 1999, p.9).

Yellowstone plants will differ from traditional assembly plants by the size (1.2 million square feet versus three million square feet) and employment (average of 2,100 workers compared to 3,600). Total production does not differ substantially between the two types of plants (200,000 automobiles for traditional plants and 215,000 autos for Yellowstone plants per year) (Kubik, p. 9).

For employees of Yellowstone plants, they will endure 250 hours of training, and an additional 75 hours of training per year. Employees will also have more responsibility in their jobs and efforts will focus on, according to Mark Hogan, "ergonomics, worker safety, teamwork, and seek[ing] to reduce strain and repetitive motion injuries by rotating workers every two hours" (Kubik, p.9). This change will relieve some of the boredom that past assembly line workers often felt with their jobs (Salpukas, 1972, p. E10). Monetarily, the total cost of a Yellowstone plant is $300 million and construction will not begin until 2002

Lordstown is especially challenged by this new ideal because General Motors has declared Lordstown as one of two possible sites for the last Yellowstone plant. However, for General Motors Lordstown to win the bid for the last plant, the community must compete with Lansing and convince GM to build here instead.

Chapter 3 The "Battle" Between Lansing and Lordstown

As General Motors begins to finalize the plans for Project Yellowstone, they must decide soon on the location on the final assembly plant. Although they continue to postpone this decision, both Lordstown and Lansing remain optimistic about their chances in being selected. Their hopefulness is ushered by their ongoing campaigns and programs to build support for a new assembly plant. The objectives of these campaigns include offering tax incentives, improving education and amassing local support groups to oversee activities concerning this cause. In the meantime, both communities are keeping the company aware of these efforts and on any improvements made in these areas.

The concerns and issues listed above are a few of the important factors in a firm's decision to locate in a certain region. The research regarding these elements and the progress made by each community in these areas are discussed below.

There is widespread belief that the business climate of a particular state is instrumental in attracting new businesses. Consequently, an unhealthy business climate, such as high state and local taxes, absence of right-to-work legislation, low quality of life, inadequate spending on public goods and governmental apathy to expansion of business opportunities can harm the possibility of bringing in new industry (Patch, 1995, p.35).

On the other hand, some of the major components of a positive business climate include the existence of opportunities for financing projects through state and local revenue bonds, a state's willingness to loan funds for initial construction costs, and issuance of tax exemptions on land, capital and equipment. In examining this variable's position in the location process, Patch examines a 1979 study by Carlton. This study shows that the above characteristics of a business climate to be significant in attracting new firms in fabricated plastic products, communication transmitting equipment and electronic component industries. These results however may not be a true reflection of all businesses since the study only considered three industries (p.36).

One of the most important aspects of the business climate mentioned above involves taxes. According to Walthall (1996), at least twenty-five states maintain various "economic development credits and incentives" to lure new businesses into their region (p. 43). Many experts believe that taxes play a major role in determining the best location of new plants; however, conflicting evidence of this belief exists. Early studies, pre 1960, find that taxes play no significant role in a firm's decision to locate in a certain area; instead variables such as proximity to markets, labor accessibility and power and fuels are determined to be more significant. According to Patch, these early studies support the widespread opinion that taxes are only a small part of total costs; hence small differences in taxes have little impact on decision-making (p.38). Additionally, Walthall states that these types of packages do little to bring in new business, and instead use up valuable funds that could have been spent elsewhere (p.43).

Studies following 1960 bring both similar and different conclusions than the earlier studies. For instance, some deem taxes as important in the decision-making process. Specifically, Patch cites two different studies, both using the corporate tax rate, to reveal this detail. First, Bartik and Newmann study employment growth by industry and conclude that, for capital concentrated industries, the corporate tax rate significantly accounts for an increase in new industry (p.40). Similarly, Newmann's study also finds that the corporate tax has a positive role in attracting new businesses, especially in the durable goods industries.

Differently, in a study by Walthall (1996), he finds the opposite case in the automobile industry, which is also one of the largest durable goods industries. According to Walthall, transportation issues played the biggest role in the decision of General Motors to build a Saturn plant in Tennessee while taxes played no role. Interestingly, tax breaks were completely irrelevant since Tennessee legislation forbids giving any kind of tax incentives to firms. Walthall does however agree that taxes are still a factor in location decision making, and he believes that tax issues become more important as businesses begin the final phase in the selection of sites. In fact, he notes that this issue was paramount in the attraction of a Mercedes-Benz plant to Alabama.

Therefore, the conflicting results from the studies above hinder any rational conclusions about the importance of taxes in the location decision equation. However enough evidence exists to consider this variable to be important in the decision-making process (pp. 43-47).

In the present "battle" for the new assembly plant, Nequetto and Shilling (1998) report that both Lansing and Lordstown are offering General Motors tax incentive packages for re-establishing operations. For Lordstown, the effort is lead by Congressman James Traficant and includes many prominent politicians and businessman (p. A1). The package consists of various tax and other local, state and federal incentives and mimics the ones offered by Toledo when they won the bid for a Jeep assembly plant (Welker, 1998, p. A1). Besides tax incentives, both communities are pursuing efforts to improve their respective region's quality of life.

Quality of life refers to the alluring qualities of a region that make it a favorable area to live and run a business (Patch, p.41). According to Carn and Rabianski (1991), the quality of life factors should include differences in the cost of living, quality of housing as well as other elements that will provide a healthy living and business environment. (p.320). In obtaining this type of environment, Patch believes that a better quality of life can be reached as government spending on public goods increases, especially on education (p.41).

Numerous studies have been conducted researching the amount of money spent on this area and its influence on the location of new plants. In her book, Patch especially talks about the importance of education as a quality of life factor, and she mentions several studies contributing to this importance. For example, Wasylenko and McGuire and Plaut and Pluta conclude that the percentage of income spent on education is positively related to new employment within a state (p.42). The conclusions above can however be disputed by examining other studies on the subject. For example, studies by Bartik find no significant connection of education spending and employment growth (Patch, p.42). Patch however believes that inconsistent findings do not discredit the positive role education plays in improving the quality of life of an area.

Quality of life involves much more than the amount of money spent on education, and recent research has encountered several other factors. For instance, Patch notes that several studies indicate a positive statistical relationship between expenditures on public goods and new business, including the importance of proximity to rail lines and interstate highways (Patch, p.43). These results indicate that government spending on infrastructure will also aid in attracting new business.

Many government policies can be implemented to increase the quality of life of a region; thus as governments appropriate more funds toward community improvements, the quality of life increases for its residents. Believing in this cause, both Lordstown and Lansing have worked to improve their quality of life.

The majority of the work undergone in this area by the communities, according to Shilling (1998), concerns improvements in education. For Lansing, they adopted education improvement programs that focused on decreasing drop out rates, increasing efficiency test scores and cooperative education programs. Widespread community support for these programs through volunteer tutoring by adults and college students and hiring senior citizens to patrol for delinquent children have also helped with this cause. Thus, within the last two years, these programs have proven successful as test scores rose and drop out rates decreased (p. A3). Although Shilling did not report the efforts of the communities surrounding Lordstown toward this cause in his article, news reports have indicated that similar programs are being adopted to improve education.

Besides education, Lansing and Lordstown's campaigns are both heavily concerned with gathering community support for their causes. These projects include both advertising (newspaper, radio, television and special news coverage) and holding informational meetings about the plants importance and meaning to their respective areas (Shilling p. A1; Welker p. A1). Evidently, both communities are working hard to convince GM to continue operations in their areas.

Chapter 4 Literature Review

The research regarding impact studies of plant openings and closings deals primarily with Ex Post studies of exiting plants and both Ex Post and Ex Ante studies of new plants to a region. The models used for these studies can be divided into one of two main types: econometric and non-econometric. Much of the available research concerning the impact of plant closings involve the non-econometric technique of input-output analysis while studies on plant openings consist of both types.

This section will present some of the important studies surrounding this topic, and its content will focus primarily on the technique used to perform the impact study. Furthermore, because limited examples of plant impact studies exist for econometric techniques, several important models will instead be discussed, and the impact studies conducted with these models will also be mentioned.

Chapter 4.1 Econometric Techniques

One of the common techniques in analyzing and explaining a particular regional economy involves forecasting and impact studies. In order to apply these techniques, first, an economic model, summarizing the various industries and business interrelationships, of the region is built. Although many different modeling techniques exist, one of the most common choices involves econometric modeling. Bolton (1985) describes a regional econometric model as "a set of equations, perhaps highly simultaneous, describing the economic structure of a regional economy, usually a state or province or metropolitan area" (p.495).

Most of the early research, the 1950's and 1960's, and models use and apply the theory from national scale models; however, today, with the complexity of markets, regional econometric models obtained their own identity (Bolton, p.495). Nevertheless, most econometric models still retain a unique relationship with national models.

According to Bolton, it is necessary to join a regional model and national model because typically the national economy will influence the regional economy (p.498). These type of models are known as "top down" models which are different from "bottom up" models. Bottom up models describe the situation where the regional economy affects the national economy while top down models characterize the national influence on the local economy. This difference can especially be seen in the specification of each model. For top down models, the national variables remain exogenous to the model whereas, for bottom up models, the national variables are defined as endogenous. When examining existing econometric models, top down models tend to be the most popular (Bolton, p.499).

Econometric regional model building however has one very important shortcoming: its costs. Significant costs are incurred in both building a model and continued updating of the model for future forecasts. Additionally, these costs are compounded as model size and intricacy increases. This fact has lead to smaller scale econometric models thereby reducing the project's total cost (Fiske, Lamb and Moress, 1991, p.49).

A structured econometric model contains a list of equations where each dependent variable is explained by a number of independent variables. Two important types of SEM's include the simultaneous system and the recursive system. For recursive systems, Cleary and Levenbach (1986) note that the equations must be logically ordered in order to account for multiple effects among the independent variables--independent variables being influenced by previous values of other independent variables (p.191). Because of this characteristic, these types of models are also known as recursive models. One of the many problems that can occur with these models include specification errors and, for simultaneous models, the "simultaneity" problem. Specification errors occur through the misstating of the econometric equation while the simultaneity problem relates to the correlation among independent variables.

One of the early examples of a SEM model follows the regional economy of the vast metropolitan area of Los Angeles. Uniquely, Hall and Lecari's (1974) regional model of the city uses SMSA data for the historical values of the endogenous variables. The structure of the model is governed by a product-total production relationship where economic activity is measured by summing production from each economic sector. Specifically, the model separates Los Angeles into these four sectors of manufacturing: wholesale trade, regional trade, other (including finance services and construction) and government (federal, state, county and city) (p.338).

The variables used in this model contain numerous endogenous and exogenous variables; endogenous variables are variables determined within the model while exogenous variables are determined outside the model.

The complete model of Los Angeles contains 29 equations (nineteen stochastic and ten identities). To estimate the stochastic equations, Hall and Lecari perform both an OLS (ordinary least Squares) regression and two stage least square (TLS). Although not shown here, the two regression procedures produce satisfactory results as nearly every coefficient had significant t scores and the coefficient's of determination (R^2) remain close to one. Additionally, the calculated DW (Durbin Watson) statistic, nearly two for all equations, indicates no significant presence of autocorrelation (Hall and Lacari, pp.340-341).

In addition, the model's accuracy is determined by computing the MAPE or mean absolute percent error of the endogenous variables. The equation for MAPE is shown below where Y^*_i (t) is the historical value for the i^{th} variable at time t and N is the sample size.

$$(1) \qquad MAPE_i = \sum_{i=1}^{N} \frac{\{[Y_i(t) - Y_i^*(t)]/Y_i(t)\}*100}{N}$$

Many statisticians believe that MAPE values at 5% or less is sufficient for designating a model as being accurate. In response to their model's accuracy, Hall and Licari note that the average MAPE for the endogenous variables hovers around 2% (p.343).

Besides being a reliable forecast model, Hall and Lucari explain that the model can also calculate "impact multipliers." Multipliers help explain, empirically, the impact of external or internal changes in the economy. Generally, these changes occur with the endogenous variables and are calculated by taking the differences in the endogenous variables resulting from a change in an exogenous variable. From the results of multipliers, appropriate business decisions and policy changes can be made and harmful decisions can be avoided (p. 344).

In their study, Hall and Lecari used the model to conduct various impact studies. For instance, in one study, they measured the impact of a one billion-dollar increase in GNP in the export sector. Ultimately the impact generated a $26.9 million increase in Gross Revenue Product or a multiplier of 26.9 and positive multipliers in several other sectors (p. 347). Table 1 below shows the results mentioned above, and it also includes other multipliers as responses to increases in other exogenous variables.

Table 1: Impact Multipliers for Exogenous and Endogenous Variables

		Exogenous	Variables	
	USGNP	TAXR	POP	GREVA
C	10.125	173.33	-.047	.744
EGOV	.253	22.333	-.001	.094
GEXP	2.539	223	-.012	.948
GREV	2.679	235.333	-.012	1
GRP	26.901	465.333	-.074	1.926
LF	1.321	29.667	.104	.127
NWY	6.513	100.667	-.018	.466
P	-.007	.333	0	.001
TEMP	1.524	34.333	-.003	.146

Source: *Journal of Regional Science*. "Building Small Region Econometric Models: Extension of Glickman's Structure To Los Angeles", p. 347.

Specifically, for the average tax rate (TAXR), table 3 shows the results of a 1% increase in the variable on the selected endogenous variables in the far-left column. Similar impact studies are recorded for one thousand increases in the regional population (POP) and autonomous revenues (GREVA) (p. 347).

The model has also been used to conduct employment and income multipliers. These multipliers in particular measure the change in aggregate employment or income from a change in employment or income in a particular sector. Furthermore, the econometric and the input-output method remain the two most popular methods for their calculation.

Because an input-output model also existed for Los Angeles, the authors were able to make comparisons between the multipliers by initiating the same changes for each model (pp. 348-349). Table 4 summarizes these results, and interestingly nearly identical solutions exist for the two models.

Table 2: Comparison of Regional Models for Employment and Income Multipliers

Employment Multiplier			Income Multiplier		
Sector	Multiplier	Model	Sector	Multiplier	Model
Private exports	2.76	Econometric	Private exports	2.43	Econometric
Private exports	2.13	Input-Output	Private exports	N/A	Input-Output
Local Gov't	1.54	Econometric	Local Gov't	2.03	Econometric
Local Gov't	1.71	Input-Output	Local Gov't	N/A	Input-Output

Source: *Journal of Regional Science*. "Building Small Region Econometric Models: Extension of Glickman's Structure To Los Angeles", p. 350.

Similar regional models have been built using the idea of the SEM model with SMSA data, and one such important model concerns the model of Chicago.

Chicago Model

Another famous use of SMSA data and econometric modeling is the Duobinis (1981) Chicago model (pp.293-316). The general specification of the model uses the "Transcendental logarithmic production function" to describe productions of goods in each sector. Eventually the model uses each sector's figures to calculate Gross Metropolitan Product (GMP) which is equivalent to its national scale counterpart Gross Domestic Product. According to Duobinis, fluctuations in the values of this variable will determine the amount of expansion taking place in the Chicago statistical area (pp. 293-296).

The model's business sectors are broken down into four main divisions: manufacturing, government, and farming and mining. Fourteen industries comprise the manufacturing sector, the largest of the divisions. Interestingly, Duobinis reveals that most of the demand for this sector's goods lies outside the region, but local linkages also exist. In order to express this local demand relationship, he constructs input-output tables using "estimation location quotients. (p.296). The local linkage and external demand for each manufacturing industry is determined by the following equation.

$$(2) \quad \ln V d_i = \ln \alpha_1 = B_1 + B_2 * \ln LAL_i + B_3 * \ln NAL_i$$

where: $V^D{}_i$ = amount of output
d_i = national price of the product for each industry
LAL_i = local level of activity
NAL_i = National activity level in each manufacturing industry

In addition, a "transcendental logarithmic function" is added to each of these equations to describe the entire effect (Duobinis, p.296).

The model estimates similar equations for the remaining sectors and represents them with numerous local and national variables. The complete model contains 170 equations with the majority being identity equations (Duobinis, pp. 306-312). Because of the numerous linkages, the flow diagram is extremely complex and therefore will not be shown. In addition the size of the model will also prevent the presentation of the model's equations. However, as noted before, most of the equations follow the structure in equation 1. Also, specifically, the model is a "block recursive system" where each block is solved separately, and the information solved in one block can be used to solve the next set of blocks.

The model's accuracy was tested using the Mean Absolute Percent Error (MAPE) or a procedure Duobinis refers to as "Ex Post forecasting." His summary of MAPE results shows that the model performed favorably with over half of all variables having a MAPE less than 1% (p.313).

One of the main functions of this model, according to Duobinis, is to perform simulations. Specifically, Duobinis performs two simulations by first altering a regional variable and then changing a national variable. In the first simulation, the local tax rate is increased by 1% for each year of the simulation. Thus, Duobinis goal is to determine the local impact of a change in a regional variable. The second simulation study reports the results of a percentage decrease in federal taxes (pp. 315-316). Evidently, Duobinis' model and experiments show that local impacts can be determined from regional models.

Impact Study with Automobiles

In the research on automobile plants, only one impact study could be found, and this example concerned the analysis of a new plant. Additionally, this study is the sole representative on econometric techniques for plant openings and closings. Specifically, Campbell (1989) performed an impact study of Diamond Star Motors, a new business entrant in the Kentucky Bluegrass region. From the plants initial construction to completion, Campbell, examined the effects of three different stages including a building stage, producing stage, and the multiregional effects. To estimate this impact, Campbell, uses the conjoined input-output model (a model that combines an input-output and econometric model). Uniquely, the model is driven by employment in Motor Vehicles upon which data was readily available. Like many new entrants, employment levels slowly increased as the plant increased its production levels (p.31).

In analyzing the impact of the actual plant's construction stage, the effect was solely concentrated in one specific region: the plants actual location. The multiplier effects of this impact revealed however that some new employment was created. The construction stage however lasted for only a year and more dramatic effects were witnessed when the plant began operations (Campbell, p.33).

The impact after the plant started operations showed a much larger multiplier effect than the construction phase. Some sectors such as Wholesale trade and Finance, Insurance and Real Estate increased employment twofold while others reported more moderate gains. In addition, demand for certain occupations (secretaries and engineers, for example) also increased. Thus the initial employment of the plant's 2,900 workers created many more jobs (Campbell, 1989, p.33).

The last stage of the analysis examined an interregional effect. Immediate impacts occurred in the region of the plant's actual location and some adjacent ones while less of an impact occurred in the remote areas. Statistically, Campbell finds that 30% of the jobs created were formed from increases in "consumer spending" and increases in several durable and nondurable good sectors (p.33).

Chapter 4.2 Non-Econometric Models

Amid the ongoing expansion in regional model building and interest in impact analysis, the input-output has become one of the most popular design choices for new models. An input-output model describes the interdependency and unique relationships among a region's economic sectors by aggregately organizing each sector's source of inputs and resulting outputs in a single table. Individually, each sector's economic activity is represented by a linear equation, and, together, these equations describe the workings of region's economy. Traditionally, the entire regional economy and its interindustry relationships are transformed into matrices, and these relationships are structurally labeled in a coefficient matrix (Leontief 1986 p. 19).

Table 3 below shows a typical input-output table for a simplified economy composed of three sectors.

Table 3 Input-Output Table for a Simple Three-Sector Economy

Outputs From:	Outputs To:				
	1	2	3	Final Demand	Total Output
1	X_{11}	X_{12}	X_{13}	Y_1	X_1
2	X_{21}	X_{22}	X_{23}	Y_2	X_2
3	X_{31}	X_{32}	X_{33}	Y_3	X_3
Value Added	V_1	V_2	V_3		V

Source: *Input-Output and Regional Economics,* p. 27

Using row two as an example, the total output equation is calculated as:

$$(3)\ \ X_2 = X_{21} + X_{22} + X_{23} + Y_2$$

where X_{ij} is the purchases of industry j from industry i

If a constant relation among the amount of goods bought by the industries from industry 2 and their output exist, equation 3 is formed (Richardson 1972 p.26).

$$(4)\ X_2 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + Y_2$$

where $a_{ij} = X_{ij}/X_j$

The a_{ij}'s are commonly known as "direct input coefficients" and represent the amount of inputs needed by industry j from industry i per unit of output from industry j (Richardson pp. 26-27). When assuming the constant relation above, a mathematical relationship then exists between final demand and total output. Using this information, any economy, whether simple or complex, can then be represented by the equation below.

(5) $X = AX + Y$

where: X is a $(n \times 1)$ vector matrix of total output for n sectors
A is the coefficient matrix
Y is the vector matrix for final demand

Then by manipulating the matrix, equations 6 and 7 result

(6) $X(I - X) = Y$

(7) $X = (I - A)^{-1} Y$

where I is the identity matrix

Next, by letting $B = (I - A)^{-1}$, equation 8 can be formed.

(8) $X = BY$

Each b_{ij} represent the "indirect and direct purchases from industry i by industry j in satisfying one additional unit of final demand" (Schaffer p.157).

Using equation 3, Harris (1993) then illustrates a technique to measure the economical impact of a new plant and new sector on the economy of Nevada (pp. 100-106). He first partitions matrix A in the following manner (p. 102).

$$(9) \quad A = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix}$$

where: A_{11} is a (n-p) × (n-p) coefficient matrix
A_{12} is a (n-p) × p coefficient matrix
A_{21} is a p × (n-p) coefficient matrix
A_{22} is a p × p coefficient matrix
P = new sectors

Given the partition of matrix A above, we can then rewrite equation 5 as:

$$(10) \quad \begin{pmatrix} X_1 \\ X_2 \end{pmatrix} = \begin{pmatrix} I - A_{11} & -A_{12} \\ -A_{21} & I - A_{22} \end{pmatrix}^{-1} \begin{pmatrix} Y_1 \\ Y_2 \end{pmatrix}$$

The new sector's impact is measured by total output X_2 and final demand Y_2.

Next, Harris revises equation 8 by considering only the new industry's impact on existing sectors and this new equation becomes:

$$(11) \quad \begin{pmatrix} X_1 \\ X_2 \end{pmatrix} = \begin{pmatrix} I - A_{11} & 0 \\ 0 & I \end{pmatrix} \begin{pmatrix} Y_1 \\ Y_2 \end{pmatrix}$$

where the Y's are sectors that are exogenous to the model.

Harris then multiplies the A matrix in equation 9 by equation 11 below to obtain an inverse (p.102).

(12) $J_P = \begin{pmatrix} I & 0_1 \\ 0_2 & 0_3 \end{pmatrix}$

where: I = (n-p) × (n-p) identity matrix
0_1 = (n-p) × p null matrix
0_2 = p × (n-p) null matrix
0_3 = p × p null matrix

The inverse then becomes

(13) $(I - J_pAJ_p)^{-1}$ *and* $J_pAJ_p = \begin{pmatrix} A_{11} & 0 \\ 0 & 0 \end{pmatrix}$

Finally, from equations 6 and 7 the impact of the new industry p becomes:

(14) $D = (I\text{-}A)^{-1} - (I - J_pAJ_p)$

where: D = n × n matrix of coefficients that shows the interindustry relationships with the new sector.

Harris then used the model to study the impact of a new potato processing plant on two counties in Nevada. Also, in studying the impact, Harris includes the household sector as endogenous to the model to measure the "induced" impact of each sector's sales to final demand (p.103).

The analysis begins with a breakdown of equation 10. In the equation, the $(I\text{-}A)^{-1}$ matrix measures the impact of the regional economy with the potato processing plant included while the coefficients of the $(I - J_pAJ_p)^{-1}$ measures the impact without the new sector. Then, by comparing the differences between the two matrices, the impact of the new industry is measured (p.104).

Harris also reveals that his model can perform an impact for an exiting plant. However, the procedures can become more complex, Harris contends, when an entire sector is removed rather than just one plant. With this scenario, he argues that the analysis must consider many important details and will become multi-faceted. For instance, one must now explore the impact on the sectors that buy imports from the exiting sector, and also the ramifications on those sectors that sell inputs to the departing sector. According to Harris, all these circumstances will then make the analysis more complicated (p. 105).

The technique used above to measure the impact of a new industry is just one way to perform an impact study using the input-output method. Differently, the next example shows an alternative way to perform an impact study using the input-output method

Schaffer (1976) also constructs an input-output model to describe the impact of a new plant in Georgia. Similar to Harris, he includes households as endogenous to the model by including it among the interindustry matrix (p.157).

The study focuses on the impact of a new plant in the already flourishing veneer and plywood industry. The Georgia input-output tables used to summarize this impact emulate the U.S. input-output tables. For example, the model contains 300 of the 367 industries of the U.S. model; thus 67 of the industries lie outside the region. The model also includes information about the factor of production payments; federal, state and local taxes and other expenses by the industries. These figures then become the foundation for various income multipliers (pp. 160-161)

To analyze the impact of the new plant, the standard input-output is adjusted to include the veneer and plywood industry as a separate industry. Then by taking the inverse, the standard input-output table changes and organized to conduct an impact analysis . A reduced version of the original inverted table is shown below.

Table 4. Reduced Version of Table Indicating the Changes in the Georgia Economy From A New Plant

Industry	Output		Number of Employees	Changes in: Personal Income	City and County Revenue	State Revenue
	Value	Percent				
Agriculture	.2	0	0	.1	0	0
Mining	0	0	0	0	0	0
Lumber and wood products	.7	.2	33	.2	0	0
Veneer and plywood	5.3	12.2	318	2	0	0
Households	4.2	0	0	0	.1	.1

Source: *On the Use of Input-Output Models for Regional Planning*, pp. 162-163.

To find the impact, the column in the table is multiplied by unity (representing output) and one of the following: a ratio of employee to output and an income-output ratio for one of the levels of government. Finally, each column is multiplied by a change in industry output resulting from the new plant (p.161). This procedure for each applied to each column and industry is described below

(15) $b_{ij} * v_{pj} * \Delta ej$

where: j represents the new industry
Δe_j = expected change in industry output
b_{ij} = direct, indirect and induced sales of industry i to industry j (inverse of A)
v_{pj} = employee-output or income -output ratio

By summing each columns $b_{ij} * v_{pj}$ or $\sum b_{ij} * v_{pj}$, a multiplier is found and then the sum of the columns will equal the multiplier times the expected change (p. 161). Table 2 shows the results of the procedures listed above in calculating the various multipliers for selected industries. The multipliers indicated in the table are calculated for a regional economy encompassing an entire state while the previous example considered a regional economy made up of two counties. The next example considers an economy even bigger then the previous studies: a country. However, a regional study still exists because the example calculates an impact for the various regions within the country.

In Sweden, the possible abolishment of Nuclear power and hence the closedown of all nuclear power plants became an issue in the late 1970's. To study this impact, the Commission on Consequences was created, and this group reported the economical effects on employment, regional planning, the environment and household consumption in Sweden (Albegov, Andersson and Snickaris 1982 p.361). The commission concentrated heavily on assessing the regional impacts using various types of models. For determining the economic impacts, the input-output model described below was used. The impact addressed the question of the consequences of a decrease in production and plant closings in energy dependent sectors which is the direct result of eliminating the power plants (Albegov et al. p. 371).

The model begins by letting a_{ij}^{kl} = the purchased products of sector j region i to produce an additional unit of output from sector I region k. Also let f_i^k = final demand of sales of sector i, region k; x_i^k = operating level in sector i, region k and δ_i^k = labor-output ratio in sector i, region k.

Then, if A is a n × n matrix of a_{ij}^{kl} and F and X are vectors of the elements above, the following equation can be written (p. 372).

$$(16) \quad X = AX + F \text{ or}$$

$$X = (I - A)^{-1} F$$

Now, letting $(I-A)^{-1} = B$

$$(17) \quad X = BF$$

Using the equations above, a certain decrease in final demand in sector j results in an identical decrease in output. Therefore δ_j^l represents the average reduction in employment in sector j. region l (p. 372).

Using equation 16, the interindustry effects are determined. Now, letting Δs_j^l be the reduction in employment in sector j region l, the multiple employment loss is equal the Δl below.

$$(18) \quad \Delta_l^k = \sum_i \delta_i^k \sum_j \sum_l b_{ij}^{kl} \Delta s_j^l \big/ \lambda_j^l$$

The results of the study were then used to determine the appropriate policy regarding the elimination of nuclear power in Sweden.

Chapter 5 The Model

The Youngstown-Warren Econometric Model is a "labor oriented" model consisting of 72 equations, 44 stochastic and 28 identity and can be considered both a forecasting and an impact study tool. According to its developers, Yih-Wu Liu and Anthony Stocks, the forecasts can be used by "local development agencies in evaluating the impacts of new business entrants or the expansion or contraction of existing local firms" (p.1)

Table 4 below shows the regions diverse business sectors and the disaggregated variables representing each one. In addition, the model's structure indicates that it can predict changes in four main areas: employment, weekly wages, wage bill and man hours. According to the authors, these four divisions are chosen because of the availability of the data and the wide applicability of the results (Liu and Stocks, p.1).

Table 5 The Model's Endogenous Variables

Sectors	Employment, Weekly Wages, Man Hours, Wage Bill
Construction	SECC, SWWCC, SMHCC, SWBCC
Stone, Clay and Glass	SEMFD32, SWWMFD32, SMHMFD32, SWB32
Primary metals	SEMFD33, SWWMFD33, SMHMFD33, SWB33
Fabricated metals	SEMFD34, SWWMFD34, SMHMFD34, SWB34
Non-electric Machinery	SEMFD35, SWWMFD35, SMHMFD35, SWB35
Electrical Machinery	SEMFD36, SWWMFD36, SMHMFD36, SWB36
Transportation Equipment	SEMFD37, SWWMFD37, SMHMFD37, SWB37
Manufacturing Nondurable Goods	SEMFN, SWWFN, SMHMFN, SWBMFN
Transportation and Public Utilities	SETU, SWWTU, SMHTU, SWBTU
Finance, Insurance and Real Estate	SEFIR, SWWFIR, SMHFIR, SWBFIR
Services	SESER, SWWSER, SMHSER, SWBSER
Government	SEGV, SWWGV, SMHGV, SWBGV
Retail Trade	SERT, SWWRT, SMHRT, SWBRT
Wholesale Trade	SEWT, SWWWT, SMHWT, SWBWT

The flow chart in appendix B describes the ties between the sectors of the local economy and the top down approach of this relationship. Therefore it pictorially depicts the notion that the national economy drives the local economy with no feedback from the local economy. It explicitly shows this specification as national exogenous variables of man-hours, weekly wages and others driving several local sectors. In turn, these local sectors influence other industry sectors until the loop is complete. The diagram also shows the relationships among the four areas listed in the table above.

For example, the flow diagram shows that each business segments' employment levels are derived from man-hours, and, then employment becomes an explanatory variable for weekly wages. The connection continues as employment and weekly wages combine to determine the wage bill. Finally, the Youngstown-Warren wage bill, found by adding together the wage bill of the manufacturing and non-manufacturing sectors, is used as an independent variable in certain nondurable sectors.

This relationship can also be observed by referring to the entire model in appendix A. A close examination of the model will reveal that for each of employment, man-hours, and weekly wages, an imprecise equation can be adopted. For example, employment equations can be represented as:

$$(19) \quad \ln(E) = A_0 + A_1 * \ln(E(-1)) + A_3 * \ln(MH(-1)) + A_4 * T1 + A_5 * SD1 + A_6 * SD2 + A_7 * SD3 + A_8 * DSHIFT + \varepsilon_1$$

where: MH = quarterly manhours
E = Employment
T1 = trend variable
DSHIFT = dummy variable for MSA update
SD1, SD2, SD3 = seasonal dummies
$\in$ = disturbance term

Similarly, man-hours can be reduced to a general equation, but unlike employment, most of these equations contain a proxy variable. In this case, the proxy variable represents real output and originates from national variables. This format is shown below.

$$(20) \quad \ln(MH) = B_0 + B_1 * \ln(MH(-1)) + B_3 * \ln(PV) + B_4 * T1 + B_5 * SD1 + B_6 * SD2 + B_7 * SD3 + B_8 * DSHIFT + \varepsilon_2$$

where MH = man hour
PV= proxy variable
$\in_2$ = stochastic term

Finally, wages in manufacturing and nonmanufacturing can be generalized by the following equation:

$$(21) \quad \ln(WW^{MF}) = C_0 + C_1 * \ln(WW^{MF}(-1)) + C_2 * \ln(WW^{US})^1 + C_3 * SD1 + C_4 * SD2 + C_5 * SD3 + C_6 * T1 + C_7 * DSHIFT + \in_3$$

where WW^{MF} = regional average weekly wages in manufacturing
WW^{US} = national average weekly wages in each manufacturing sector
$\in_3$ = stochastic term

Chapter 6 Data

The model's data is broken down into fourteen business sectors and four areas of interest per sector: employment, weekly hours, weekly earnings and the wage bill. From its inception in the early 1980's, the model has consistently generated forecasts for the Youngstown - Warren regional economy; therefore data for the variables were already collected up to the last forecast (1996). Preliminary steps were then taken to update all exogenous and endogenous variables from the 1996 period to date.

For the endogenous variables, this process began by locating and gathering two important sources of information: The Labor Market Review and Covered Employment and Payroll. The Labor Market Review is published by The Ohio Bureau of Employment Services and records monthly employment, average weekly wages, and average weekly hours for designated Metropolitan Statistical Areas (MSA's) and the state of Ohio. The Ohio Bureau of Employment Services also publishes the second source, Covered Employment and Payroll. This particular publication supplies income and employment data for the various business sectors of Ohio's MSA's. Using these two publications, data

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[1] For the nonmanufacturing equation, this variable will become $\ln(WW^{MF})$.

was recorded form 1996 through second quarter 1998, overlapping some of the existing data. This process allowed for adjustments on any figures that were previously estimated. After obtaining each sector's employment, average weekly hours and average weekly wages, the information was then used to calculate the same sector's wage bill and man-hours. The following equations below describe the process.

$$(22) \quad WB_i = WW_i * E_i * 13$$

where: WB_i = the Wage Bill in the ith sector
WW_i = the average weekly wage of the ith sector
E_i = the employment in the ith sector

$$(23) \quad MH_i = WH_i * E_i * 13$$

where: MHi = the man hours in the ith sector
WH_i = the average weekly hours in the ith sector

Special proxies and conversions were also used for those sectors that lacked available data; these particular variables and their origins are shown below.

Table 6 Conversions For Endogenous Variables

Employment	
Variable	Method of Calculation
SEMFD36 (Electrical Machinery)	10% of Durable Goods
SEMFD32 (Stone, Clay and Glass)	6% of Durable Goods

Weekly Wages	
Variable	Method of Calculation
SWWMFD32 (Stone Clay and Glass)	Ohio as Proxy
SWWMFD36 (Electrical Machinery)	Ohio as Proxy
SWWFIR (Finance, Insurance and Real Estate)	SWWFIR = SWBFIR / (SESER*13)
SWWSER (Services)	SWWSER = SWBSER / (SESER * 13)
SWWGV (Governent)	SWWGV = SWBGV / (SEGV *13)
SWWCC (Construction)	Ohio as Proxy
SWWTU (Transportation and Public Utilities)	SWWTU = SWBTU / (SETU *13)

Weekly Hours	
Variable	Method of Calculation
SWHSER (Services)	Average of Ohio data including Business, Health and Engineering
SWHMFD36 (Electrical Machinery)	Ohio as Proxy
SWHFIR (Finance, Insurance and Real Estate)	National Data as Proxy
SWHCC (Construction)	Ohio as Proxy
SWHTU (Transportation and Public Utilities)	National Data as Proxy
SWHMFD32 (Stone, Clay and Glass	Ohio as Proxy

After finishing updating all endogenous variables, attention then shifted towards the exogenous variables. This process entailed searching through the various sources listed on the next page.

Table 7 Sources For Endogenous Variables

Exogenous Variables	Source
SMSACPI (Consumer Price Index for Youngstown - Warren)	Monthly Labor Review (Average of Pittsburgh and Cleveland)
UIIPR (US Production Index in Primary Metals)	Federal Reserve Bulletin
UIPIMVP(US Production Index for Motor Vehicles and Parts)	Federal Reserve Bulletin
UMHMFD36 (US Man Hours in Manufacturing Center in Electrical Machinery)	Federal Reserve Bulletin
UMHMFD35 (US Man Hours in Non-Electric Machinery)	Federal Reserve Bulletin
UMHMFD33 (US Man Hours in Manufacturing Center in Primary Metals)	Federal Reserve Bulletin
USCMI (US Conventional Mortgage Rates on New Homes Including Finance Charges)	Federal Reserve Bulletin
UWWMFD37 (US Average Weekly Wage in Transportation Equipment)	Internet (BLS website)
UWWMFD35 (US Average Weekly Wage in Non-Electric Machinery)	Internet (BLS website)
UWWMFD33 (US Average Weekly Wages in primary Metals)	Internet (BLS website)
UWWMFD32 (US Average Weekly Wages in Stone, Clay and Glass)	Internet (BLS website)

In examining Table 7, the consumer price index was found by taking the average price index of Pittsburgh and Cleveland. This particular method was chosen because the Monthly Labor Review alternates the recording of the two cities' indices every other quarter. In addition, the data gives a good approximation to Youngstown's index due to proximity.

The table also reveals that several other variables were gathered in unique ways. For instance, US Weekly wages in Transportation Equipment; Non-electric machinery; Primary metals; and Stone, Clay and Glass were found using the Bureau of Labor and Statistics website. Using this information, the final block of exogenous variables was calculated using formula 1 or updated using dummy values. The fortunate existence and accessibility of the historical tables for the information above simplified the data-gathering step and decreased the total time expended on this step. On the otherhand, the most difficult task of the project concerned the development of the models in order to do the various analyses.

Chapter 7 Methodology

General Motors has been a vital part of the economies of Mahoning and its surrounding counties for over thirty years. During this period, the Lordstown plant, as highlighted in the history chapter, adapted to many changes and conquered even more challenges. Since the closing of the van plant in 1992, many questions have been raised concerning Lordstown's permanence. In recognition of these questions, the project will consider four separate scenarios, each pertaining to a separate situation.

Each situation and their corresponding question will be investigated and conclusions will be reached by analyzing time series graphs of predicted values and by calculating multipliers. In obtaining these summary statistics, each model is first simulated in Troll, a program devoted to forecasting and simulation, and the data is entered in SPSS for constructing graphs. After declaring each scenario, the original model, shown in appendix A, was altered to fit the particular situation. These changes as well as each scenario's description is reported below.

Scenario 1

The first situation addresses the thoughts of those who believed in a possible shutdown of Lordstown at the beginning of the 1990's. In examining this particular case, several introductory steps are taken to properly set up the model. First, all exogenous and endogenous variables of the Transportation and Equipment sector are removed; thereby reducing the model to sixty-eight equations. This action is taken because employment at the Lordstown facility occupies nearly all of the sector's employment totals. The remaining employees may or may not be associated with General Motors; however; their inclusion or deletion will hardly affect the results. Finally, after eliminating the sector, aggregate values are recalculated and renamed to express the entire shock. This step concludes the preliminary work needed to prepare the model for simulation, and, to separate it from other models, it is renamed SMSA2 .

With the original model altered, in Troll, an OLS (Ordinary Least Squares) procedure is performed from the first quarter of 1981 to the fourth quarter of 1997 to estimate the equations; these dates are chosen to account for the revised statistical area[2]. This procedure is consistent with this type of model as shown in the literature review. Finally, a historical simulation procedure is performed from the first quarter of 1990 to the fourth quarter of 1997, and these values will serve as comparative figures to establish conclusions. Historical simulation uses previous values of endogenous variables to perform the simulation; however, the technique can only be used when data for these variables exist. Historical simulation will therefore outperform the alternative technique of dynamic simulation.

Scenario 2

Using model SMSA2, the second scenario builds upon the results obtained in the first one. This particular situation studies the impact of the economy where scenario 1 left off (from the first quarter of 1998) and extends this forecast until the fourth quarter of 2002. In order to run this simulation, exogenous data through the simulation period are estimated, and two different techniques are implemented to obtain these statistical projections. First, in SPSS, using historical values for each exogenous variable, a curve estimation procedure is run to obtain a best-fit line. After testing several different types of curves, the linear best-fit line produced the largest R^2 values; consequently, those values are used for the initial guesses. Similarly, in Troll, a NAINTERP command also serves to find initial guesses for the endogenous variables. NAINTERP replaces any missing data, represented as NA, with values calculated by "linear interpolation". The combination of these two methods gives the necessary starting points for projecting values. In addition, time series graphs are plotted to view the historical path of the data and to gain further prospective on its future course. Blending the two procedures' results, using the time series graphs and with a little intuition, values are selected for each variable.

Since this scenario uses the same model as scenario 1 and an OLS procedure was previously performed, the coefficient values of the equations are already saved.

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[2] Beginning in 1981, the Youngstown-Warren MSA data includes Columbiana County

Therefore, to conclude the analysis, the simulation task is performed and the results are saved. The simulation task in this scenario however differs from the simulation technique in the first scenario.

In this situation, an historical simulation does not apply--no historical data exist for the future--so it relies on dynamic simulation. This simulation technique uses the simulated values as the starting values of the endogenous variables. The technique, although not as accurate as historical simulation, produces good results.

The next two sections bring an added dimension to this project by making an important assumption. It assumes that Lordstown loses the bid for the Yellowstone project and General Motor's decided to build the plant in 1990. The key feature relates to the changing of the employment level in Transportation Equipment sectors from their historical levels to no employment.

Scenario 3

Scenario 3 studies the impact of the Youngstown - Warren economy from the first quarter of 1990 to the fourth quarter of 1997 assuming General Motors had built the new plant in 1990. Similar to scenario 1, the model is refined to estimate this impact. First, employment levels in the relevant sector are converted from the original levels to a constant 2,100. Next, related variables are calculated and renamed to separate them from their original values. Two variables however involving the transportation and equipment sector remain the same. These include weekly wages and weekly hours variables, and it is determined that a new plant probably will not have any affect on them. The altered model is then named SMSA3 and is shown in the appendix B.

Similar to scenario 1, an OLS procedure is run to solve for the coefficients in the various stochastic equations, and, after, a simulation command is performed. The results from both these procedures are saved for future forecasts and analysis.

Scenario 4

The last scenario extends the research in the third scenario and simulates from the first quarter 1998 to the fourth quarter 2002. Using the same predicted exogenous variables as described in scenario 2 and the same coefficient values as estimated in scenario 3, a simulation task is run and the results are saved.

The results will ultimately declare the intensity of the future impact on the market with a new plant. Both scenario 2 and this case relate to the present situation of General Motors, Lordstown; therefore their results will be more important to this study.

Chapter 8 Results

The results for the scenarios described earlier are shown below. Each of these situations presents a separate case involving an alteration of General Motors Lordstown's current operations. Therefore, each circumstance carries its own specifications and conclusions, and this chapter is divided into four sections to handle each case separately. The following terms will explain the language contained in both the explanations and the sources used for conclusions.

Definitions:

Original Model (SMSA) = the model assuming the current operations of Lordstown

Excluded Model (SMSA2) = the model without Lordsown

Reduced Model (SMSA3) = the model with a new assembly plant

In addition to these definitions above, the reader should be aware that all results presented here have been annualized from quarterly values to make the data more meaningful and manageable. Moreover, some of these results are embedded in the text while others are located in Appendix C. Also, as noted in the last section, the model has been producing forecasts for over fifteen years; therefore, from the beginning, a reliability assumption is made about the model. In respect to this decision, no regression results nor mean percentage errors are reported.

Scenario 1

In brief, SMSA2 describes the impact on the Youngstown - Warren economy during the 1990's, assuming that General Motors Lordstown closed operations at the beginning of the decade. The graphs of aggregate variables below give a visual representation of this presumption.

Figure 1 Total Employment

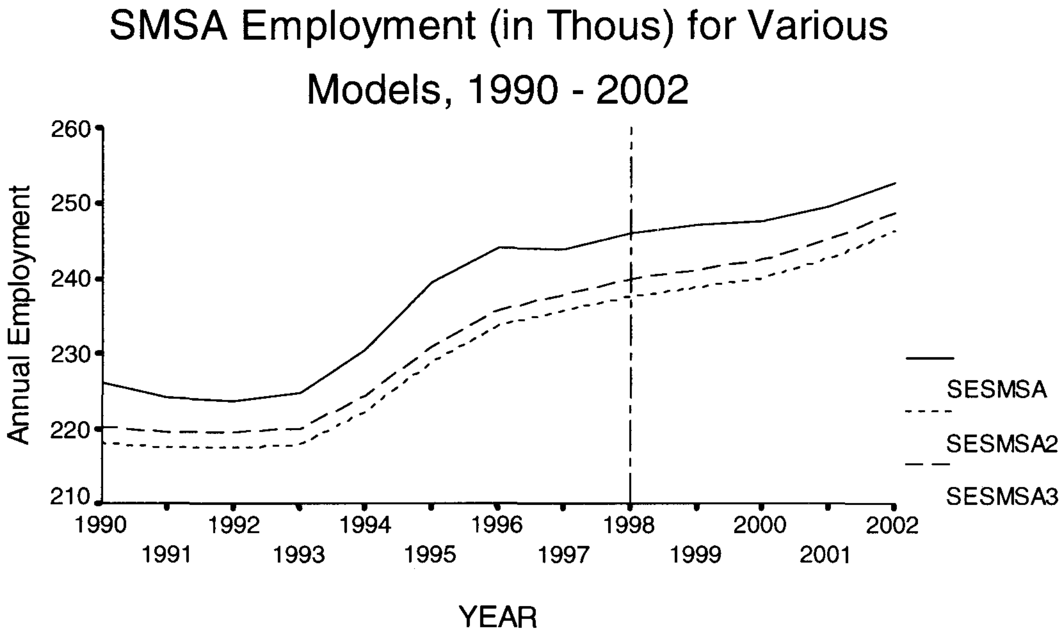
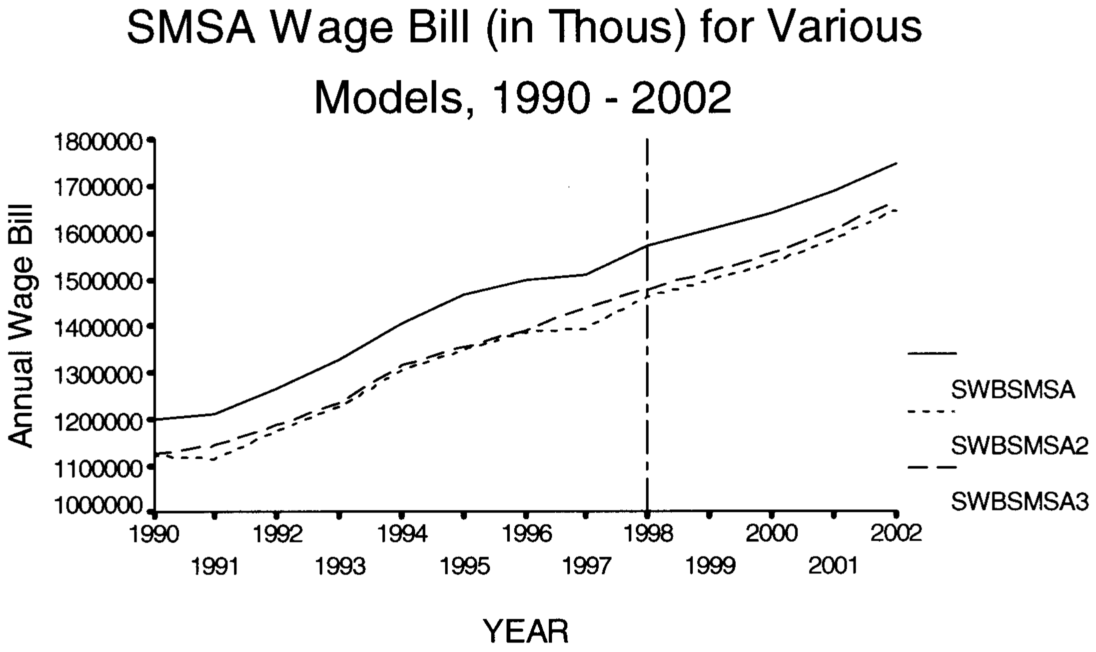


Figure 2 Total Wage Bill



The time series plots above follow the movement of the economy's total employment and total wage bill through the year 2002. The reference line at the year 1998 indicates where the break occurs between simulated values and historical values. As shown in the legend, the solid curves refer to the original model while the dotted and dashed curves represent the excluded and reduced models respectively, all of which were described earlier. Each point then represents annualized data of a specific model over the relevant time period

In analyzing these two graphs for scenario 1, a few interesting patterns emerge. For the graph of total employment, the original model's curve (SESMSA) and the excluded model's curve (SESMSA2) seem nearly parallel. This picture then suggests that the curves have similar slopes at various tangent lines along the curves. Since the slope of a line is equivalent to equation 24 below, and the slopes of the graphs appear the same, the ΔE would be almost equal. From this analysis, it may then be hypothesized that the economy, during this period, shows no signs of recovering the initial jobs lost from the plant closing down.

$$(24) \qquad slope = \frac{\Delta E}{\Delta T}$$

where: E = Employment
T= Time

This type of conclusion may be a realistic outcome for several reasons. For one, the majority of workers with seniority at General Motor plants have clauses in their contracts that guarantee them jobs in the event of a complete shutdown. At Lordstown, many workers at the plant fall in this category; consequently, they can escape the hardships and frustrations of finding new jobs. Therefore, the existence of a guaranteed work clause may lead to a departure from the area and relocation at another plant. With this situation, it may not be necessary for these people to search for local work; therefore, the community will not be responsible for recovering these lost jobs. This occurrence may also culminate in an increase in residential homes for sale and, importantly, a decrease in overall consumer spending in the area. This last reason especially needs addressed since the average pay for a General Motor employee is generally higher than most other manufacturing firms. In sum, a comparison of the curves says a lot about the ability of the community to recoup any losses from the economic shock.

Instead of comparing graphs, by examining only the shape of the excluded model's curve, some positive remarks can be made. For instance, the graph shows an upward trend for this period, indicating that, aside from the initial shock, the economy has rebounded quickly. This fact is evident between the years 1993 and 1996 when a significant increase occurs and afterwards when a more moderate increase occurs.

Besides time series plots, another way to conduct this analysis is to examine the actual data. The tables in appendix C shows the data plotted in both figures for the original and excluded models. In addition, the changes in absolute and percent changes are listed to describe the differences. Given the data, an employment multiplier can be calculated that indicates the strength of the impact on employment. In this case, the initial reduction in employment in transportation and equipment (8,175) in 1990 caused an 8,400 decrease in employment or a multiplier of 1.03 by the end of that same year. Intuitively, this number means that for a 1,000 change in employment, total employment would change by 1,030. The weak multiplier effect shows that little linkage exists among the various sectors of the economy. A further analysis of multipliers can also take the form of examining the various sectors to determine where the multipliers rest. In this scenario, by examination of the manufacturing and non-manufacturing sector tables in appendix C, the impact is shown to take place exclusively on the manufacturing sector. A further analysis, within the manufacturing sector, comparing durable goods and non-durable goods shows that the change in employment had a heavier impact on the former.

Derived from employment, the wage bill also has very powerful explanatory capabilities. For example, the variable is used to approximate the amount of total income earned in the economy. From these figures, two important conclusions can be drawn.

First, income or its proxy variable the wage bill determines the amount of taxable income generated in the economy. Second, with taxes withdrawn, disposable income determines how much money is available for consumption on goods and services. Because car manufacturing jobs pay considerably more than other manufacturing jobs, it is expected that total employment loss in the sector to have adverse effects on the wage bill. Indeed, by simultaneously examining figures 1 and figures 2 and the tables in appendix C, this contention is confirmed.

From the tables in appendix C, it can be found verified that the wage bill dropped significantly during 1990, decreasing nearly $78,500,500 or 7%. From these figures, an income multiplier can be calculated indicating the degree of this change. Thus the loss of General Motors Lordstown during this period resulted in an initial change in the wage bill of $78,487,900 and comparing this figure to the total loss in the wage bill results in a multiplier near one. This figure indicates that the changes in total wage bill and the wage bill of transportation and equipment were nearly equal. A further analysis of this drop in the wage bill can also be obtained by examining figure 2.

When comparing the original (SWBSMSA) and excluded model (SWBSMSA2) curves, a similar pattern as in employment emerges. The curves remain almost parallel, again indicating that the market does not seem to be making up for the initial losses in total income.

While the economy does not seem to recoup the initial loss in income from the plant closing down, the inference that tax money will be significantly reduced and never return to previous levels can also be made. The initial drop in income can now be used to draw conclusions on its effects on the economy.

As stated before, a drop in income decreases the amount of taxes received by local, state and federal governments. In this case, the impact will affect the local governments, especially the village of Lordstown. Depending on the particular tax rate, the local governments combined can lose millions of dollars. A series of consequences can arise including a decrease in spending on public goods or governments cutting funding in programs to make up for the losses.

Another significant effect occurs in the drop in consumer spending. This particular occurrence can have a large long-term multiplier effect as businesses fold due to the decrease in business activity. In total, the twofold impact has adverse effects on all aspects of the economy.

The graphs and thus the economy however could have demonstrated different patterns. For instance, a divergent series, as shown in figure 4, could have developed. In this type of situation, employment in the excluded model declines while the employment level in the original model continues to rise. With this phenomenon, the loss of Lordstown would result in much bigger employment losses (higher multipliers) and no signs of recovery.

Figure 3 Convergent Series

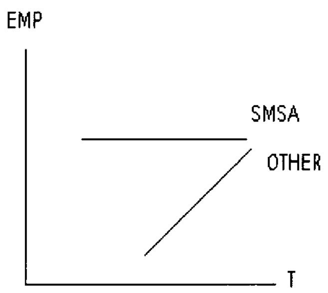
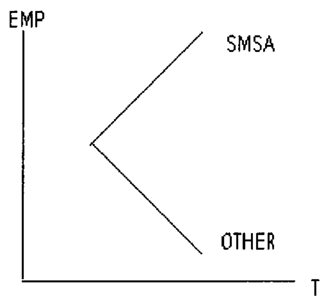


Figure 4 Divergent Series



A second type of possibility would be a strong convergent series as shown in figure 3. In this case, the economy has rebounded quickly and any unemployed workers are able to find jobs elsewhere. In comparison of the two graphs, this situation represents the ideal situation for any region experiencing business loss.

Scenario 2

Scenario 2 extends the notion of a complete shutdown by examining the impact through the year 2002. The results of the simulation appear in figure 3 and figure 4, and the dashed line boundary at the year 1998 separate it from the first scenario. Notice that in extending this simulation well beyond the present year, most of the conclusions reached in the first scenario continue to hold. In reference to these figures, any future projections beyond one period should be handled very carefully since the probability of miscalculating numbers increase with each successive period forecasted.

As mentioned in scenario 1, the graphs of the excluded and the original model remain nearly parallel throughout the 1990's; however, beyond this period, some changes start to occur. The graphs begin to show signs of converging, especially toward the end of the simulation period. Therefore, while convergence did not occur for the majority of the time series, in a longer time span, the economy is beginning to show signs of regaining those lost jobs.

An examination of the excluded model's curve indicates that employment continues to rise throughout this period; therefore, the effects of General Motors, according to the forecasts, did not significantly hamper business growth. In fact, this curve is nearly a positive straight line, indicating a relatively constant growth rate through the 1990's.

In order to gain perspective on the impact of the closing during the simulation period, an employment multiplier can be calculated. In 1997, a decrease in employment in transportation and equipment of 8,270 caused a reduction in employment in 1998 of 8,380 or a multiplier of 1.01. Therefore a 1,000 decrease in total employment would cause employment to decrease by 1,001.

Looking at appendix C, this impact can be compared among several sectors. For instance, the impact between employment in non-manufacturing and manufacturing and employment in manufacturing non-durable goods and manufacturing durable goods follow scenario 1's findings. Therefore, the brunt of the impact was concentrated in manufacturing and specifically manufacturing durable goods. Additionally, the results from comparing non-manufacturing to manufacturing say that linkages among these two sectors are weak.

Similar to the findings on employment, the graphs of the wage bill remain parallel. One of the major differences however is that there are no signs of converging; thus the wage bill continues to rise and at the same rate as the original model. This parallel course indicates that the initial income lost from the shutdown is not being made up in the future.

Along with this analysis, a multiplier can be calculated to gain further information of this impact. The wage bill multiplier in this case is calculated by taking the change in the wage bill of transportation equipment in 1997 (-$115,871,500) and describing its changes on the total wage bill in 1998. The multiplier then is .93 or less than the multiplier obtained in scenario 1.

Scenario 3

This particular section takes a more optimistic view of the fate of Lordstown. In this and the last scenario, it is assumed that Lordstown has won the bid for a new plant, and employment in the relevant sector remains at 2,100 (the average number of employees at Yellowstone plants). Different from scenario 4, this situation analyzes the impact of this type of plant on the economy had it been built during the early 1990's.

Again, referring to figure 1 of total employment, the dashed curve SESMSA3 describes this scenario's course through the year 2002. Similar to scenario 1, the excluded model, it remains parallel to the original model's curve, and the curve, as expected, lies above the curve plotted without Lordstown. In relation to the difference in employment between the original model and the reduced model, in 1990, Lordstown had an average employment of 8,200 workers, and with a new plant, employment is reduced to 2,100.

Since parallel curves exist, similar conclusions to those listed in scenario 1 are considered. These include, among others, that the economy does not appear to recover the losses in employment from the shutdown--at least in this time period. With a smaller employment loss than in scenario 1, however, it is assumed that a lower employment multiplier will occur. In applying this multiplier, the initial decrease in 1990 in employment in transportation and equipment amounts to 8,200, and the total employment reduction in that same year is 5,930. From this data, a multiplier of .72 is achieved and concurs with the expectations. In comparing this impact among the manufacturing and non-manufacturing and the durable goods and non-durable goods sectors, as witnessed before, the manufacturing and, within manufacturing, the durable goods sectors experience more of the impact.

In examining figure 2 of the wage bill, it again gives much of the same results as seen in the first scenario. For example, the curves remain parallel to the original model's curve with Lordstown, indicating that the initial reduction in income is not being recouped in later years. However, because the reduced model's curve has a steady incline, there is no indication of any additional adverse effects on the economy. Therefore, even though the new plant reduces total income, the effects seem to pass quickly.

In order to determine the strength of the impact, as before, an income multiplier is calculated. The initial change in income in 1990 in transportation and equipment (-$78,487,900) is then compared to the change in the total wage bill in 1990 (-$76,183,250). Using this data, a multiplier of .97 is obtained, indicating a less then equal change in total income from a change in the individual's sector income.

Additionally, from the tables in appendix C, it is shown that the majority of the impact is felt by the manufacturing sector and specifically for durable goods.

Scenario 4

With a relatively steady rise in total employment and total wage bill for the reduced model from 1990 to 1997, it is safe to assume similar predictions for the future. Looking at figure 2 and figure 3 and beyond the reference line, the conclusions are corroborated. For total employment, simulated future values show the extension of the general trend in the 1990's; however the curve is beginning to show signs of convergence with the original model's curve. In response to the reduced model's total employment curve, the trend again indicates that business growth occurs throughout this period, and the economy continues to be healthy. Next, because the curve is beginning to converge with SESMSA, similar reasons discussed in scenario 1 apply. Thus the economy is beginning to make up the loss in employment from the building of a smaller plant. Since this situation applies to the present situation of Lordstown, the impact multiplier is especially relevant to this project

In determining the multiplier, the initial impact within the transportation and equipment will occur in 1997 while the total employment change will be calculated for 1998. For transportation and equipment, the change in employment in the above year is -8,100, and this response on total employment results in a decrease of 6,400. The employment multiplier then becomes .79.

In analyzing the impact of this model on the wage bill, similar strategies are used as those used on employment. Notice, from figure 2, the trend continues from its 1990 course with relatively parallel lines existing between all three models. The paths however are extremely linear and therefore have constant growth throughout the period.

In addition, the impact or the job loss continues to have no additional ramifications on the economy. Again, to empirically describe this impact, an income multiplier is calculated. Using the same years as for employment, the reduction in transportation and equipment is $115,871,500, and the decrease in the total wage bill in $91,943,300 or a multiplier of .79. The impact as seen in the appendix is again concentrated in manufacturing and specifically the manufacturing durable goods.

Chapter 9 Conclusions

The idea for this project originated in response to General Motor's announcement of its plans to restructure its assembly line methods. Since the late 1980's, questions about General Motor's permanence at Lordstown have consistently been addressed. The goal of this project then was to provide some statistical answers to these questions, expressed within four distinct scenarios. Using SMSA data for the Youngstown - Warren region and a previously defined model of this area, simulations were run for each possible shutdown case and the results organized to provide the conclusions. Then, from this data, several conclusions were given concerning the overall effects on employment and the wage bill.

First, for all four scenarios, the impact concentrated strictly on the aggregate sector of durable goods with little leakage to the other sectors of the economy. As noted before, this result reveals that the other aggregated sectors (non-durable goods and non-manufacturing for example) are not very dependent on Lordstown for business.

Second, for both employment and income (wage bill), the graphs of the original model and the changed models are nearly parallel to each other and for most of the time period. Once again, this observation leads to the belief that the economy is struggling to make up for the initial losses.

Finally, the low values calculated for the multipliers indicate that the initial impact of each situation dominates the total impact with little repercussions elsewhere. This outcome affected all four scenarios in the study. General Motor's influence on other businesses may therefore be less than what was expected.

When examining all the scenarios as a whole, the conclusion that no matter what situation Lordstown faces, the economy will respond with continued growth can be reached. However, within the scope of the model, the economy will struggle to recover the initial losses. Although General Motors is important to the study's economy, the above analysis indicates that the economy will wholly survive a shutdown.

Chapter 10 Limitations

The limitations surrounding this impact study--and all impact studies--are varied. One of the most important of these constraints rests with the dilemma of obtaining inaccurate forecasts, especially with those residing in the future. In this project, simulations were extended four years past the present; therefore, those predictions three or four years in the future will probably not produce accurate predictions. These errors originate from the estimation that occurs for the exogenous variables, which are part of the preliminary steps to running a dynamic simulation procedure. Thus, without historical values, the forecasters must rely on computer-generated approximations and intuition to provide these values. Additionally, as mentioned in the methodology, certain variables are used as proxies for the regional variables. These replacements may then misrepresent the true values of the variables and correspondingly produce inaccurate predictions for these variables.

A specific limitation on the data and the predictions occurs when considering the impact of the new plant. Unequivocally, the Yellowstone project will provide a completely new plant and drop employment in the assembly plant to 2,100; however, unknown is the degree in which this plant stimulates additional growth. For example, the new plant may bring branch plants (paint spraying, for example) that assist in the assembly methods. Additionally, the plant may attract new businesses that establish operations in close proximity and provide the modules for assembly. The model takes a "worst case scenario" stand on this issue by only considering the influence of a new assembly plant. The absence of any additional items occurs because of the unavailability of the data and extremity of assumptions.

Related, no model can precisely describe the workings of the economy and completely predict all changes in it. It can then be assumed that errors are inherently present in modeling. Keeping this idea in mind, errors then will naturally emanate from the model and circulate to the predicted values. However, most models will generate predictions that are relatively close to the actual values, measured by the MAPE. This model falls in this category. When forecasting in the future, an "accurate" model will provide a person with good approximations to the actual data; however, nothing can be more reliable than an ex post analysis. This project may be a good candidate for this type of study since one of these scenarios will become reality.

Appendix A: The Model

Model SMSA1

ENDOGENOUS
SECC SEFIR SEGV SEM SEMFD SEMFD32 SEMFD33 SEMFD34 SEMFD35 SEMFD36 SEMFD37 SEMFN SENM SERT SESER SESMSA SETU SEWT SMHCC SMHFIR SEMHGV SMHM SMHMFD SMHMFD32 SMHMFD33 SMHMFD34 SMHMFD35 SMHMFD36 SMHMFD37 SMHMFN SMHNM SMHRT SMHSER SMHSMSA SMHTU SMHWT SWBCC SWBFIR SWBGV SWBM SWBMFD SWBMFN SWBNM SWBRT SWBSER SWBSMSA SWBTU SWBWT SWB32 SWB33 SWB34 SWB35 SWB36 SWB37 SWWCC SWWFIR SWWGV SWWM SWWMFD SWWMFD32 SWWMFD33 SWWMFD34 SWWMFD35 SWWMFD36 SWWMFD37 SWWMFN SWWNM SWWSER SWWSMSA SWWTU SWWWT

EXOGENOUS
DSHIFT SD1 SD2 SD3 SMSACPI T1 UIIPR UIPIMVP UMHMFD33 UMHMFD35 UMHMFD36 USCMI UWWMFD32 UWWMFD35 UWWMFD37

EQUATIONS

1: LOG(SMHMFD33) = A1 + A3 * LOG(SMHMFD33(-1) + A4 * T1 + A5 * SD1 + A6 * SD2 + A7 * SD3 + A9 * UIIPR + A10 * DSHIFT

2: LOG(SMHMFD34) = G1 + G2 * LOG(UMHMFD33(-1)) + G3* LOG(SMHMFD34(-1)) + G6 * SD1 + G7 * SD2 + G8 * SD3 + G9 * T1+ G10 * DSHIFT

3: LOG(SMHMFD35) = B1 + B2 * LOG(UMHMFD35(-1)) + B3* LOG(SMHMFD35(-1)) + B4 * SD1 + B5 * SD2 + B6 * SD3 + B7 * T1+ B8 * DSHIFT

4: LOG(SMHMFD36) = D1 + D2 * LOG(UMHMFD36(-1)) + D3* LOG(SMHMFD36(-1)) + D6 * SD1 + D7 * SD2 + D8 * SD3 + D9 * T1+ D10 * DSHIFT

5: LOG(SMHMFD37) = C1 = C2 * LOG(SMHMFD37(-1)) + C3 * SD1 + C4 * SD2 + C5 * SD3 * SD3 + C8 * LOG(UIPIMVP) + C6 * DSHIFT + C7 * T1

6: LOG(SMHMFD32) = F1 + F3 * LOG (SMHMFD32(-1)) + F4 * T1 + F5 * SD1 + F6 * SD2 + F7 * SD3 + F2 * DSHIFT

7: LOG(SMHMFN): E1 + E3 * LOG(SMHMFN(-1)) + E5 * SD1 + E6 * SD2 + E7 * SD3+ E4 * DSHIFT + E8 * T1

8: LOG(SMHCC) = K1 + K2 * LOG(USCMI)-2)) + K3 * LOG(SMHCC(-1)) = K4 * SD1 + K5 * SD2 + K6 * SD3+ K7 * DSHIFT + K8 * T1

9: LOG(SMHWT) = K10 + K12 * LOG(SMHWT(-1)) + K13 * T1 + K14 * SD1 + K15* SD2 + K16 * SD3 + K11 * DSHIFT

10: LOG(SMHRT) = M1 + M2 * LOG(SMHRT(-1)) + M3 * LOG(SWBSMSA/SMSACPI) + M4 * T1 + M5 * SD1 + M6 * SD2 + M7 * SD3 + M8 * DSHIFT

11: LOG(SMHTU) = N1 + N2 * LOG(SMHTU(-1)) + N3 * LOG(SMHMFD) + N4 * T1 + N5 * SD1 + N6 * SD2 + N7 * SD3 + N8 * DSHIFT

12: LOG(SMHSER) = L1 + L2 * LOG(SMHSER(-1)) + L3 * T1 + L4 * SD1 + L5 * SD2 + L6 * SD3 + L7 * DSHIFT

13: LOG(SMHFIR) = L10 + L11 * LOG(SMHFIR(-1)) + L12 * LOG(SWBSMSA/SMSACPI) + L13 * T1 + L14 * SD1 + L15 * SD2 +L16 * SD3 + L17 * DSHIFT

14: LOG(SMHGV) = P1 + P2 * LOG(SMHGV(-1)) + P3 * T1 + P4 * SD1 + P5 * SD2 + P6 * SD3 + P7 * DSHIFT

15: SMHMFD = SMHMFD32 + SMHMFD33 + SMHMFD34 + SMHMFD35 + SMHMFD36 + SMHMFD37

16: SMHM = SMHMFD + SMHMFN

17: SMHNM = SMHCC+ SMHWT + SMHRT+ SMHTU + SMHSER + SMHGV + SMHFIR

18: SMHSMSA = SEM + SENM

19: LOG(SEMFD34) = G21 + G22 * LOG(SEMFD34(-1)) + G23 * LOG(SMHMFD34) + G24 * T1 + G26 * LOG(SMHMFD34(-1)) + G27 * SD1 + G28 * SD2 + G29 * SD3 + G30 * DSHIFT

20: LOG(SEMFD33) = A21 + A22 * LOG(SEMFD33(-1)) + A23 * LOG(SMHMFD33) + A24 * T1 + A25 * LOG(SMHMFD33(-1)) + A26 * SD1 + G27 * SD2 + G28 * SD3 + G29 * DSHIFT

21: LOG(SEMFD32) = F21 + F22 * LOG(SEMFD32(-1)) + F23 * LOG(SMHMFD32) + F24 * T1 + F26 * LOG(SMHMFD33(-1)) + F27 * SD1 + F28 * SD2 + F29 * SD3 + F30 * DSHIFT

22: LOG(SEMFD37) = C21 + C22 * LOG(SEMFD37(-1)) + C23 * LOG(SMHMFD37) + C24 * T1 + C26 * LOG(SMHMFD37(-1)) + C27 * SD1 + C28 * SD2 + C29 * SD3 + C30 * DSHIFT

23: LOG(SEMFN) = E21 = E22 * LOG(SEMFN(-1)) + E23 * LOG(SMHMFN) = E24 * T1 + E25 * SD1 + E26 * SD2 + E27 * SD3 + E28 * DSHIFT

24: LOG(SECC) = K21 + K22 * LOG(SECC(-1)) + K23 * LOG(SMHCC) + K24 * LOG(SMHCC(-1)) + K25 * T1 + K26 * SD1 + K27 * SD2 + K28 * SD3 + K29 * DSHIFT

25: LOG(SEWT) = = K31 + K32 * LOG(SEWT(-1)) + K33 * LOG(SMHWT) + K34 * LOG(SMHWT(-1)) + K35 * T1 + K36 * SD1 + K37 * SD2 + K38 * SD3 + K39 * DSHIFT

26: LOG(SERT) = = M21 + M22 * LOG(SERT(-1)) + M23 * LOG(SMHRT) + M24 * LOG(SMHRT(-1)) + M25 * T1 + M26 * SD1 + M27 * SD2 + M28 * SD3 + M29 * DSHIFT

27: LOG(SETU) = = N21 + N22 * LOG(SETU(-1)) + N23 * LOG(SMHTU) + N24 * LOG(SMHTU(-1)) + N25 * T1 + N26 * SD1 + N27 * SD2 + N28 * SD3 + N29 * DSHIFT

28: LOG(SEMFD35) = B21 + B22 * LOG(SEMFD35(-1)) + B23 * LOG(SMHMFD35) + B24 * LOG(SMHMFD35(-1)) + B25 * SD1 + B26 * SD2 + B27 * SD3 + B29 * DSHIFT

29: LOG(SEMFD36) = D21 + D22 * LOG(SEMFD36(-1)) + D23 * LOG(SMHMFD36) + D24 * LOG(SMHMFD36(-1)) + D25 * SD1 + D26 * SD2 + D27 * SD3 + D29 * DSHIFT

30: LOG(SESER) = L21 + L22 * LOG(SESER(-1)) + L23 * LOG(SMHSER) + L24 * T1 + L25 * SD1 + L26 * SD2 + L27 * SD3 + L28 * DSHIFT

31: LOG(SEFIR) = L31 + L32 * LOG(SEFIR(-1)) = L33 * LOG(SMHFIR) + L34 * LOG(SMHFIR(-1)) + L35 * T1 + L36 * SD1 + L37 * SD2 + L38 * SD3 + L39 * DSHIFT

32: LOG(SEGV) = P21 + P22 * LOG(SEGV(-1)) + P25 * SD1 + P26 * SD2 + P27 * SD3 + P23 * LOG(SMHGV) + P24 * T1 + P28 * DSHIFT

33: SEMFD = SEMFD32 + SEMFD33 + SEMFD34 + SEMFD35 + SEMFD36 + SEMFD37

34: SEM = SEMFD + SEMFN

35: SENM = SECC + SEFIR + SEWT + SERT + SETU + SESER + SEGV

36: SESMSA = SEM + SENM

37: LOG(SWWMFD32) = F31 + F32 * LOG(SWWMFD32(-1)) + F33 * LOG(UWWMFD32) + F34 * SD1 + F35 * SD2 + F36 * SD3

38: LOG(SWWMFD33) = A31 + A32 * LOG(UWWMFD33) + A33 * SD1 + A34 * SD2 + A35 * SD3

39: LOG(SWWMFD34) = G31 + G32 * LOG(SWWMFD34(-1)) + G33 * T1 + G34 * SD1 + G35 * SD2 + G36 * SD3 + G38 * LOG(1/SEMFD34)

40: LOG(SWWMFD35) = B31 + B32 * LOG(SWWMFD35(-1)) + B33 * LOG(UWWMFD35) + B34 * SD1 + B35 * SD2 + B36 * SD3 + B37 * LOG(1/SEMFD35)

41: LOG(SWWMFD36) = D31 + D32 * LOG(SWWMFD36(-1)) + D34 * T1 + D35 * SD1 + D36 * SD2 + D37 * SD3

42: LOG(SWWMFD37) = C31 + C32 * LOG(SWWMFD37(-1)) + C33 * LOG(UWWMFD37) + C34 * SD1 + C35 * SD2 + C36 * SD3 + C37 * LOG(1/SEMFD37)

43: SWWMFD = (SWWMFD32 * SMHMFD32 + SWWMFD33 * SMHMFD33 + SWWMFD34 * SMHMFD34 + SWWMFD35 * SMHMFD35 + SWWMFD36 * SMHMFD36 + SWWMFD37 * SMHMFD37)/ SMHMFD

44: LOG(SWWCC) = K41 + K42 * LOG(SWWCC(-1)) + K43 * T1 + K44 * SD1 + K45 * SD2 + K46 * SD3 + K47 * LOG(1/SECC)

45: SWWWT = K50 + K51 * SWWWT(-1) + K52 * T1 + K53 * SD1 + K54 * SD2 + K55 * SD3

46: LOG(SWWRT) = M31 + M32 * LOG(SWWRT(-1)) + M33 * SD1 + M34 * SD2 + M35 * SD3 + M36 * LOG(SWWMFD)

47: LOG(SWWTU) = N31 + N32 * LOG(SWWTU(-1)) + N33 * T1 + N34 * SD1 + N35 * SD2 + N36 * SD3 + N37 * LOG(SWWMFD)

48: LOG(SWWFIR) = L41 + L42 * LOG(SWWFIR(-1)) + L43 * SD1 + L44 * SD2 + L45 * SD3 + L46 * LOG(SMSACPI)

49: LOG(SWWSER) = L51 + L52 * LOG(SWWSER(-1)) + L53* T1 + L54 * SD1 + L55 * SD2 + L56 * SD3 + L57 * LOG(1/SESER)

50: LOG(SWWGV) = P31 + P32 * LOG(SWWGV(-1)) + P33* SD1 + P34 * SD2 + P35 * SD3 + P36 * LOG(1/SEGV)

51: SWWMFN = E40 + E41 * SWWMFN(-1) + E42 * SWWMFD + E43 * T1 + E44 * SD1 + E45 * SD2 + E46 * SD3

52: SWWM = (SWWMFD * SMHMFD + SWWMFN * SMHMFN) / SMNM

53: SWWNM = (SWWCC * SMHCC + SWWRT * SMHRT + SWWTU * SMHTU + SWWFIR * SMHFIR + SWWSER * SMHSER + SWWWT * SMHWT + SWWGV * SMHGV) / SMHNM

54: SWWSMSA = (SWWM * SMHM + SWWNM * SMHNM) / SMHSMSA

55: SWB32 = SEMFD32 * SWWMFD32 * 13

56: SWB33 = SEMFD33 * SWWMFD33 * 13

57: SWB34 = SEMFD34 * SWWMFD34 * 13

58: SWB35 = SEMFD35 * SWWMFD35 * 13

59 : SWB36 = SEMFD36 * SWWMFD36 * 13

60: SWB37 = SEMFD37 * SWWMFD37 * 13

61: SWBCC = SECC * SWWCC * 13

62: SWBMFN = SEMFN * SWWMFN * 13

63: SWBTU = SETU * SWWTU * 13

64: SWBFIR = SEFIR * SWWFIR * 13

65: SWBSER = SESER * SWWSER * 13

66: SWBGV = SEGV * SWWGV * 13

67: SWBRT = SERT * SWWRT * 13

68: SWBWT = SEWT * SWWWT 8 13

69: SWBMFD = SWB32 + SWB33 + SWB34 + SWB35 + SWB36 + SWB37

70: SWBM = SWBMFD + SWBMFN

71: SWBNM = SWBCC + SWBTU + SWBFIR + SWBSER + SWBRT + SWBWT + SWBGV

72: SWBSMSA = SWBM + SWBNM

Appendix B: Flow Chart of the Youngstown-Warren Economy

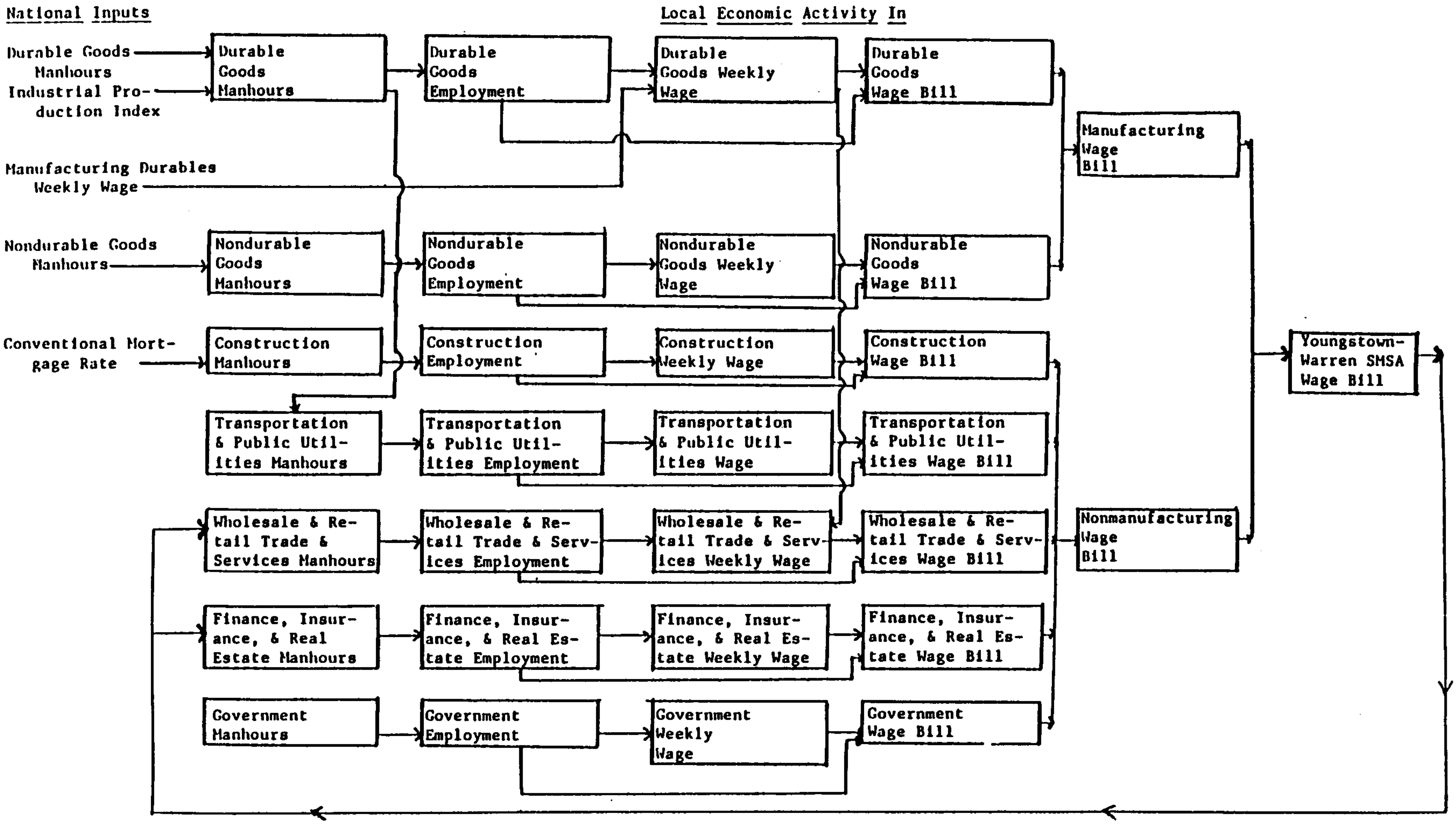


Figure 1: A Simplified Flow Chart of the Youngstown-Warren Econometric Model

Appendix C Tables of Exogenous Variables

Table C1 Total Employment W/O GM (in thousands)

YEAR**	ACTUAL/FITTED* TOTAL EMPLOYMENT	TOTAL EMPLOYMENT W/O GM (SESMSA2)	CHANGE	%CHANGE
1990	226.19	218.15	-8.04	-3.6%
1991	224.05	217.48	-6.57	-2.9%
1992	223.78	217.51	-6.27	-2.8%
1993	224.9	217.88	-7.02	-3.1%
1994	230.6	222.33	-8.27	-3.6%
1995	239.45	228.87	-10.58	-4.4%
1996	244.2	233.7	-10.5	-4.3%
1997	243.81	235.79	-8.01	-3.3%
1998	245.97*	237.59	-8.38	-3.4%
1999	247.07*	238.82	-8.25	-3.3%
2000	247.62*	240.07	-7.55	-3.1%
2001	249.62*	242.64	-6.98	-2.8%
2002	252.67*	246.24	-6.43	-2.6%

** Note: All data is annualized from quarterly values

Table C2 Total Wage Bill W/O GM (in billions)

YEAR**	ACTUAL/FITTED* TOTAL WAGE BILL	TOTAL WAGE BILL W/O GM (SWBSMSA2)	CHANGE	%CHANGE
1990	1.200842	1.107981	-.09286050	-7.7%
1991	1.211626	1.128167	-.0834590	-6.9%
1992	1.265525	1.169124	-.0964008	-7.6%
1993	1.326941	1.217547	-.109394	-8.2%
1994	1.406273	1.294729	-.111545	-7.9%
1995	1.469244	1.336544	-.132699	-9.0%
1996	1.498718	1.373702	-.125015	-8.3%
1997	1.512067	1.423197	-.0888698	-5.9%
1998	1.572638*	1.464601	-.108037	-6.9%
1999	1.607754*	1.498462	-.109293	-6.8%
2000	1.643705*	1.535865	-.107840	-6.6%
2001	1.690705*	1.586630	-.104076	-6.2%
2002	1.747261*	1.647607	-.0996535	-5.7%

** Note: All data is annualized from quarterly values

Table C3 Total Employment With New Plant (in thousands)

YEAR**	ACTUAL/FITTED* TOTAL EMPLOYMENT	TOTAL EMPLOYMENT WITH NEW PLANT (SESMSA3)	CHANGE	%CHANGE
1990	226.19	220.26	-5.93	-2.6%
1991	224.05	219.58	-4.48	-2.0%
1992	223.78	219.60	-4.19	-1.9%
1993	224.90	220.00	-4.90	-2.2%
1994	230.60	224.43	-6.17	-2.7%
1995	239.45	230.93	-8.52	-3.6%
1996	244.20	235.79	-8.41	-3.4%
1997	243.81	237.86	-5.94	-2.4%
1998	245.97	239.94	-6.04	-2.5%
1999	247.07	241.19	-5.88	-2.4%
2000	247.62	242.50	-5.12	-2.1%
2001	249.62	245.13	-4.49	-1.8%
2002	252.67	248.77	-3.90	-1.5%

** Note: All data is annualized from quarterly values

Table C4 Total Wage Bill With New Plant (in billions)

YEAR**	ACTUAL/FITTED* TOTAL WAGE BILL	TOTAL WAGE BILL WITH NEW PLANT (SWBSMSA3)	CHANGE	%CHANGE
1990	1.200842	1.124659	-.07618325	-6.3%
1991	1.211626	1.144908	-.0667180	-5.5%
1992	1.265525	1.186657	-.0788680	-6.2%
1993	1.326941	1.236348	-.0905925	-6.8%
1994	1.406273	1.315041	-.0912320	-6.5%
1995	1.469244	1.354804	-.114440	-7.8%
1996	1.498718	1.391816	-.106902	-7.1%
1997	1.512067	1.441566	-.0705013	-4.7%
1998	1.572638	1.480695	-.0919433	-5.9%
1999	1.607754	1.516653	-.0911018	-5.7%
2000	1.643705	1.555427	-.0882783	-5.3%
2001	1.690705	1.607230	-.0834753	-4.9%
2002	1.747261	1.669015	-.0782463	-4.5%

** Note: All data is annualized from quarterly values

Table C5 Employment in Non-Manufacturing W/O GM (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN NON-MANUFACTURING	EMPLOYMENT IN NON-MANUFACTURING W/O GM (SENM2)	CHANGE	%CHANGE
1990	171.65	171.33	-.32	-.2%
1991	171.35	172.80	1.45	.9%
1992	172.25	173.68	1.43	.8%
1993	172.53	174.18	1.66	1.0%
1994	177.38	177.12	-.25	-.1%
1995	182.08	180.73	-1.35	-.7%
1996	184.28	183.66	-.63	-.3%
1997	183.92	184.30	.38	.2%
1998	187.42	187.26	-.16	-.1%
1999	189.65	189.13	-.52	-.2%
2000	191.36	190.79	-.57	-.3%
2001	193.22	192.68	-.54	-.3%
2002	195.32	194.83	-.48	-.3%

** Note: All data is annualized from quarterly values

Table C6 Employment in Manufacturing W/O GM (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN MANUFACTURING	EMPLOYMENT IN MANUFACTURING W/O GM (SEM2)	CHANGE	%CHANGE
1990	54.54	46.82	-7.72	-14.2%
1991	52.70	44.68	-8.02	-15.2%
1992	51.53	43.83	-7.69	-15.0%
1993	52.38	43.71	-8.67	-16.6%
1994	53.23	45.21	-8.02	-15.1%
1995	57.38	48.14	-9.23	-16.1%
1996	59.92	50.04	-9.88	-16.5%
1997	59.88	51.49	-8.39	-14.0%
1998	58.56	50.33	-8.23	-14.1%
1999	57.17	49.69	-7.48	-13.1%
2000	56.26	49.29	-6.98	-12.4%
2001	56.41	49.96	-6.45	-11.4%
2002	57.35	51.41	-5.94	-10.4%

** Note: All data is annualized from quarterly values

Table C7 Employment in Non-Durable Goods W/O GM (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN NON-DURABLE GOODS	EMPLOYMENT IN NON-DURABLE GOODS W/O GM (SEMFN2)	CHANGE	%CHANGE
1990	6.80	6.92	.12	1.8%
1991	6.73	6.85	.12	1.8%
1992	7.08	7.02	-.05	-.7%
1993	6.90	7.06	.15	2.3%
1994	7.08	7.14	.07	.1%
1995	7.30	7.29	-.01	-.2%
1996	7.35	7.28	-.07	-.9%
1997	7.78	7.42	-.36	-4.6%
1998	7.42	7.30	-.12	-1.7%
1999	7.34	7.33	-.01	-.2%
2000	7.37	7.37	.00	0%
2001	7.40	7.40	.00	0%
2002	7.43	7.43	.00	0%

** Note: All data is annualized from quarterly values

Table C8 Employment in Durable Goods W/O GM (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN DURABLE GOODS	EMPLOYMENT IN DURABLE GOODS W/O GM (SEMFD2)	CHANGE	%CHANGE
1990	47.74	39.90	-7.85	-16.4%
1991	45.98	37.83	-8.15	-17.7%
1992	44.45	36.81	-7.64	-17.2%
1993	45.48	36.65	-8.83	-19.4%
1994	46.15	38.07	-8.08	-17.5%
1995	50.08	40.85	-9.22	-18.4%
1996	52.57	42.76	-9.81	-18.7%
1997	52.10	44.07	-8.02	-15.4%
1998	51.13	43.03	-8.10	-15.9%
1999	49.83	42.36	-7.47	-15.0%
2000	48.90	41.92	-6.98	-14.3%
2001	49.01	42.56	-6.45	-13.2%
2002	49.92	43.97	-5.95	-11.9%

** Note: All data is annualized from quarterly values

Table C9 Employment in Manufacturing With New Plant (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN MANUFACTURING	EMPLOYMENT IN MANUFACTURING WITH NEW PLANT (SEM3)	CHANGE	%CHANGE
1990	54.54	48.94	-5.61	-10.3%
1991	52.70	46.78	-5.93	-11.2%
1992	51.53	45.92	-5.60	-10.9%
1993	52.38	45.82	-6.56	-12.5%
1994	53.23	47.31	-5.92	-11.1%
1995	57.38	50.22	-7.16	-12.5%
1996	59.92	52.13	-7.78	-13.0%
1997	59.88	53.58	-6.31	-10.5%
1998	58.56	53.04	-5.52	-9.4%
1999	57.17	52.27	-4.90	-8.6%
2000	56.26	51.85	-4.41	-7.8%
2001	56.41	52.53	-3.88	-6.9%
2002	57.35	53.98	-3.37	-5.9%

** Note: All data is annualized from quarterly values

Table C10 Employment in Non-Manufacturing With New Plant (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN NON-MANUFACTURING	EMPLOYMENT IN NON-MANUFACTURING WITH NEW PLANT (SENM3)	CHANGE	%CHANGE
1990	171.65	171.33	-.32	-.2%
1991	171.35	172.80	1.45	.9%
1992	172.25	173.68	1.43	.8%
1993	172.53	174.18	1.66	1%
1994	177.38	177.12	-.25	-.1%
1995	182.08	180.73	-1.35	-.7%
1996	184.28	183.66	-.63	-.3%
1997	183.92	184.30	.38	.2%
1998	187.42	186.90	-.52	-.3%
1999	189.65	188.92	-.73	-.4%
2000	191.36	190.65	-.71	-.4%
2001	193.22	192.60	-.62	-.3%
2002	195.32	194.79	-.53	-.3%

** Note: All data is annualized from quarterly values

Table C11 Employment in Non-Durable Goods With New Plant (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN NON-DURABLE GOODS	EMPLOYMENT IN NON-DURABLE GOODS WITH NEW PLANT (SEMFN3)	CHANGE	%CHANGE
1990	6.80	6.92	.12	1.8%
1991	6.73	6.85	.12	1.8%
1992	7.08	7.02	-.05	-.7%
1993	6.90	7.06	.15	2.3%
1994	7.08	7.14	.07	1.0%
1995	7.30	7.29	-.01	-.2%
1996	7.35	7.28	-.07	-.9%
1997	7.78	7.42	-.36	-4.6%
1998	7.42	7.42	.00	0%
1999	7.34	7.34	.00	0%
2000	7.37	7.37	.00	0%
2001	7.40	7.40	.00	0%
2002	7.43	7.43	.00	0%

** Note: All data is annualized from quarterly values

Table C12 Employment in Durable Goods With New Plant (in thousands)

YEAR**	ACTUAL/FITTED* EMPLOYMENT IN DURABLE GOODS	EMPLOYMENT IN DURABLE GOODS WITH NEW PLANT (SEMFD3)	CHANGE	%CHANGE
1990	47.74	42.01	-5.73	-12.0%
1991	45.98	39.93	-6.05	-13.2%
1992	44.45	38.90	-5.55	-12.5%
1993	45.48	38.77	-6.71	-14.8%
1994	46.15	40.17	-5.99	-13.0%
1995	50.08	42.93	-7.15	-14.3%
1996	52.57	44.85	-7.71	-14.7%
1997	52.10	46.15	-5.94	-11.4%
1998	51.13	45.62	-5.52	-10.8%
1999	49.83	44.93	-4.90	-9.8%
2000	48.90	44.48	-4.41	-9.0%
2001	49.01	45.13	-3.88	-7.9%
2002	49.92	46.55	-3.38	-6.8%

** Note: All data is annualized from quarterly values

Table C13 Wage Bill in Durable Goods W/O GM (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN DURABLE GOODS	WAGE BILL IN DURABLE GOODS W/O GM (SWBMFD2)	CHANGE	%CHANGE
1990	.3977115	.3142445	-.0785	-16.4%
1991	.4010920	.3065133	-.0815	-17.7%
1992	.3967485	.3160595	-.0764	-17.2%
1993	.4390025	.3326780	-.0883	-19.4%
1994	.4754123	.3689850	-.0808	-17.5%
1995	.4845610	.3664618	-.0922	-18.4%
1996	.4984555	.3779593	-.0981	-18.7%
1997	.5138063	.4019018	-.0802	-15.4%
1998	.5202435	.4111583	-.0810	-15.9%
1999	.5176918	.4110938	-.0747	-15.0%
2000	.5189518	.4150653	-.0698	-14.3%
2001	.5293975	.4294113	-.0645	-13.2%
2002	.5474445	.4515133	-.0595	-11.9%

** Note: All data is annualized from quarterly values

Table C14 Total Wage Bill in Non-Durable Goods W/O GM (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN NON-DURABLE GOODS	WAGE BILL IN NON-DURABLE GOODS W/O GM (SWBMFN2)	CHANGE	%CHANGE
1990	.03903832	.03928915	.00025083	.6%
1991	.03866238	.03956288	.00090050	2.3%
1992	.04150398	.04006288	-.00144110	-3.5%
1993	.04110250	.04155125	.00044875	1.1%
1994	.04170490	.04258180	.00087690	2.1%
1995	.04184960	.04267403	.00082443	2.0%
1996	.03922023	.03943860	.00021838	.6%
1997	.04281328	.04084523	-.00196805	-4.6%
1998	.04268883	.04306350	.00037468	.9%
1999	.04321218	.04372460	.000512.42	1.2%
2000	.04411898	.04439465	.00027568	.6%
2001	.04498083	.04507243	.0009160	.2%
2002	.04580220	.04575630	-.0004590	-.1%

** Note: All data is annualized from quarterly values

Table C15 Wage Bill in Manufacturing (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN MANUFACTURING	WAGE BILL IN MANUFACTURING W/O GM (SWBM2)	CHANGE	%CHANGE
1990	.4367500	.3535335	-.08321650	-19.1%
1991	.4397540	.3460763	-.0936778	-21.3%
1992	.4382525	.3561223	-.0821303	-18.7%
1993	.4801048	.3742290	-.105876	-22.1%
1994	.5171170	.4115668	-.105550	-20.4%
1995	.5264105	.4091358	-.117275	-22.3%
1996	.5376755	.4173978	-.120278	-22.4%
1997	.5566198	.4427473	-.113873	-20.5%
1998	.5629323	.4542220	-.108710	-19.3%
1999	.5609038	.4548185	-.106085	-18.9%
2000	.5630708	.4594595	-.103611	-18.4%
2001	.5743785	.4744838	-.0998948	-17.4%
2002	.5932468	.4972700	-.0959768	-16.2%

** Note: All data is annualized form quarterly values

Table C16 Wage Bill in Non-Manufacturing W/O GM (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN NON-MANUFACTURING	WAGE BILL IN NON-MANUFACTURING W/O GM (SWBNM2)	CHANGE	%CHANGE
1990	.7640928	.7544483	-.00964450	-1.3%
1991	.7718718	.7820913	.01021950	1.3%
1992	.8272725	.8130023	-.0142703	-1.7%
1993	.8468363	.8433185	-.00351775	-.4%
1994	.8891565	.8831625	-.00599400	-.7%
1995	.9428335	.9274095	-.0154240	-1.6%
1996	.9610423	.9563053	-.00473700	-.5%
1997	.9554475	.9804508	.02500325	2.6%
1998	1.009706	1.010380	.00067400	.1%
1999	1.046851	1.043644	-.00320725	-.3%
2000	1.080634	1.076405	-.00422925	-.4%
2001	1.116323	1.112146	-.00417625	-.4%
2002	1.154015	1.150338	-.00367625	-.3%

** Note: All data is annualized from quarterly values

Table C17 Wage Bill in Durable Goods With New Plant (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN DURABLE GOODS	WAGE BILL IN DURABLE GOODS WITH NEW PLANT (SWBMFD3)	CHANGE	%CHANGE
1990	.3977115	.3311148	-.06659675	-16.7%
1991	.4010920	.3234535	-.0776385	-19.4%
1992	.3967485	.3337860	-.0629625	-15.9%
1993	.4390025	.3516153	-.0873873	-19.9%
1994	.4754123	.3894205	-.0859918	-18.1%
1995	.4845610	.3851948	-.0993663	-20.5%
1996	.4984555	.3965843	-.101871	-20.4%
1997	.5138063	.4208388	-.0929675	-18.1%
1998	.5202435	.4329900	-.0872535	-16.8%
1999	.5176918	.4343543	-.0833375	-16.1%
2000	.5189518	.4393948	-.0795570	-15.3%
2001	.5293975	.4546013	-.0747963	-14.1%
2002	.5474445	.4774728	-.0699718	-12.8%

** Note: All data is annualized from quarterly values

Table C18 Wage Bill in Non-Durable Goods With New Plant (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN NON-DURABLE GOODS	WAGE BILL IN NON-DURABLE GOODS WITH NEW PLANT (SWBMFN3)	CHANGE	%CHANGE
1990	.03903832	.03931265	.00027433	.7%
1991	.03866238	.03958575	.00092338	2.4%
1992	.04150398	.04006795	-.0143603	-3.5%
1993	.04110250	.04154380	.00044130	1.07%
1994	.04170490	.04255165	.00084675	2.0%
1995	.04184960	.04268940	.00083980	2.0%
1996	.03922023	.03945825	.00023803	.6%
1997	.04281328	.04086143	-.0195185	-4.6%
1998	.04268883	.04268590	-.00000292	0%
1999	.04321218	.04319650	-.00001568	0%
2000	.04411898	.04409830	-.00002067	-.1%
2001	.04498083	.04494385	-.00003697	-.1%
2002	.04580220	.04573300	-.00006920	-.2%

** Note: All data is annualized from quarterly values

Table C19 Wage Bill in Manufacturing With New Plant (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN MANUFACTURING	WAGE BILL IN MANUFACTURING WITH NEW PLANT (SWBM3)	CHANGE	%CHANGE
1990	.4367500	.3704278	-.06632225	-15.2%
1991	.4397540	.3630393	-.0767148	-17.4%
1992	.4382525	.3738540	-.0643985	-14.7%
1993	.4801048	.3931593	-.0869455	-18.1%
1994	.5171170	.4319723	-.0851448	-16.5%
1995	.5264105	.4278840	-.0985265	-18.7%
1996	.5376755	.4360425	-.101633	-18.9%
1997	.5566198	.4617000	-.0949198	-17.1%
1998	.5629323	.4756755	-.0872568	-15.5%
1999	.5609038	.4775508	-.0833530	-14.9%
2000	.5630708	.4834933	-.0795775	-14.1%
2001	.5743785	.4995448	-.0748338	-13.0%
2002	.5932468	.5232055	-.0700413	-11.8%

** Note: All data is annualized from quarterly values

Table C20 Wage Bill in Non-Manufacturing With New Plant (in billions)

YEAR**	ACTUAL/FITTED* WAGE BILL IN NON-MANUFACTURING	WAGE BILL IN NON-MANUFACTURING WITH NEW PLANT (SWBNM3)	CHANGE	%CHANGE
1990	.7640928	.7542318	-.0986100	-1.3%
1991	.7718718	.7818690	.0999725	1.3%
1992	.8272725	.8128040	-.144685	-1.8%
1993	.8468363	.8431898	-.0364650	-.4%
1994	.8891565	.8830695	-.0608700	-.7%
1995	.9428335	.9269200	-.159135	-1.7%
1996	.9610423	.9557740	-.0526825	-.6%
1997	.9554475	.9798665	.02441900	2.6%
1998	1.009706	1.005019	-.0468650	-.5%
1999	1.046851	1.039102	-.0774875	-.7%
2000	1.080634	1.071934	-.0870025	-.8%
2001	1.116323	1.107686	-.0863700	-.8%
2002	1.154015	1.145810	-.0820500	-.7%

** Note: All data is annualized from quarterly values

References

Albegov, M., AKE, A. E., & Snickers, F. (1982). *Regional Development Modeling: Theory and Practice.* New York: North-Holland Publishing Company.

Bolton, R. (1985). "Regional econometric models." *Journal of Regional Science*, 25 (4), 495-317.

Campbell, H. S. (1989, Summer). "State and regional economic impact of Diamond-Star Motors." *Economic Development Review*, 7(3), 31-34.

Carn, N. G. & Rabianski, J. (1991, August). "Selecting industrial locations, sites." *National Real Estate Investor*, 33, 28-29.

Cleary, C. P. & Levenbach, H. (1986). *The Professional Forecaster: The Forecasting Process Through Data Analysis.* California: Lifetime Learning Publications.

Duobinis, S. F. (1981). "An econometric model of the Chicago Standard Metropolitan Statistical Area." *Journal of Regional Science*, 21 (3), 293-316.

"Filter 35,000 applications to fill 2,500 plant jobs." (1966, October 16). *Youngstown Vindicator.* p. E5.

Fiske, J. R., Lamb, J. C. & Morss, M. F. (1991, July). "Practical economic forecasting for small regions." *Business Economics*, 26, 49-54.

"Get 775 acres for GM plant." (1956, February 21). *Youngstown Vindicator.* p.13

Given, K. (1972, May). "The unmaking of the Vega." *Motor Trend.* p.50.

"GM traces lineage to pioneers , Durant, Chevrolet, A P. Sloan." (1966, October 16). *Youngstown Vindicator.* p. E10.

"GM's new mini car is named 'Vega 2300'." (1966, October 16). *Youngstown Vindicator.* p.1.

Hall, O. P. & Lecari, J. A. (1974) "Building small region econometric models: Extension of Glickman's structure to Los Angeles." *Journal of Regional Science*, 14 (3), 221-251.

Harris, T. R. (1983). "Using Input-Output Analysis for Estimation of Distributional Impacts from Plant Openings and Closings." In D. M. Otto and T.G. Johnson (Eds). *Microcomputer-Based Input-Output Modeling* (pp. 100-106). Boulder: Westview Press.

Jagnow P. (1964, September 30). "Six blasts signal start on $40,000,000 industry." *Youngstown Vindicator.* p.1.

Jensen, C. & Livingston S. (1987, October 13). "GM's Lordstown van plant to shut." *Youngstown Vindicator.* p.A2.

Kubik, M. (1999, January). "Project Yellowstone promises profits on GM's small cars." *Business Journal.* p.9.

Leontief, W. 1986. *Input-Output Economics.* New York: Oxford University Press.

Liu, Y. & Stocks, A. H. (1983). "A Labor-Oriented Quarterly Econometric Forecasting Model Of The Youngstown-Warren SMSA." *Regional Science and Urban Economics*, 13, 317-340.

"Lordstown turns out Vegas." (1970, November 24). *Youngstown Vindicator.* p.1.

"Magazine Features GM Manager - Lordstown auto complex purrs under Abernathy's direction." (1976, July 26). *Youngstown Vindicator.* p. B17.

Mahoney, M. (1981, April 1). "20 J-cars per hour is GM goal for today at Lordstown Plant." *Youngstown Vindicator.* p.B17.

"The 'new breed' surfaces at Lordstown, Ohio." (1972, March 1). *Automotive Industries.* p. 18.

Niquette, M. & Shilling D. (1998, November 13). "Efforts on GM factory diverge." *Youngstown Vindicator.* p A3.

Patch, E. P. (1995). *Plant Closings and Employment Loss in Manufacturing.* New York: Garland Publishing.

Reiss, G. R. (1956, May 9). "GM plant is delayed six months." *Youngstown Vindicator.* p. 1+.

---. (1970, March 17). "Lordstown turns out vans." *Youngstown Vindicator.* p.1.

---. (1977, May 21). "Recall set of 1,600 workers." *Youngstown Vindicator.* p. 1+.

Richardson, H. W. 1972. *Input-Output and Regional Economics.* New York: John

Wiley & Sons.

Rothschild, E. (1972, January 23). "GM in more trouble." *N.Y. Review*. pp. 18-24.

Salpukas, A. (1972, February 6). "Turn the nut, turn the nut, turn the … ." *New York Times*. p. E10.

Schaffer, W. A. 1976. *On the Use of Input-Output Model for Regional Planning*. Leiden: Martinus Nijhoff Social Sciences Division.

Shilling, D. (1998, November 22). "Lansing's bid for GM began before valley's." *Youngstown Vindicator*. p. A1.

Walthall, R. C. (1996, June). "State and local tax incentives." *International Tax Review*. pp. 43-47.

Welker, G. (1998, November 22). "In Toledo, Jeep effort succeeded." *Youngstown Vindicator*. p A1.

Williams, L. (1992, August 28). "Dealers wait for repercussions to hit sales." *Youngstown Vindicator*. p. C2.