A TIME-SERIES INVESTIGATION INTO FACTORS INFLUENCING U.S. AUTO ASSEMBLY EMPLOYMENT

An Economic Policy Analysis

by

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In 1971, Lawrence J. White wrote "Policy on the auto tariff does not seem to have been protectionist oriented. The auto companies have never asked for tariff protection."[1] In recent years, however, U.S. auto makers have increasingly asked for, and received, protection from import competition. The restrictions have primarily taken the form of voluntary restraint agreements (VRAs) negotiated under the implicit threat of more stringent explicit restrictions if foreign producers did not "volunteer".[2]

In determining whether any such protection is merited, and if existing programs are cost-effective, estimates of the impact of import competition on domestic employment are required. The broad facts of the case can be presented as follows. First, U.S. employment in the auto industry has declined. Between 1978 and 1979, an average of 356,300 workers were employed in the U.S. auto assembly industry, an all-time high. In the twelve months preceding the April 1981 imposition of the VRA,

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[1] White [1971], p. 277. Actually, a small (3 to 6 percent) auto import tariff did exist over the decade of the '60s, the period White discusses.

[2] Thus, White's observation is still strictly correct: the auto companies have not asked for tariff protection. However, in 1981 Japanese light trucks were subjected to a tariff of 25 percent (up from 4 percent) and large motorcycles to a 49.4 percent tariff (up from 4.4 percent). Further, while VRA's are non-tariff, they are not non-protective.

employment had fallen to 245,900.[3] At the same time, imports were up. In 1980 the U.S. imported 3.12 million cars, compared to 0.56 million in 1965. Japanese autos represented nearly 65 percent of this total. U.S. production had fallen to 6.4 million vehicles, compared to 9.3 million in 1965.

Clearly, the rise in imports is concurrent with the decline in U.S. employment. The question we would like to address is whether increased competition from imports caused the decline or whether the decline in domestic production is primarily the result of other factors. This paper adapts to the U.S. auto market a methodology developed in two studies of the steel industry (Grossman [1984] and Webbink [1984]). We find that other influences, such as the 1980-82 recession and high total compensation of U.S. auto workers, in relation to compensation paid manufacturing workers in general, are important explanations of the recent decline in employment in U.S. automobile production. In the absence of the '80-'82 recession, U.S. auto

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[3] Throughout this paper, employment figures include only employees involved in the assembly of automobiles. The figures do not include workers involved in truck and bus assembly or those producing parts and accessories. Using a broader definition of the industry, which includes these other segments of motor vehicle manufacturing, total employment was 716,000 in 1981. (See Congressional Budget Office [1982], p. 37.)

assembly employment would have been 55,300, or 22.6 percent, higher than it was. If U.S. auto workers' compensation were adjusted closer to the U.S. all-manufacturing average, 41,400 or 16.9 percent more workers would have been employed. By comparison, if real import prices, broadly adjusted for quality changes, had remained at their September 1979 levels, only 27,400 (11.2 percent) more workers would have been employed. Increased competition from imported autos played a significant, but not the primary, role in reducing domestic employment.

The Motivation and Plan of the Paper

Before proceeding, it is important to describe what is meant by increased import competition, and why we focus on its effects. In this analysis, the degree of competition from imports is measured by the dollar price, in real terms, at which imported automobiles are sold. If the constant dollar price of imported vehicles falls, then imports are more

competitive with domestic autos; if the real price rises, imports are less competitive.[4]

Defining increased import competition is an important issue in many cases involving proposals to limit imports. For example, in deciding whether to grant "escape clause relief" under section 201 of the Trade Act of 1974, the International Trade Commission is directed to determine:

> "whether an article is being imported into the United States in such increased quantities as to be a substantial cause of serious injury, or the threat thereof, to the domestic industry producing an article like or directly competitive with the imported article . . . ." (19 U.S.C. 2251(b)(1)).

From the legislative language cited above, it may appear that the correct way to measure competition from imports is to look at the quantity of a product imported into this country. However, such an approach would clearly be too broad.

The quantity of a good imported can be affected by purely domestic factors such as the domestic demand and factors affecting the price at which domestic firms supply the good. For example, an

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[4] Technically, imports are said to be more competitive if the supply curve of imported automobiles with price expressed in constant dollars shifts downward. We have assumed in this report that U.S. consumers can purchase all of the Japanese cars they want at a constant price--that is the supply curve of imported automobiles is infinitely elastic. In such a case, the price of imported vehicles completely describes the supply curve. No generality of the model is lost by making this assumption in the period prior to the V.R.A.

increase in demand would be expected to lead to an increase in the quantity of imports. Similarly, if the cost of producing a good in this country increases while the cost of the imported product does not change, then we would expect consumers to buy more of the imported product and less of the domestically-produced good. In both of these cases, imports would increase; and yet it seems inappropriate to say that imports have become more competitive or to grant relief from imports. We seek to provide a means of distinguishing between these situations.

The paper is divided into four sections. First, the theoretical model of the auto market is explained, and a reduced form equation for auto industry employment is derived. In the second section estimates of the parameters of the model are obtained using historical data for the period January, 1972, through March, 1981. Section three uses the estimated coefficients to perform counterfactual simulations. These simulations compare the relative magnitudes of the effects of changes in consumer income, domestic worker compensation, and the effects of increased import competition in explaining the observed time path of domestic auto employment. The final section summarizes the results and their implications for policy.

I. A Theoretical Model

Following Grossman [1984], a reduced form equation for domestic auto employment is derived by specifying a production function, a multiplicative demand function, and three expressions describing levels of input use. These equations are solved for employment (labor input) and the resulting solution, the reduced form, is then estimated in the next section.

We specify a simple production function for autos (A) using labor (L), capital (K), and steel (S) as inputs into the production process. Although auto production is extremely complex, these three represent the most important aggregate inputs into the production function.[5] We use the following augmented Cobb-Douglas production function:

$$Y_A^S = Be^{\pi t} K_A^{a1} L_A^{a2} S_A^{a3} \qquad (1)$$

B is a constant, π is the Hicks-neutral rate of technological progress, and t is time. The elasticities are assumed to sum to unity: $a_3 = 1-a_1-a_2$. Capital (K_A) devoted to auto production is assumed to grow at a trend rate δ (net of depreciation) per unit time from a base size of $\bar{K}$. That is:

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[5] Langenfeld [1983] derives an auto materials cost index using Department of Commerce (BEA) Input-Output data. He demonstrates that iron and steel (fabricated, shaped, or in the form of parts) account for about 2/3 of all auto materials cost, with the remaining third shared among a broad array of products, energy, and raw materials.

$$K_A = \bar{K}_A e^{\delta t}. \qquad (2)$$

Labor and steel are both assumed to be employed at the value of their marginal productivity (i.e., manufacturers do not have monopsony power).[6] Therefore,

$$L_A = \frac{a_2 P_A Y_A}{P_L}, \text{ and} \qquad (3)$$

$$S_A = \frac{a_3 P_A Y_A}{P_S} \qquad (4)$$

where P_i is the price of input i per unit time, i = {A,L,S}.

The demand equation builds on previous work in specifying and estimating the demand for new automobiles.[7] The results of this literature suggest, not surprisingly, that demand for domestic autos depends on own price, incomes of consumers, and the prices of substitutes and complements. The

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[6] Although the assumption that each factor is employed up to the point that factor price, which is exogenous in the model, equals the value of its marginal product requires the simplifying assumption that domestic auto manufacturers price competitively, the same reduced form equation would result if it were assumed that the manufacturers faced downward-sloping demand curves and that the ratio of price to marginal revenue was constant over the period. In that case, each factor would be employed up to the point where its price equalled its marginal revenue product.

[7] For a review of this literature, see Charles River Associates [1976], Crandall, Keeler, and Lave [1982], and Langenfeld [1983].

functional form assumed here is:[8]

$$Y_A^D = e^{b_7 t_B}\left[\frac{PA}{CPI}\right]^{b_1}\left[\frac{P'_A}{CPI}\right]^{b_2}\left[\frac{PG}{CPI}\right]^{b_3} \left[\frac{DPI}{CPI}\right]^{b_4}[UCAP]^{b_5}[P_C]^{b_6} \quad (5)$$

The variables can be categorized as follows.

1. Own Price
   - (i) Price of U.S. autos: P'_A
   - (ii) Real price of credit: P_C
2. Income of Consumers
   - (iii) Disposable personal income per capita: DPI
3. Substitutes
   - (iv) Price of imported autos
     P_A - Average dollar price of imported autos.
   - (v) Stock of used cars per capita: UCAP
4. Complements
   - (vi) Price of gasoline: P_G

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[8] The choice of functional form is based on a compromise between simplicity and generality. The multiplicative form, with real prices as arguments, simplifies the estimation of elasticities.

5. Other[9]

Constant: B

Time Trend: t

Price Index: CPI

Demand Elasticities: b_1, b_2, b_3, b_4, b_5, b_6.

The endogenous variables Y_A^S, L_A, K_A, P_A', and S_A are determined by equations (1)-(5). The exogenous variables are P_C, DPI, P_A, UCAP, P_G, P_S, P_L, and CPI. Solving for L_A and taking logs we obtain an estimable reduced form for auto employment:

$$\text{Log}(L_A) = C_0 + C_1 \text{ (trend)} + C_2 \text{ Log}[\frac{DPI}{CPI}] + C_3 \text{ Log } (P_C) + C_4 \text{ Log } [\frac{P_A}{CPI}] + C_5 \text{ Log[UCAP]} + C_6 \text{ Log } [\frac{P_G}{CPI}] + C_7 \text{ Log } [\frac{P_L}{CPI}] + C_8 \text{ Log}[\frac{P_S}{CPI}] \quad (6)$$

An implicit assumption of the form is that the supply curve for foreign autos is perfectly elastic. That is, all supply information is embodied in the price of imported autos, so that the quantity of imports need not appear.

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[9] The time trend proxies for population growth, structural shifts in demand for transport services, etc. The price index is used in this equation to put variables in constant dollar (1967) terms. The elasticity parameters measure the responsiveness of employment to changes in the exogenous variable.

II. Estimating The Model

We estimate the elasticities and other parameters using the following monthly data. A more complete description and a list of sources can be found in the Data Appendix.

The dependent variable, L_A, is the monthly average of total weekly hours for auto assembly workers. The series used is derived from average weekly hours per worker multiplied by the number of production workers in SIC 3711, "Motor Vehicles and Car Bodies." Both are reported by the Bureau of Labor Statistics (BLS).

The explanatory variables can be described as follows. Trend is a simple time trend, beginning at 0 in January, 1972. DPI is disposable personal income per capita, using BLS data on income and Census Bureau figures on population. CPI is the urban, all products, price index calculated by the BLS. P_C is the real interest rate charged on new car loans by finance companies, as reported by the Federal Reserve. P_A is the transactions price of imported autos in dollars, as reported by the Department of Commerce (Bureau of Economic

Analysis).[10] UCAP is the stock of used autos (see Appendix). P_G is the U.S. city average price of leaded regular gasoline. P_L is the average hourly total compensation of workers in SIC 3711 (Vehicles and Car Bodies); P_S is an average index of carbon sheet and stainless strip steel prices.

The reduced form equation (6) was estimated over the period January 1972 to March 1981. Monthly, seasonally-unadjusted data are used in the estimation. The starting point is the earliest for which all relevant data are available.[11] The end point is the necessary result of an assumption of the model, that foreign autos are available at infinite elasticity of supply. Because the voluntary restraint agreement in autos was put in place April 1981, the supply of Japanese autos was perfectly inelastic thereafter, assuming the VRA was binding.[12]

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[10] The BEA data measure the price of a vehicle of the same quality in each period. Thus, for example, if the percentage of imported vehicles that have a particular accessory, such as air conditioning or sun roofs, increases over time, BEA adjusts actual transactions price data downward in an attempt to reflect the fact that average vehicle quality had increased.

[11] Before 1972, the data on interest rates were computed on a different basis, and gasoline prices were not computed by BLS as a CPI component.

[12] For evidence the auto VRA is effective, see Tarr and Morkre [1984 Wharton EFA [1983].

The model provides reduced form estimates of comparative equilibrium effects of changes in the values of the exogenous variables. Since some time may be needed for a new equilibrium to be reached following a change in an exogenous variable, some form of lag structure must be incorporated. Since no prior theoretical expectations are held on the length or form of the lag structure, a simple structure of straight lags is used on all variables except for compensation and import auto prices. These two variables, the main focus of our study, are likely to have complex and long-term effects on employment. To allow for these effects to be captured, a 24-month, third-order polynomial distributed lag is used.[13]

The resulting estimation for equation (6) is presented in Table 1.[14] The overall explanatory power of the equation is satisfactory, explaining 92 percent of the variation of the dependent variable

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[13] The polynomial distributed lag structure allows the use of longer lags than a system of straight lags. The reason is that imposing the restriction that each lag is related to other lags of the same variable conserves degrees of freedom. The results presented are quite robust with respect to changes in lag length or the order of the polynomial.

[14] The reported coefficients do not require correction for auto-correlation (the D.W. of 1.946 rejects the hypothesis of auto-correlation in errors).

TABLE 1

Regression Results for Auto Industry

Dependent Variable: Total Monthly Hours Worked (3711)

Independent Variable	Sum of Lag Coefficients	t-statistics*	Number of Lags**
Price of Foreign Cars	2.846	1.19	24
3711 Total Compensation	-3.467	-1.42	24
Interest Rate	24x10-16	0.667	6
Regular Gas Price	-1.584	-2.839	6
Price of Steel	-.405	0.332	6
Real Disposable Income Per Capita	3.42	1.810	4
Used Cars Per Capita	-3.299	-0.638	--
Trend	.0036	0.536	--
Constant	-29.2	-1.610	--

$R2 = .92$

$\bar{R2} = .88$

D.W. = 1.946

F(29,59) = 22.689

* The individual estimates and t-statistics of the lag coefficients are available from the author.

** The coefficient estimates of import prices and compensation are third-order polynomial distributed lags; all others are straight lags.

($\bar{R}^2$ = .88). The statistic F(29, 59) = 22.689 rejects the aggregate null hypothesis at the .005 level.

The signs of the summed lags of the individual coefficient estimates are generally consistent with the expected effects of each variable. Each is discussed separately below.

(i) Foreign Car Price. The coefficient of 2.846 is positive, as predicted: an increase in the price of foreign cars induces domestic consumers to substitute away from foreign cars, and increases domestic auto employment. The sum of the estimated lag coefficients is insignificant, although 8 of the 24 lagged terms are significant at the 5 percent level.

(ii) Total Compensation. The negative coefficient indicates that as the price of an input (compensation to labor) increases, the resultant increase in the price of domestic autos induces substitution toward other forms of transportation, as well as towards more capital-intensive (i.e., robotic or automated) production. The reported aggregate t-statistic is insignificant at the 5 percent level. Of the 24 individual lagged terms, 9 are significant at or above the 10 percent level.

(iii) Interest Rate. The real finance charge on new car installment loans is expected to be negatively related to cars purchased. The estimated coefficient reveals no relation whatsoever, as each lag estimate is insignificant and uniformly close to zero.

(iv) Gasoline Price. Gasoline is a complementary good for consumption of auto services. As such, increases in gasoline price can be expected to induce substitution toward other forms of transportation (e.g., mass transit) or more fuel efficient autos (which, over the sample period, means imports). The expected negative sign for gasoline is observed, and the estimate of the sum of the lag coefficients on gas price is significant at the .5 percent level.[15]

(v) Steel Prices. Steel, like labor, is an input in the model, so the theoretically predicted sign is negative. The observed coefficient is consistent with this expectation, but is insignificant.

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[15] Some runs, using used car price instead of stock, produced a positive, marginally significant coefficient on gasoline. However, this fact can be attributed to the complicated relationship between used car prices and fuel prices. An OLS estimate of a regression of used car price on gas price (along with a trend and constant term) demonstrated a significant negative relationship. If gas price goes up $0.10, used car prices decline approximately $200 in real terms.

(vi) Used Car Stock Per Capita. Used cars are substitutes for new cars, and thus affect auto employment. Because autos are a durable good, as Langenfeld [1983] points out, an increase in the existing stock (per capita) leads to a lower price for used cars. And because used cars are a substitute for new cars, we expect a lower price for used cars to affect employment. The estimate reported for used car stock is of the expected negative sign: the larger the number of existing autos per capita, the lower the demand for new auto assembly. However, the coefficients is insignificant.[16]

(vii) Disposable Personal Income. Because autos are a consumer durable, the expectation is that sustained increases in disposable income should increase demand, so that more autos are purchased.[17] This result is observed and is marginally significant (at the 10 percent level).

Having concluded the discussion of the estimated equation, we turn now to the counterfactual simulations.

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[16] Used car stock (not per capita) was also tried, but did not significantly affect the results. Used car stock per capita is theoretically preferable, and is used in the reported simulation. Earlier runs with six lags demonstrated that the fifth and sixth terms were completely insignificant and near zero, and were dropped.

[17] This formulation is simply an embodiment of the "permanent income hypothesis" (Friedman [1957]).

III. Simulations

This section contains the results of four counterfactual simulations. The results are summarized in Table 2. These simulations allow us to compare the level of employment in SIC 3711 under several plausible, but hypothetical, scenarios. We can thus identify the most important factors affecting these workers.

As indicated earlier, this information is already required of the International Trade Commission in making section 201 ("escape clause") decisions. Specifically, section 201 of the Trade Act of 1974 has been interpreted as requiring that imports must be at least as great an influence in the decline of employment in an industry as any other factor in order for a relief recommendation to be granted.[18] Unfortunately, such information has not been available in many cases, and the ITC has been forced to make decisions based on conflicting and hard-to measure evidence. The simulations in this section explicitly provide a means of making such comparisons, at least in the case of the auto industry.

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[18] See 19 U.S.C. 2251(b)(1). The phrase "substantial cause" has been interpreted as requiring that no other cause be coequal or greater.

The simulations are conducted as follows. Values of the dependent variable, hours worked in auto assembly, are generated for four alternative counterfactual simulations using the estimated coefficients reported above in Table 1. The reported simulations are for the 12-month period immediately preceding the imposition of the voluntary restraint agreement; the resulting 12 monthly figures are then averaged in order to control for problems of seasonality. Each simulation illustrates the result of a particular counterfactual assumption about the time path of import auto prices, worker compensation, or consumers' incomes, _ceteris paribus_. Table 2 presents the simulated effects of these assumptions on auto assembly employment.

Simulation 1: Constant Real Prices of Imported Automobiles

Have Japanese automobiles become more competitive in recent years? And, to what extent was any increase in competitiveness responsible for the slump in employment in the domestic auto industry prior to the imposition of the voluntary restraint agreements in April 1981? Recall that an increase in import competition is measured by a decrease in the real price of the imported good. Figure 1, where the solid line shows the constant dollar price of imports, demonstrates that the competition faced

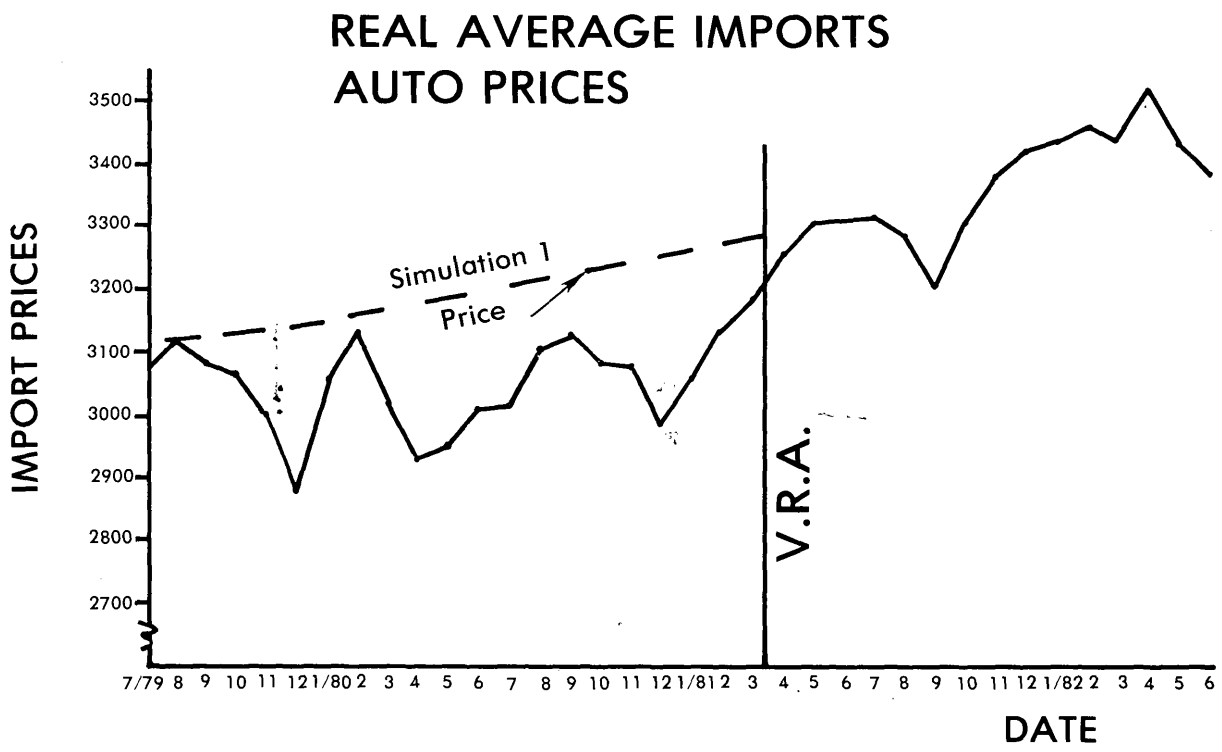
TABLE 2

Results of Simulation

Counterfactual Assumption	Results in Jobs	Rank
- No Recession	+ 55,300	1
- Compensation ratio at Japanese level	+ 41,400	2
- Higher Import Auto Prices (Quality-Adjusted)	+ 27,400	3
- Constant Autoworker Compensation (December, 1979)	+ 23,500	4

Note: Actual Employment was approximately 244,500 in 1980-81.

Figure 1


REAL AVERAGE IMPORTS
AUTO PRICES
IMPORT PRICES
3500
3400
3300
3200
3100
3000
2900
2800
2700
Simulation 1
Price
V.R.A.
7/79 8 9 10 11 12 1/80 2 3 4 5 6 7 8 9 10 11 12 1/81 2 3 4 5 6 7 8 9 10 11 12 1/82 2 3 4 5 6
DATE

by domestic automakers from imports did increase in the period before the imposition of the voluntary restraint agreements. The real price of an imported automobile fell beginning in the fourth quarter of 1979 and, except for one month in early 1980 and one or two months in the middle of 1980, remained below its August 1979 level until a run-up in early 1981 (possibly in anticipation of the voluntary restraints). Thus, Japanese vehicles were more competitive in the fall of 1979, all of 1980 and early 1981 than in August 1979. More domestic vehicles would have been sold if the price of Japanese cars had remained at their August 1979, level.

However, even if the price of imported automobiles had remained constant in real dollars between 1979 and 1981, the Japanese would have become more competitive by virtue of the fact that the vehicles they were sending to this country were of increasing quality. Paying the same price for a good of higher quality represents a lowering of price as much as lowering the price for a good of constant quality. Thus, in order truly to hold the price of imported vehicles constant, it is necessary to have the observed prices rise at the rate the quality of the imported vehicles has increased.

Feenstra (1984) estimates that the quality of Japanese autos increased by approximately 6 percent between 1980 and 1981.[19] Thus, in simulating what employment would have been had the real price of imported autos remained at their September 1979 level, a price path that begins at the September 1979 level and then moves upward by 6 percent over the period between September 1979 and March 1981 is assumed. This price path is indicated by the dashed line in Figure 1.

The results of the simulation are shown in Table 3. If, rather than falling, real prices of imported vehicles had remained constant so that the competitiveness of imports had been unchanged, employment in automobile assembly would have been approximately 27,400 higher than it was.

Simulation 2: Constant Autoworker Compensation at December 1979 Levels.

As the solid line in Figure 2 shows, real compensation of autoworkers rose approximately 10 percent between December 1979 and the imposition of the V.R.A. We seek to determine what would have happened if this increase had not taken place.

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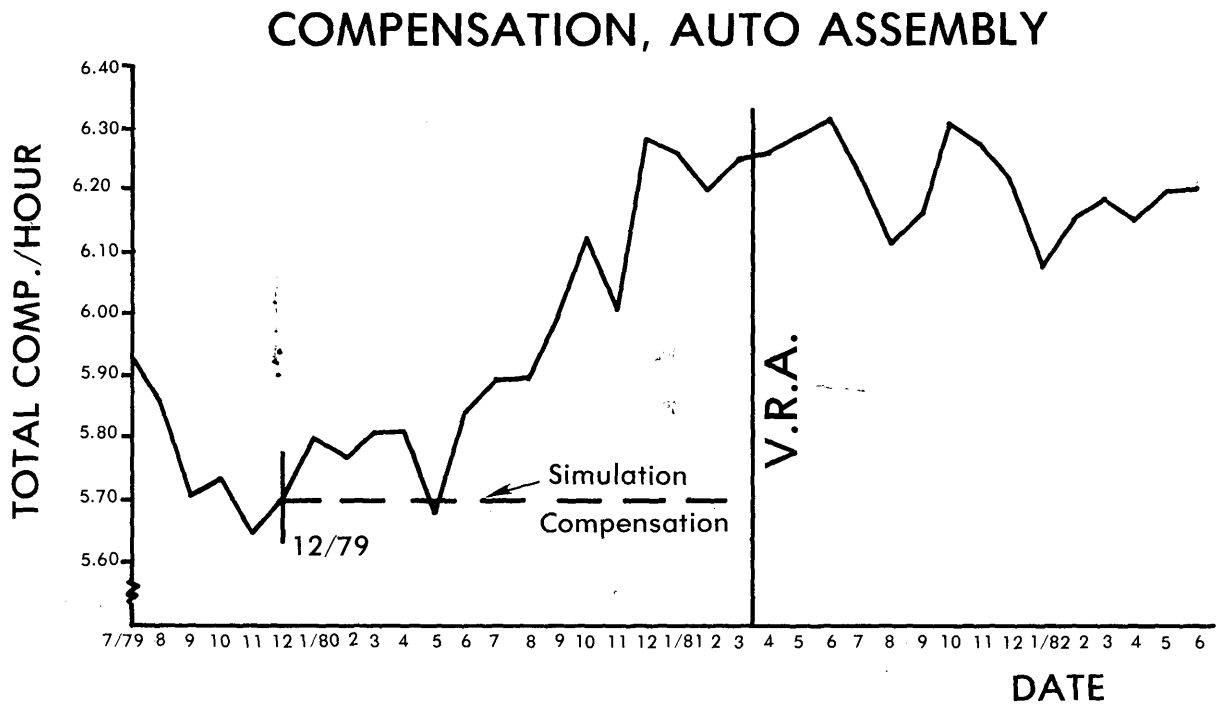
[19] It be should emphasized Feenstra's estimate is for Japanese autos, while simulation 2 increases the quality-adjusted price of all imports.

Table 3: Quality-Adjusted Import Prices

Date	Additional Jobs
April, 1980	-3,700
May	22,500
June	22,700
July	13,100
August	51,200
September	42,700
October	32,000
November	33,900
December	15,700
January, 1981	45,500
February	45,100
March	-7,753
Simulation 1 Average:	27,400

Figure 2


COMPENSATION, AUTO ASSEMBLY
TOTAL COMP./HOUR
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
12/79
Simulation
Compensation
V.R.A.
7/79 8 9 10 11 12 1/80 2 3 4 5 6 7 8 9 10 11 12 1/81 2 3 4 5 6 7 8 9 10 11 12 1/82 2 3 4 5 6
DATE

The results of the simulation are presented in Table 4. If wages had remained constant rather than rising along the actual path observed, average employment during the year preceding the imposition of the voluntary restraint agreement would have been increased by 23,500 workers. That is, the increase in real autoworkers-compensation between December 1979, and April 1981 was responsible for as almost as many lost jobs in the auto industry as was the increase in import competition.

Simulation 3: Autoworker Wages Become More Competitive

In the previous simulation, the employment effects of auto worker wage increases between December 1979 and April 1981 were estimated. However, those estimates assume that wages in the auto industry remained at their level of late 1979, measured in real terms. If, in late 1979, wage levels were already so high that the U.S. auto industry could not compete successfully, maintaining those wages should not be expected to solve the auto industry's problems.

As Table 5 shows, the labor costs in the motor vehicle industry in the U.S. rose much more rapidly in the 1960's and 1970's than did labor costs in the average manufacturing industry. By the time the voluntary restraint agreements were imposed in 1981, U.S. auto workers were earning 164 percent of the

Table 4

Autoworker Compensation at December 1979 Levels

Date	Additional Jobs
April, 1980	-5,000
May	22,000
June	24,400
July	12,200
August	47,200
September	34,500
October	20,100
November	22,100
December	8,000
January, 1981	45,400
February	49,500
March	1,000
Simulation 2 Average:	23,500

Table 5

Ratio of Motor Vehicle Hourly Labor Compensation to All Manufacturing Hourly Labor Compensation

	U.S.	Japan	Germany
1960	130	131	N/A
1965	135	115	N/A
1970	135	115	N/A
1975	149	117	124
1980	165	123	126
1981	164	126	126
1982	160	126	127
1983	155	127	128

Source: Bureau of Labor Statistics, unpublished data, 1984.

average of the wages earned by workers in U.S. manufacturing industries. This contrasts significantly with the situation in Japan where the wages in the motor vehicle industry were only 126 percent of the all manufacturing average. The situation in Germany appears to be approximately the same as that in Japan. Determining whether these figures indicate that auto worker wages are non-competitive is beyond the scope of this paper: we do not seek to determine what the competitive level of wages would be.[20]

The change in employment that would have resulted if U.S. wage levels had been reduced to 126 percent of the all-manufacturing average wage, the level found in Japan, however, can be estimated as follows. We allow the real compensation of auto workers to decline linearly between January 1980 and March 1981, so that at the end of that period motor vehicle compensation would have been 126 percent of

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[20] Kreinin [1984] makes international comparisons based on similar measures (i.e., the ratio of compensation to autoworkers compared to all manufacturing workers). He notes that, for autos, "the productivity ratio is identical in the two countries [U.S. and Japan]... To be competitive with Japan, U.S. labor compensation would have to decline by 24 percent" (p. 47). This is approximately the same decline in wages posited in the present study. Some qualifications to this technique of comparison are offered by Marks [1984].

the all manufacturing average. As Table 6 indicates, we estimate that such a trend in wages would have increased employment in the motor vehicle industry by an average of 41,000 between April 1980 and March 1981.

Simulation 4: Real Disposable Personal Income Constant at Mid-1979 levels.

The period just before the imposition of the voluntary restraint agreement was one of widespread recession. Actual real disposable personal income (DPI) per capita fell nearly five percent between 1979 and April 1981. As a result, workers in a variety of industries, including auto assembly, were laid off. This simulation eliminates the cyclical downturn in DPI per capita, which is widely recognized to influence purchases (and hence production) of durables such as autos. If real per capita disposable personal income had remained constant at its June 1979 level, employment in 1980-81 would have increased by an average of 55,300. The employment levels by month are presented in Table 7.

IV. Conclusions

This paper compares the effects of various plausible factors in explaining the decline in U.S. jobs in automobile production. A methodology derived in Grossman [1984] is adapted to the U.S. auto market, resulting in an estimable reduced form

Table 6

Parity with Japanese Auto Worker/All Manufacturing Compensation Ratio

Date	Additional Jobs
April, 1980	-6,000
May	21,500
June	22,000
July	11,700
August	48,800
September	39,900
October	31,000
November	41,200
December	36,200
January, 1981	83,800
February	98,100
March	62,500
Simulation 3 Average:	41,400

Table 7

No Recession

Date	Additional Jobs
April, 1980	23,100
May	60,500
June	77,700
July	65,200
August	97,400
September	68,900
October	56,800
November	46,100
December	31,500
January, 1981	66,600
February	62,700
March	6,700
Simulation 4 Average:	55,300

equation. This equation is derived from a Cobb-Douglas production function, a multiplicative demand function and input market equilibrium conditions. The reduced form equation is then estimated using empirical proxies for the exogenous variables. Finally, the estimated coefficients are used to run simulations that allow comparison between the domestic employment effects of several counterfactual scenarios.

The conclusion to be drawn from the empirical results presented in this paper is that increased competition from imports was not the primary cause of the unemployment problem in the motor vehicle industry in the period prior to the imposition of the voluntary restraint agreements. Even if the quality adjusted price of all imported automobiles had remained at its September 1979 average level, employment in the U.S. auto industry would have only been increased by an estimated 27,400. By contrast, if there had been no recession and therefore no resulting drop in the demand for automobiles, there would have been an additional 55,300 jobs in the auto industry. Further, if, in response to the increased competition from imported autos, wages in the motor vehicle industry in this country had fallen relative to the average manufacturing wage

to the relative level they occupy in Japan or Germany, it is estimated that the number of jobs in the industry would have increased by 41,400.

In sum, we found that lowering motor vehicle wages could expand employment in that industry more than eliminating any increase in Japanese competitiveness. Further, since increased import competition was not the primary cause of reduced employment in the auto industry, it is natural to wonder about the appropriateness of using import restrictions to assist the industry. As Morkre and Tarr (1985) demonstrate, the costs of the voluntary restraint agreement are very large. The restrictions increase the price of an imported car by approximately $400, and cost consumers in excess of $1.1 billion per year. The U.S. economy loses almost $1 billion per year. The present value of the cost to consumers over a period of four years is $4.02 billion and the cost to the economy is $3.60 billion. Further, Morkre and Tarr estimate that the restriction only creates 4,598 new jobs.

Finally, as noted above, the largest single effect on employment in the auto industry appears to be the 1980-82 recession. But cyclical downturns in income and aggregate demand are a well-recognized aspect of the general business environment, with such

downturns affecting a wide variety of industries. Why should auto firms and workers receive preferential protection from demand reduction resulting from a factor that affects virtually all firms and all workers? And even if such a policy response to recession were believed to be correct, how can this justify maintaining the voluntary restraint agreements now that the recession is ended?

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Data Appendix

Price Index: The price index used in this study is the Consumer Price Index, Urban, All Regions, computed by the Bureau of Labor Statistics (BLS). The base used was 1967=100.

Hours Worked: The dependent variable is total monthly hours worked by employees in SIC 3711, "Motor Vehicles and Equipment." The series is constructed by multiplying average weekly hours for SIC 3711 workers by the number of these workers. Both average hours and number of production workers were obtained on printouts from BLS, Industry Employment and Earnings Statistics.

Price of Foreign Cars: The foreign car price series is the average transactions price for all imported autos. These monthly data were obtained from the Department of Commerce, (Bureau of Economic Analysis).

Disposable Personal Income Per Capita: Total personal income, minus taxes, divided by population. These data were obtained from various issues of the Survey of Current Business.

Finance Charges on New Autos: The rate charged by finance companies on new car loans. These data were obtained on a printout from Charles Luckett, Federal Reserve Board of Governors.

Price of Gasoline: Average price of leaded regular gasoline, net of taxes, U.S. city average. Leaded regular was chosen over unleaded, which most current autos use, because a consistent series extends over the entire sample period. The data come from printouts provided by BLS, Prices and Living Conditions (CPI), Retail Prices (Gasoline).

Steel Prices: The steel price variable is an index, 1972=100, obtained by averaging an index for cabron sheet steel and for stainless strip steel. These data come from BLS, Prices and Living Conditions, Producer Price Indexes, metals.

Stock of Used Cars Per Capita: The stock of used cars is derived from information published in Automotive News: 1984 Data Book Issue. The stock in a given year is total cars in use minus new cars registered plus existing cars scrapped over the previous year. These data were linearized from yearly to monthly observations.

Total Compensation: The total compensation series is derived from two other series: hourly wages to SIC 3711 workers and the fringe benefits (in percent) received by workers in the broader SIC 371 (Motor Vehicles and Equipment). The wage variable is monthly and the fringe benefits variable is annual. Since benefit contracts are negotiated annually, the fringe benefit value is used for all 12 months in the year it occurs. Total hourly compensation is constructed as follows: THC = Wage + (FB%)*wage. The wage data come from the BLS, Employment and Unemployment Statistics, Industry Employment and Earnings. The fringe benefits variable comes from the Survey of Current Business, various July issues.