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Factors Influencing Employment in the U.S. Automobile Industry

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During the 1980s, increased attention was paid by the United Auto Workers union and politicians to the U.S. automobile industry and the problems it was facing from Japanese competition. Now, with 1992 being a presidential election year, the candidates are continuing to draw attention to what they see as the problems of the U.S. auto industry. And this concern is not without reason. The share of the U.S. market held by the Big Three domestic producers (GM, Ford, and Chrysler), has decreased dramatically over the past three decades. As is shown in Figure 1, the market share of U.S. based producers has fallen from a high of 95.11% in 1962, to around 82% in the mid-1970s, to a low of around 64% in 1987 (MVMA World Motor Vehicle Data, 1990). These figures become even more alarming if we look at the market share of foreign transplants (i.e.-foreign auto production plants in the U.S.) and imports taken together. They accounted for 41% of the market in 1990 (Singleton, 1992, p.22).

The problems of the Big Three can also be seen in the generally declining levels of employment over the past 10 to 15 years (see Figure 2). From a peak level of 1,004,900 employees in 1978, employment fell to a low of 704,800 in 1982, and is now just above 800,000 employees (Monthly Labor Review, various issues). The purpose of this paper, then, is to explain these drastic fluctuations in auto industry employment from 1960 through 1990. Both theoretical and empirical analysis are used to test several demand-side hypotheses about these changing employment levels. Specifically, employment is hypothesized to

FIGURE 1

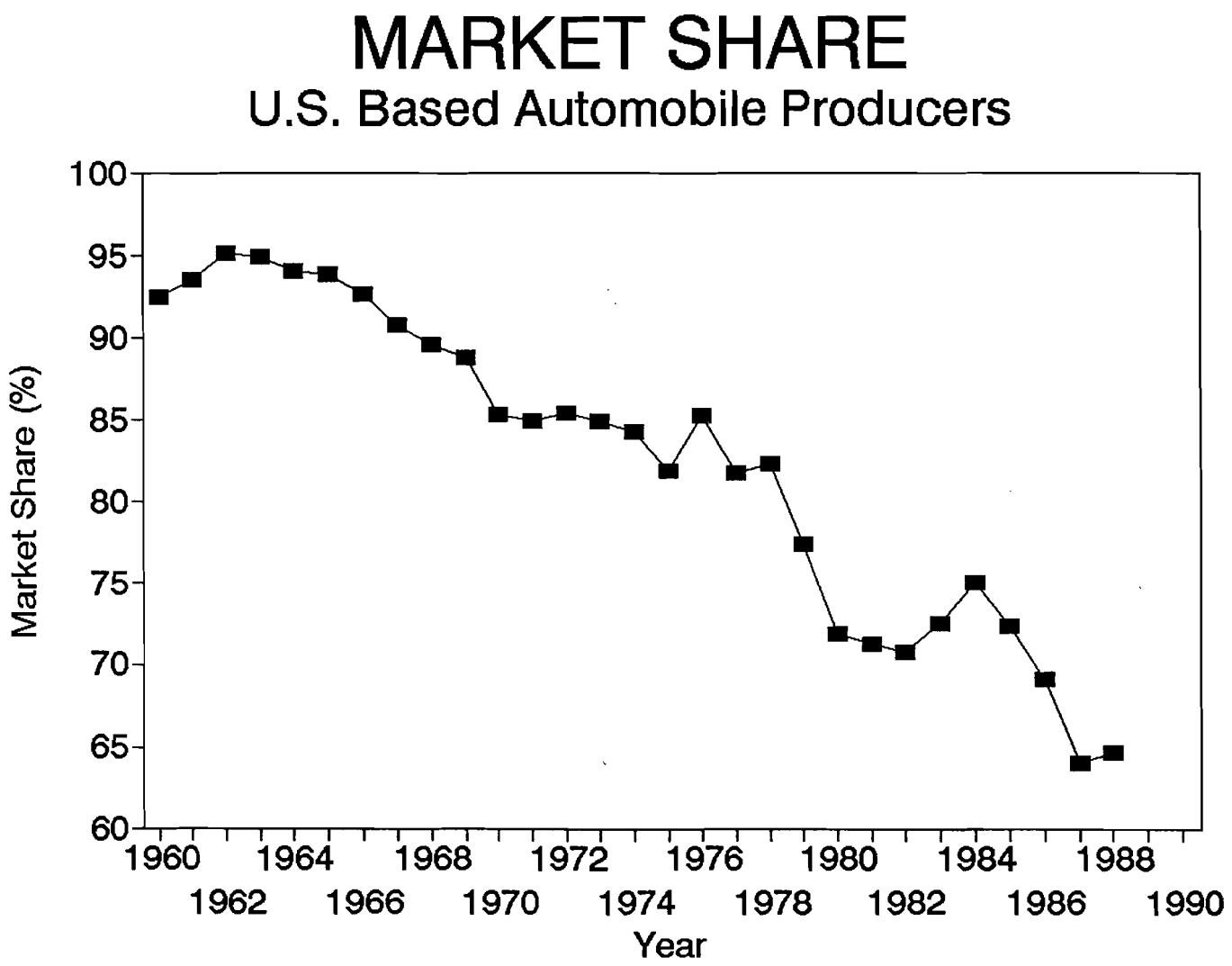
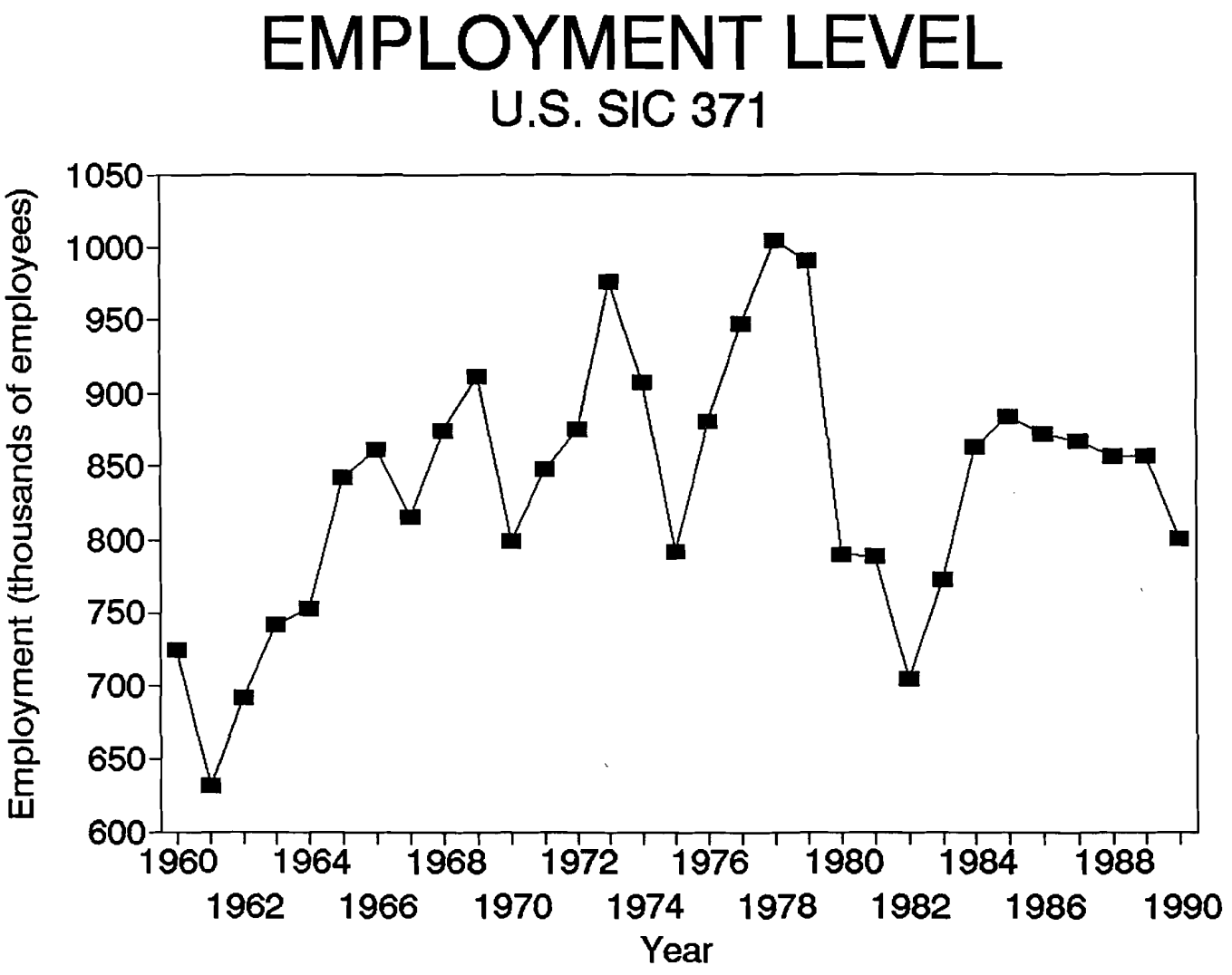

MARKET SHARE
U.S. Based Automobile Producers
Market Share (%)
100
95
90
85
80
75
70
65
60
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
Year

FIGURE 2


EMPLOYMENT LEVEL
U.S. SIC 371
Employment (thousands of employees)
1050
1000
950
900
850
800
750
700
650
600
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
Year

be influenced by 1) the level of international competition, 2) the extent of union (UAW) power, 3) the implementation of labor-saving and productivity-enhancing technologies, and 4) outsourcing arrangements of the Big Three. Changes in these four areas can be shown to shift or change the elasticity of the demand curve for labor in the automobile industry.

The rest of this paper will proceed as follows: Section I will present a brief historical overview of the U.S. auto industry since the 1960s. Section II will discuss the theoretical arguments behind each of the four employment influencing areas mentioned earlier. The empirical model based on this theoretical discussion will be presented in Section III, with the results being given in Section IV. Finally, Section V will draw some conclusions and make some suggestions for future research.

I. THE U.S. AUTO INDUSTRY: AN HISTORICAL BACKGROUND

In the late 1960s, the U.S. auto industry was very different from what it is now. The Big Three (GM, Ford, Chrysler) dominated the U.S. market for automobiles, facing very minimal foreign competition (Singleton, 1992, p.18). Only Volkswagen was competing in the U.S. market, allowing U.S. producers to capture between 90 and 95% of the market for the majority of the decade. Practically 100% of the employees in the industry were members of the United Auto Workers (UAW), giving the union a large degree of

"monopoly power" (i.e.--the ability to maintain wages above equilibrium along a relatively inelastic demand curve for labor). Because the industry was highly concentrated with the Big Three controlling almost the entire market, they could accept these higher wage demands and more strict work rules, passing the higher labor costs along to consumers in the form of higher product prices (i.e.--the product demand curve was relatively inelastic). In other words, the lack of competition allowed the Big Three to maintain automobile prices high enough to guarantee profitability, even in the face of high union labor costs.

However, things started to change in the early 1970s with the first oil shock in 1973. OPEC restricted the supply of crude oil, causing the price of oil and gasoline to skyrocket. Consumer preferences began to shift toward smaller, more fuel efficient automobiles which were not offered by the Big Three (Singleton, 1992, p.19). Enter Japan. Offering a line of smaller, lower cost, fuel efficient cars and relying on a new image of technical excellence and high product quality, the Japanese began taking larger and larger parts of the U.S. market from the Big Three (Tolliday and Zeitlin, 1986, p.197). This trend accelerated through the 1970s, with the Japanese increasing their market share from 7.6% in 1969 to 22.7% after the second oil shock of 1979.

As the Big Three tried to catch up in the production of small, fuel efficient cars, they began working against their comparative advantage in the production of large cars. Incurring

high product development and design costs for this new line of small cars, the profits of the Big Three started to shrink. Labor costs (as well as the costs of other inputs) therefore became more of an issue as the Big Three tried to maintain profits and market share. With the competition from Japan becoming more intense, the latest in manufacturing technologies were being adopted "to raise productivity, lower costs, and improve quality" (Bureau of Labor Statistics, 1985).

The auto industry by the 1980s had emerged as a more competitive industry, very different from the highly concentrated industry of the 1960s. The high union labor costs could no longer be passed on to consumers, so employment began to fall and plant closings were threatened. A period of concessionary bargaining began in the early 1980s as the UAW scrambled to save the jobs of its members.

More recently, U.S. producers have been increasingly moving toward outside suppliers of parts and components--nonunion suppliers in many cases--to take advantage of lower labor costs. Moves to Mexico by many parts suppliers have become reality rather than just threats, jeopardizing the jobs of many U.S. workers. New outsourcing arrangements for parts have become more and more important as U.S. auto producers strive to match the Japanese.

II. THEORETICAL FRAMEWORK

From the overview presented above, four important areas emerge as being strong influences on employment in the U.S. auto industry: 1) international competition, 2) union power, 3) technological change, and 4) outsourcing arrangements. The following discussion illustrates how changes in these areas will theoretically effect the demand for labor in the auto industry.

Changes in these areas are shown to either shift or change the elasticity of the demand curve. Basic demand theory is used to illustrate shifts in the demand curve, while the Hicks-Marshall Laws of Derived Demand are used to explain changes in the elasticity of demand for labor. These laws state that the wage elasticity of demand for a particular category of labor will be high under the following circumstances:

> "1) when the price elasticity of demand for the product being produced is high;
>
> 2) when other factors of production can be easily substituted for the category of labor;
>
> 3) when the supply of other factors of production is highly elastic...; and
>
> 4) when the cost of employing the category of labor is a large share of the total costs of production" (Ehrenberg and Smith, 1991, p.109).

It is important to note here that the four areas under

consideration as determinants of employment are all demand-side variables. The following arguments are made under the assumption that the supply of labor curve in the auto industry is upward sloping and held constant. Because the UAW is a trade union rather than a craft union, it cannot restrict the supply of labor in the industry. The auto makers are assumed to be able to hire the demanded quantity of labor at the negotiated wage rate and to be able to adjust the quantity of labor employed as market conditions change. In other words, ignoring the supply side of the labor market as a determinant of employment seems reasonable because the negotiated wage is, no doubt, above equilibrium. Evidence of this is persistent unemployment (i.e. excess supply) in the industry as well as the fact that the ratio of auto worker-to-total manufacturing wages is greater than one (see Cline, 1986). Therefore, employment is determined by equating the wage to the demand for labor curve. Workers will always be available at union-scale wages, so supply considerations are not important.

International Competition

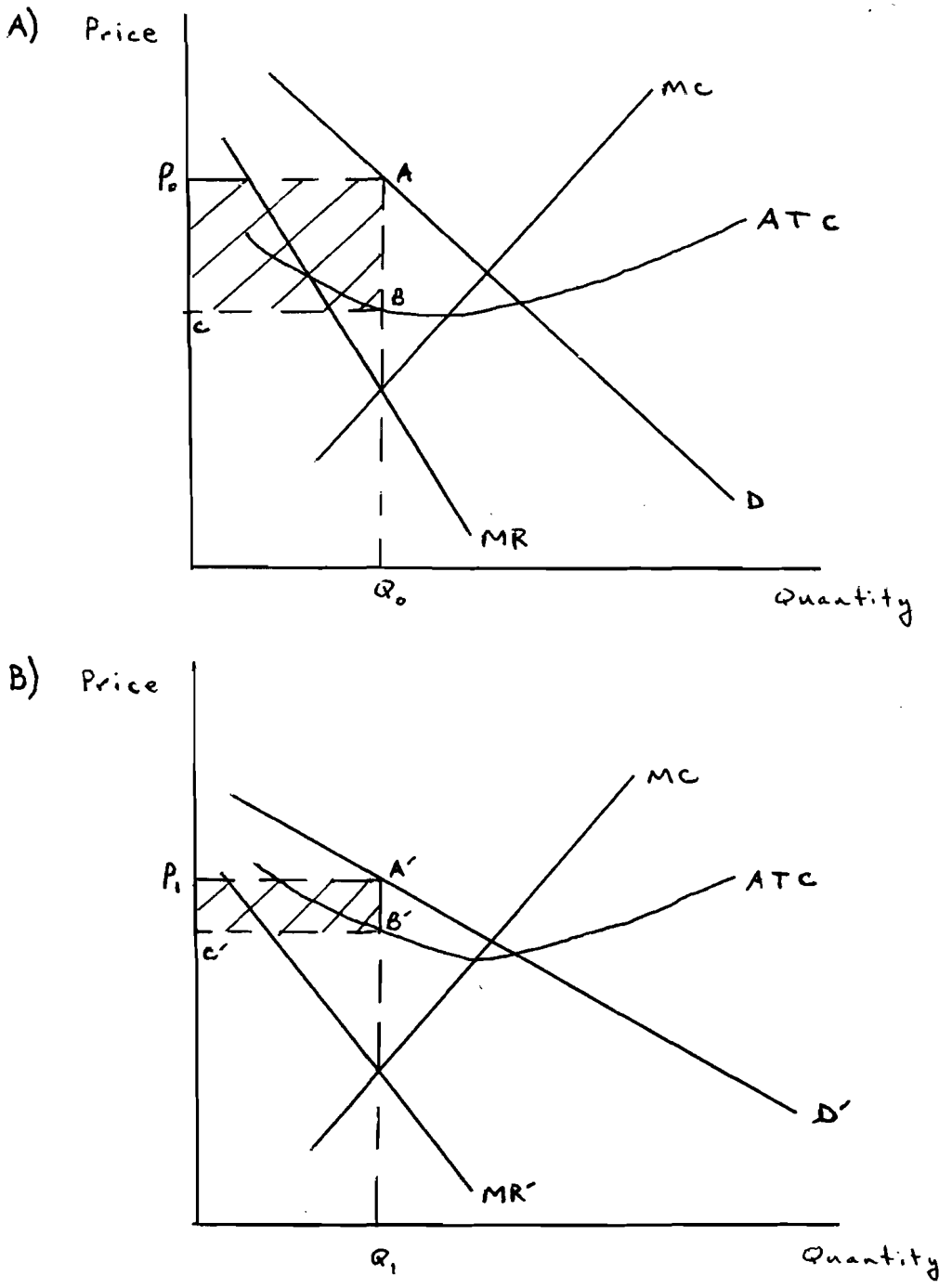
As can be seen from the discussion in Section I and the graph of U.S. market share presented in Figure 1, the structure of the auto industry has changed dramatically since the 1960s. Whereas there were only three major competitors (GM, Ford, Chrysler) in the U.S. market in the 1960s, controlling up to 95% of the market, there are now at least ten strong competitors.

Only three of these competitors are U.S. corporations (the Big Three), with foreign auto makers having taken over 35% of the market by the late 1980s (see Figure 1).

The high concentration of the industry in the 1960s and early 1970s, along with the nature of the product market, is indicative of the monopolistically competitive market structure, which lies between monopoly and perfect competition. With this type of market structure, the producers are able to set their prices above the intersection of the marginal cost and marginal revenue curves, say at P_0 (see Figure 3A). In this situation, the Big Three were able to acquiesce to the UAW's demand for higher wages and stricter work rules because these higher labor costs could be passed on to consumers in the form of higher product prices. That is, the high profits earned by the Big Three (shown as the area of P_0ABC in Fig. 3A) made room for wage increases to union workers.

However, as Japanese firms began to enter the U.S. market with the oil shocks of the 1970s, the situation facing the Big Three began to change. With more competitors in the market, the monopolistic competition model would predict that two things should happen. First, the product demand curve for each of the Big Three firms should shift to the left as they will be able to sell fewer automobiles at any given price (see Figure 3B). Second, the product demand curve facing each firm should also become more elastic as more and more automobiles are available for consumers to choose from. The demand for automobiles will be

FIGURE 3 PRICE DETERMINATION UNDER MONOPOLISTIC COMPETITION



more sensitive to price changes due to the increased options of consumers. The new demand curve will look like D' in Figure 3B (see Varian, 1986 for a more complete discussion of monopolistic competition).

Big Three producers will now only be able to charge P_1 for their output due to the increased competition from Japanese firms. Profits will be squeezed (area of $P_1A'B'C'$ in Fig. 3B) as firms move toward zero long run economic profits (Varian, 1986, p.438). Labor demands for high wages can no longer be as readily accepted as in the 1960s and early 1970s if the Big Three firms want to maintain their market share.

The effects of this change of market composition on demand for labor will be as follows: First the demand curve for labor facing U.S. producers will shift left in response to the leftward shift in product demand (remember, labor demand is derived from product demand). Second, the demand for labor curve will become more elastic according to the first of the Hicks-Marshall Laws of Derived Demand. Overall, then, the increase in international competition that began in the early 1970s and has continued through the present should cause employment in the auto industry to fall and become more sensitive to changes in wage and benefit demands by the UAW. Certainly, this relationship seems plausible from a quick analysis of Figures 1 and 2. It will be empirically tested later in the paper.

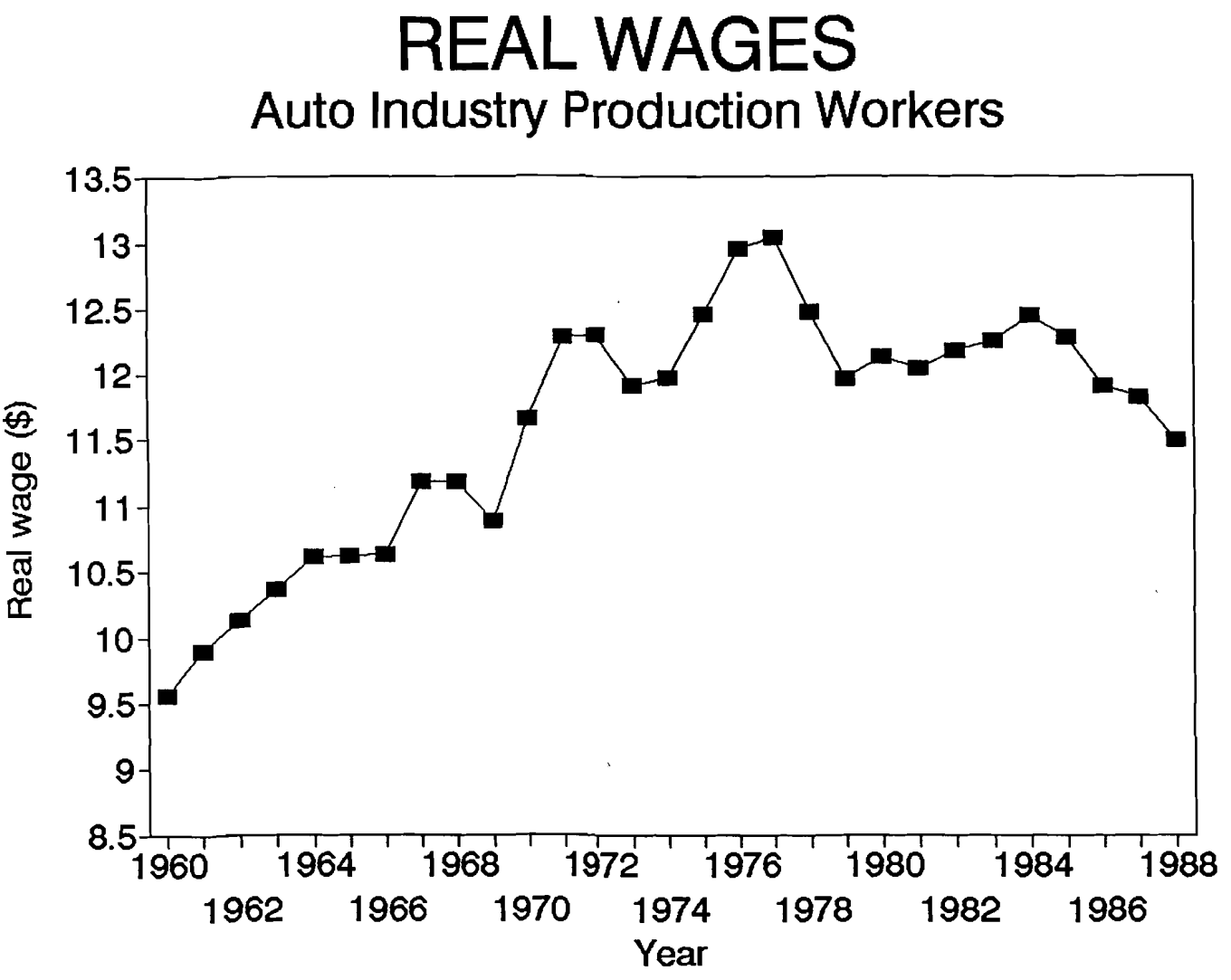
Union Power

The United Auto Workers (UAW) union has historically been very strong in the U.S. auto industry (at least back to 1960, the beginning point of this study). Although the UAW enjoys very cooperative relations with management these days, "its clout--at the bargaining table and in the political arena--is waning" (Lowell, 1985, p.1). This loss of power can be seen by looking at four areas: unionization rates, real wages, pattern bargaining, and domestic content.

The level of unionization by the UAW has been decreasing recently. UAW membership was at 1.2 million in 1985, with automotive hourly employees accounting for 587,307 members. This figure represents a 22.5% decrease from 757,328 automotive members just ten years earlier in 1975 (Lowell, Sept. 1985, p.2). Furthermore, Japanese transplants in the U.S. (with the exception of the Mitsubishi plant in Bloomington/Normal, IL) have been very reluctant to even recognize the UAW as a bargaining agent (Lowell, 1985, p.5). Although this reflects a choice by employees rather than by the employer, it still represents a general trend away from the power that the UAW once held in the U.S. auto industry.

This loss of union power can also be seen by looking at Figure 4. Over the past six to eight years, union wages have failed to keep pace with inflation, having decreased rather steadily since 1984. And in the early 1980s, the UAW was forced to abandon its goal of high wages during the period of

FIGURE 4


REAL WAGES
Auto Industry Production Workers
Real wage ($)
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
Year

concessionary bargaining in order to save jobs (Ready, 1980, p.272).

Pattern bargaining is a more difficult issue, however. While pattern bargaining during the 1960s and 1970s strongly influenced settlements in general, the 1980s saw wage settlements that varied across firms and that were driven by increased competitive pressures (Ready, 1990, p.272). The auto industry's pattern bargaining took the form of wage leadership, where one of the Big Three would settle with the UAW and then the other two would fall in line. While Ready (1990) argues that pattern bargaining in general increased over the 1977-1983 period, she concedes that the auto industry was a strong exception to this trend. Interestingly enough, an examination of the 1987 and 1990 contracts between the Big Three and the UAW seems to show a return to pattern bargaining (Monthly Labor Review, various issues). In 1987, Ford settled first, and in 1990 GM settled first, but the language and provisions of the others closely paralleled the leader's contract in both years. What exactly this means in terms of union power, I am not sure, but it may be a reflection of the more cooperative union-management relations alluded to earlier.

Finally, the decrease in union power can be shown by the increasing amounts of foreign parts in U.S. produced cars. This will be covered later, but it is useful to point out here that non-U.S. suppliers are expected to provide 36% of auto components in 1990 (Tolliday and Zeitlin, 1986, p.204). These new

outsourcing arrangements put the jobs of up to 70,000 UAW members in jeopardy (Sorge, 1991, p.20).

Overall, then, it would seem that the UAW has been losing some of its "monopoly power" over the past ten to fifteen years. As union monopoly power generally results in a more inelastic demand for labor curve, allowing for wage increases with small reductions in employment, this loss of monopoly power by the UAW should result in a more elastic demand for labor curve (Davies, 1991, p.3). The effect on employment of this more elastic demand for labor curve should be negative, as employment is now more sensitive to increased wage and benefit demands by the UAW.

Technology

The intense competition from Japanese auto makers has been causing U.S. auto makers to make many changes, one of which involves the implementation of new technologies. Industrial robots, computers, and programmable controllers are all being used to a greater extent by the Big Three these days in efforts to raise productivity and quality and to reduce costs. Ultimately, these changes will affect the level of employment in the U.S. auto industry. But will new technologies serve to reduce employment (substitution effect) or increase employment (scale effect)?

The substitution effect is probably the more common of the two when thinking about capital-for-labor substitutions. This effect will be negative according to the second Law of Derived

Demand; that is, an increase in technology implementation will reduce employment. Capital and labor are substitutes in the production process. In the auto industry, this effect can be seen in the fact that new technologies generally replace certain types or categories of workers. For example, computer-aided design and manufacturing (CAD/CAM) systems tend to "reduce unit labor requirements for engineers, drafters, machine operators, and tool-and-die makers" (Bureau of Labor Statistics, 1985, p.37). Similarly, industrial robots are said to perform the work of about 1.5 workers per shift for spot welding, and of one worker per shift for materials handling (Bureau of Labor Statistics, 1985, p.36). According to one study (Allen, 1987), the principal motivation for robotic welding is labor savings.

Of course, while some categories of workers will be displaced by the use of new technologies, there will also be new jobs associated with these technologies. These new jobs will primarily be in skilled areas such as maintenance, programming, and electrical control (Allen, 1987, p.91). Although his study is somewhat dated, Allen (1987) predicted a loss of 73,200 unskilled jobs and a gain of 6200 skilled jobs due to robots alone by 1990 (no current numbers were available to confirm this prediction). This would amount to an overall net loss of 67,000 jobs, illustrating the negative effects on employment of capital-for-labor substitutions.

The opposite effect, the scale effect, would predict an increase in employment due to technology implementation. The

scale effect in the auto industry would work as follows: The implementation of new technologies will increase the productivity (output per hour) of employees. Fewer units of labor will be required to produce the same amount of output. This will result in lower product prices and, according to basic demand theory, a higher quantity of automobiles demanded. Consequently, the demand for labor will increase because it is derived from the demand for automobiles (see Ehrenberg and Smith, 1991 for a more complete discussion of the scale effect).

Whether the substitution effect or the scale effect will dominate cannot be known from theoretical discussion alone. But labor theory does give us some idea about conditions under which capital and labor are likely to be gross substitutes based on the Hicks-Marshall Laws of Derived Demand (i.e.--conditions under which the substitution effect dominates the scale effect):

> 1) the substitution effect will be stronger to the extent that capital is a substitute for labor in the production process and that it is relatively easy for firms to make the substitution; and
> 2) the scale effect will be relatively weak if there is an inelastic product demand and if capital constitutes a small share of total cost in the industry experiencing automation (Ehrenberg and Smith, 1991, p.125).

These conditions suggest that both the substitution and scale effects may be strong in the auto industry. Condition 1 seems to hold based on the labor displacement estimates due to robotics given above, pointing to a strong substitution effect. However, condition 2 does not hold for the auto industry, as product demand is relatively elastic (sensitive to fluctuations in price) and capital would appear to constitute a relatively large share

of total cost in the industry. This points to a strong scale effect as well.

Theoretically, then, we cannot predict whether the substitution or scale effect will dominate in the auto industry. The answer to this question is left to the empirical model developed in the next section. Certainly, though, the argument that new technologies will affect employment is theoretically sound, regardless of the direction of the change.

Outsourcing

The issue of outsourcing (i.e.--auto producers going outside the company and many times outside the country for parts) has been hotly debated over the past ten years. From the employer's perspective, it makes perfect sense to go outside the company and get the same parts for $10 an hour in labor costs instead of the $27 an hour that UAW workers get (Smith, 1989). But from the viewpoint of the auto workers and the UAW, these new outsourcing arrangements put jobs at stake--the jobs of up to 70,000 UAW members, to be more precise (Sorge, 1991, p.20).

Although recent union contracts have beefed-up income protection packages for laid-off workers and restrictions on outsourcing (Cimini, 1991, p.20), outsourcing by the Big Three either to non-union suppliers or to over-seas suppliers will reduce the demand for labor in the industry. Essentially, the use of foreign-built parts reduces domestic employment by transferring demand abroad. Imports of auto parts by the Big

Three rose from $2.7 billion in 1982 to $5.6 billion in 1986 (Singleton, 1992, p.26). Tolliday and Zeitlin (1986) estimated that non-U.S. suppliers would provide 36% of auto components by 1990, up from 26% in 1985 (current figures were not available to confirm this forecast).

Another effect outsourcing could have on the demand for labor is to increase the elasticity of the demand curve. According to the second of the Hicks-Marshall Laws of Derived Demand, the elasticity of demand for auto workers will be high "when other factors of production can be easily substituted" for auto workers (Ehrenberg and Smith, 1991, p.109). The substitution taking place in the case of outsourcing would be one of non-union labor for union labor or unskilled for skilled labor as auto makers increasingly move toward foreign suppliers for parts and components. As this substitution takes place, employment in the auto industry becomes much more sensitive to changes in the wage rate.

To the extent that the demand curve for labor shifts to the left and becomes more elastic as outsourcing by the Big Three increases, employment may be drastically reduced. However, if either of these changes occurs independently, employment should still be reduced, albeit by a smaller amount.

III. EMPIRICAL MODEL

The theoretical discussion above highlights four hypotheses concerning the demand for employment in the U.S. auto industry:

1) changes in the share of the U.S. market held by domestic producers are hypothesized to directly affect the demand for labor in the industry;

2) changes in the power of the UAW are hypothesized to inversely affect the demand for labor;

3) changes in technology implementation will affect labor demand either negatively (if the substitution effect prevails), or positively (if the scale effect prevails); and

4) changes in outsourcing arrangements should inversely affect the demand for labor in the U.S. auto industry.

These four hypotheses are built into and tested by the model developed in this section (with the exception of Hypothesis 4, which will be explained later).

OLS multiple regression analysis is used with industry-wide data from SIC 371 covering the 1960-1990 period. The regression equation takes the form:

$$Employ_t = a_1 + a_2 MktSh_t + a_3 RealWage_t + a_4 Output/Hr_t + a_5 Unemp_t$$

The variables are defined in Table 1, and their sources are given. Below, each variable and its expected coefficient is explained in the context of its respective hypothesis.

TABLE 1--VARIABLE DEFINITIONS

VARIABLE	DEFINITION
Employ	Number of employees in the motor vehicles and equipment industry, SIC 371 (Source: Monthly Labor Review, various issues)
MktSh	% of the U.S. market for automobiles held by domestic producers. Measured by the % of new vehicle registrations each year in the U.S. (Source: MVMA World Motor Vehicle Data, 1990)
RealWage	Average wage of production workers in SIC 371 divided by the CPI (Source: Handbook of Labor Statistics, Business Statistics)
Output/Hr	Average output per employee hour in SIC 371. Measured as index with 1977= 100 (Source: Handbook of Labor Statistics)
Unemp	Total unemployment rate in U.S. economy (Source: Business Statistics)

Hypothesis 1

The coefficient a_2 on the market share variable should be positive according to Hypothesis 1. That is, as the share of the U.S. market held by domestic producers decreases, the demand for labor by domestic producers should decrease. This will be reflected graphically by a shift to the left and/or an increase in the elasticity of the demand for labor curve. The market share variable is measured as the percent of new vehicles registered in the U.S. that were domestically produced. The only shortcoming of this measure is that it also includes vehicles produced in foreign transplants in the U.S. If cars sold by transplants displace imported sales, the net effect on employment in the U.S. motor vehicle industry would be positive. However, if transplant sales displace the sales of the Big Three (i.e.--add to the sales of imports), employment in the U.S. auto industry will decrease (Singleton, 1992, p.23). In the latter case, the coefficient a_2 will understate the effect of loss of market share on labor demand in the U.S. auto industry; in the former, the effect will be overstated.

Hypothesis 2

The effects of changes in union power are measured by a proxy, the real wage in the motor vehicle and equipment industry (SIC 371). This should be a reasonable proxy, as union power will be shown partly by its ability to increase wages in an industry. However, it does fail to take into account fringe benefits such as supplemental unemployment benefits and job

security programs negotiated for by the UAW. This exclusion may bias the estimated coefficient a_3, but its sign should still be negative. As the UAW negotiates wage increases, the demand for labor should fall according to basic demand for labor theory. Since changes in union power will result in changes in the wage elasticity of demand for labor rather than a shift in the demand curve, the expected negative coefficient would be shown by a move to the left along the demand for labor curve.

Hypothesis 3

Unfortunately, measures of the number of technologies used by auto producers (such as robots or computer-aided design and manufacturing systems) was not available for the time period of my study. Therefore, average output per employee hour for SIC 371 is used as a proxy based on the following reasoning: As the implementation of new technologies increases, employee productivity or output per employee hour should increase. This is, however, an imperfect proxy as output per hour is influenced by things other than just changes in technology implementation. At any rate, the sign for coefficient a_4 can be either positive or negative, depending on whether the scale or substitution effect dominates. But if a positive (negative) coefficient results, it does not mean that there is no substitution (scale) effect. It simply means that the scale (substitution) effect is stronger.

Hypothesis 4

Once again, this variable has fallen victim to data

availability problems. No measures of outsourcing arrangements were available, as the auto makers and the UAW maintained this was "private information" (from telephone conversation with Lydia Fischer, Research Division, UAW). Neither was an acceptable proxy found, so this variable was omitted in computer runs of the empirical model. However, outsourcing is controlled for to a certain extent in that the data for the other variables cover the Motor Vehicles and Equipment Industry as a whole, not just the auto producers. In other words, changes in outsourcing arrangements will in part be accounted for in the employment, real wage, and output per hour variables under the "and Equipment" part of SIC 371. Increases in outsourcing by the Big Three should still result in a leftward shift or an increase in the elasticity of the demand for labor curve of the auto producers. Strong theoretical support for this argument was given in the previous section.

Finally, the unemployment rate was included to control for cyclical movements in employment levels in the auto industry. Since automobiles are big ticket items, sales fall off dramatically in economic downturns. And because the demand for auto workers is derived from the demand for automobiles, employment will also naturally fall off during recessionary periods. The coefficient a_5 should therefore be negative--as the unemployment rate in the economy increases, employment in the auto industry should decrease.

IV. RESULTS

The results of the regression equation presented in the previous section as obtained through OLS estimation are given in Table 2. In short, the results were generally favorable, with the exception of the RealWage coefficient, which had the opposite of the predicted sign. All coefficients are significant at the .01 level, the adjusted R^2 is relatively high (=.9344), and the Durbin-Watson statistic (2.175) suggests that there are no problems with auto-correlation. The estimated coefficients and their meanings will be discussed in the following paragraphs.

Hypothesis 1 was upheld by this empirical model, as is shown by the positive coefficient a_2 for the market share variable. Although the size of the coefficient suggests that its effect is relatively small, it nevertheless has the predicted effect and is significant beyond the .01 level. The market share decreases experienced by U.S. auto makers during the 1970s and 1980s, and now into the 1990s, have indeed negatively influenced the level of employment in the industry. The results demonstrate that a decrease in the market share held by U.S. producers of 1% will result in a decrease in employment of 4330 jobs (employment variable is measured as thousands of employees). It seems then that there is merit in the UAW's, the Big Three's, and politicians' concerns about the increasing levels of import penetration in the U.S. automobile market, not to mention the concerns of employees fearing for their jobs.

TABLE 2--REGRESSION RESULTS

INDEPENDENT VARIABLES	COEFFICIENT
MktSh	4.33
	(3.51)*
RealWage	98.17
	(13.59)*
Output/Hr	1.54
	(2.68)*
Unemp	-36.38
	(10.86)*
Constant	-568.89

(t-statistics in parentheses)
* significant at .01 level

Adjusted R-squared = .9344
Degrees of Freedom = 23
Durbin-Watson Statistic = 2.175

Skipping Hypothesis 2 for the moment, the estimated coefficient a_4 for the Output/Hr variable turned out to be positive and significant at the .01 level. All else constant, this coefficient suggests that an increase in technology implementation will cause employment to increase. The scale effect dominates, although the substitution effect may still be present. According to this coefficient, an increase in output per hour of one index point (output per hour was measured as an index with 1977=100) will lead to an increase in employment of 1540 workers.

The unemployment rate variable also performed favorably, with its coefficient being large, negative, and significant beyond the .01 level. As expected, employment in the auto industry moves with the business cycle, falling during downturns and rising during recoveries. The inclusion of this variable was important as it controlled for the cyclical component in the model and allowed the other variables to predict more accurately.

Back to Hypothesis 2. The estimated coefficient a_3 was puzzling at best. It turned out to be a large positive number that is highly significant, contradicting basic labor demand theory. Essentially, this positive coefficient postulates an upward sloping demand for labor curve, with an increase in the real wage causing a large increase in employment.

While this result is disappointing, there are several possible explanations for coefficient a_3 having the opposite of the predicted sign. The first and most obvious reason could be

that the real wage of auto workers may not be such a reasonable measure of or proxy for union power after all. UAW power can also be seen by changes in the level of fringe benefits, changes in the percent of industry employees unionized, the extent of pattern bargaining, and changes in the amount of "domestic content" in domestically produced automobiles. The use of a union-nonunion wage differential variable may have given a better estimation of union power, but such data were not available. Looking at the graphs of auto industry employment (Figure 1) and real wages (Figure 4), it is no surprise to find a_3 to be positive since both have a generally downward trend over the past ten to fifteen years. Interestingly enough, nominal auto worker wages (before adjusting for inflation) had the predicted negative sign.

Second, the real wage variable may be influenced by other variables outside the model, causing its coefficient to be biased. For example, since the demand for auto workers is derived from the demand for automobiles, it should be effected by both the price of automobiles and consumers' disposable income. Either of these might be correlated with wages, causing the wage coefficient to pick up their effects. Similarly, the real wage variable may actually be endogenous to the model, although it is being represented as an exogenous variable. In other words, real wages may actually depend on market share, output per hour, and the unemployment rate. In this case, a more sophisticated two-stage model may be more useful.

Finally, union power may actually be a shift parameter, rather than just causing a change in the elasticity of or a movement along the demand for labor curve. In this case, the UAW would operate more like a craft union, influencing both the level of employment and the level of wages. An increase in the negotiated real wage may be accompanied by an increase in negotiated employment, thereby causing an outward shift in the demand for labor curve (or what might appear to be an upward-sloping short-run demand curve). Needless to say, some work needs to be done on this union power variable in future research efforts.

Overall, the results of the model were favorable. Hypothesis 1 was upheld, the technology effect was decided in favor of the scale effect, and the unemployment rate performed well as a control for cyclical variations. Furthermore, the estimated coefficients were highly significant, and the adjusted R^2 was high.

V. CONCLUSIONS AND SUGGESTIONS

The purpose of this paper was to explain fluctuations in employment in the U.S. automobile industry through both theoretical and empirical analysis. Four hypotheses of factors effecting auto industry employment were developed through a look at changes in the industry over the past 30 years. All four of these hypotheses were strongly supported theoretically using

demand for labor analysis and the Hicks-Marshall Laws of Derived Demand. Three of the hypotheses were tested empirically using multiple regression analysis, two of which were supported and one of which was found to contradict basic demand for labor theory.

In support of the theory were the findings that a positive relationship exists between market share and employment in the auto industry. This finding implies that the increasing competition from Japanese auto producers does indeed cause employment of U.S. auto workers to fall. Increases in technology implementation were also found to increase employment in the industry. This is an encouraging result in that new technologies can be used to increase productivity and catch up to the Japanese without displacing as many workers as might be expected. The real wage variable was the only one that did not perform well, with the model predicting a positive relationship between employment and real wages. However, this variable was subject to some problems (discussed in the previous section) that may have influenced its estimated coefficient. Finally, the argument that increasing outsourcing by the Big Three should decrease employment was theoretically supported, but could not be empirically tested due to data constraints.

Future efforts in this area should concentrate primarily on four things:

1) a more complete and reliable measure of UAW power should be found that takes into account fringe benefits as well as other aspects of union power (pattern bargaining, domestic

content, % unionized, etc.). Furthermore, a two-stage model may be appropriate to avoid the endogenous/exogenous problem of the real wage variable;

2) a better measure of technology implementation should be used, such as the number of robots in use, which would more directly measure the effects of technology changes;

3) some quantitative measure of outsourcing should be used to make the model more complete. A possibility would be the percent of domestically produced automobiles that comes from foreign sources; and

4) a less aggregated measure of employment should be found that would include only domestic automobile production workers rather than employees in the entire industry (SIC 371).

However, I did find a significant relationship between employment in the auto industry and international competition which is consistent with economic theory. Employment was also found to be positively effected by productivity enhancing technologies. This seems to indicate that perhaps the best way to head-off the adverse effects of international competition on employment in the U.S. auto industry is to pursue policies that will increase labor productivity. The effects of these two variables may offset each other so that employment can be somewhat stabilized, even in the face of a decreasing market share for U.S. auto producers.

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