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The Role of the Automotive Industry in Detroit's Employment Fluctuations: A Multiple Restriction Regime Approach

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Abstract: Using a vector autoregressive time-series model, I analyze the validity of a multiple restriction regime approach in regional modeling as well as the historical impact of various employment shocks on the Detroit Metropolitan Area economy. For this, the model's decomposition matrix has two distinct forms that are dependent on the relation of an industry to the automotive industry, the region's largest manufacturing sector, and the causal restrictions these different regimes place on each version of the model. Results indicate that the use of two different sets of restrictions yields acceptable explanatory power and captures important dynamic characteristics of the data without a substantial increase in computational costs over a single restriction regime approach. Results also indicate that declines in employment in the automotive industry over the past two decades did have a negative effect on the Detroit Metropolitan Area, but not of the immediacy or magnitude popularly believed.

I. INTRODUCTION

What role does the specialization of a large city in a single manufacturing industry play when that industry is in decline?[1] Clearly as an industry declines nationally, a city in which a significant portion of the metropolitan work force is employed in that industry should be more adversely effected than in a city not so specialized. Those industries and businesses more closely related to that sector will be more adversely affected by its decline. Also, this decline will affect businesses that are more locally oriented and less dependent on this dominant industry, but theory suggests that the magnitude of this impact should be substantially less in a large, highly populated metropolitan area. How much less is an empirical question that is specific to each region and metropolitan area.

In this paper I test the validity of using a multiple restriction regime VAR framework to examine the effects of unexpected movements in a prominent manufacturing industry on the stability of employment in a large metropolitan area. For this, I have chosen Detroit, Michigan which historically had the automotive industry as its largest manufacturing sector.[2] In this analysis, industries are divided into two groups based on their "relation" to the automotive industry. Group 1 represents those sectors least related to the automotive industry and most likely to be locally oriented. Group 2 industries are those more closely related to the

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[1]I use the terms *industry* and *sector* synonymously throughout this paper.

[2]Up to and during the 1970s, the automotive industry accounted for more than 16.0 percent of the Detroit MSA's total private non-farm employment.

automotive industry. This division is based on the fraction of each dollar of inputs in the automotive sector that can be accounted for by an industry according to the "Commodity by Industry Table" (Table 3) in the 1977 input-output tables. While other analyses (Coulson 1993, Coulson and Rushen 1995, and Rushen 1995) have used similar time-series structures in their models, they did not incorporate the multiple restriction regime into their models. This paper incorporates the dual base/dominant industry and causal ordering restrictions of these previous papers and differentiates industries based on their relation to the dominant local industry as outlined above. In using a multiple restriction regime in a dual base model, I am able to apply reasonable causal restrictions to the model based on a particular industry's relation to the region's dominant sector. The difference between the approach used here and the one proposed by Mc Donough and Sihag (1991) is that the restrictions are based on established empirical relations between industries and are applied prior to the analysis of the data rather than as a result of the data analysis. Also, it is important to note that this paper examines only the impact of unexpected fluctuations, or shocks, to employment and their subsequent impact on local employment. While the author acknowledges that long-term trends are important for evaluating trend based movements in local employment, in this paper I am trying to determine the impact of non-trend based fluctuations in employment.

In the next section of the paper I will briefly review the key research that has contributed to this paper in a way that illustrates the evolution of this technique. I will then discuss the data and the several forms of the model used to conduct this study. I will then look at the results and discuss their implications in the following sections. This is done as both an analysis of the validity of the modeling technique I have chosen and as an evaluation of the data and what it says about the historical impact of the automotive industry on the Detroit MSA.

II. RELEVANT LITERATURE

In 1984, Arcelus expanded the flexibility of the shift-share framework by dividing the regional shift effect into two separate components. The first was the regional growth effect which was designed to reflect the degree of regional comparative advantage or specialization in the industry in question. Arcelus also referred to this as the expected effect. The second term was the regional industry mix effect or differential effect and reflected by how much local industry composition differed from the national average. The benefits of this approach were to separate local supply and demand effects and allows one to isolate idiosyncratic or local industry-specific shocks from other locally generated shocks.

In their 1991 paper, Mc Donough and Sihag expand upon Arcelus by recommending a multiple base framework. In their model, Mc Donough and Sihag incorporate Arcelus' separation of the regional shift effect into the expected and differential effects. They then add in a state effect that represents the impact of the state economy on the local economy, and a state industry mix effect that represents the impact of the industry mix of the host state on the region. Mc Donough and

Sihag do not assign which economic base, national or state, in both the primary growth effect and industry mix effect, is the primary base and which is the secondary base for the regional economy. Rather they use an ex-post approach, leaving that to be determined by which one most closely corresponds to the data.

In his 1993 paper, Coulson takes that causal ordering structure of the shift-share model and converts it into a structural VAR time-series model which he uses to decompose the components of employment shocks to the City of Philadelphia.[3] In his model, Coulson uses a single economic base, the national economy, but adopts the technique of isolating local supply and demand shocks as proposed by Arcelus. Because his model is a dynamic one, Coulson is also able to place causal restrictions on his model that more accurately reflect the transmission of the impact of employment shocks across industries at national and regional levels. Because there is no single dominant industry, from a share of the workforce perspective, in the Philadelphia MSA, Coulson makes no assumptions concerning the use of a dominant industry as a second economic base in his model. He found that in all industries except oil that the local demand or idiosyncratic shock was most important, accounting for approximately 70 percent or more of all local industry employment shocks. Aggregate national employment shocks are found to be the second most important source of local industry employment fluctuations.

In 1995, Coulson and Rushen use a similar framework to analyze what role, if any, increases in defense spending by the federal government during the 1980s played in the "Massachusetts Miracle." In their model, defense spending represents the second economic base of the model. They find that while movements in defense spending and total employment are highly correlated, there is no causal relation between defense spending and employment growth at the aggregate level. They then examine a number of local industries using a single causal structure with a single restriction regime. They find that only in the case of two industries, education (SIC 82) and other engineering services (SIC 873), did defense spending have a significant effect on employment growth. In almost all other cases, their results are similar to the results for Philadelphia in Coulson (1993), with the idiosyncratic shock accounting for almost 80 percent of all local industry employment fluctuations.

In 1995, Rushen used this time-series framework to examine the impact of national automotive industry employment shocks on a company town, i.e., Flint, Michigan. During the 1970s, employment in the automotive industry, particularly General Motors Corporation, represented almost 35 percent of total employment in Genesee County, Michigan (the Flint MSA). In his Model, Rushen used the automotive industry as the second economic base for the region. However, because of the sheer magnitude of the impact of automotive industry employment shocks on the local economy, Rushen could not impose any causal restrictions on his model, forcing him to treat the relation between all industries and the automotive industry the same. It also forced him to employ a decomposition technique

[3]In converting to a time-series model, Coulson used detrended data to capture only the impact of employment shocks and not long-term employment trends.

that did not permit him to test for over-identification in his model.[4] Unlike Coulson (1993) and Coulson and Rushen (1995), Rushen found that fluctuations in national automotive employment had an enormous impact on the local economy, and were responsible for over 50 percent of the fluctuations in aggregate and manufacturing employment in the MSA. Most non-manufacturing industries had larger idiosyncratic effects, but their combined impact on aggregate employment in Flint was minimal by comparison.

III. THE DATA AND THE MODEL

Monthly employment figures were obtained from the Bureau of Labor and Statistics *Monthly Employment and Earnings Reports* (both printed editions and magnetic tapes) for the United States and the Detroit MSA.[5] Time-series for the data for each industry varied from lengths of over thirty years, to time frames of less than six years, with the longest series of observations being from January 1956 to April 1992. Data of an adequately long time series, at least ten years (120 observations) in length and running from at least 1:1980-12:1989, was found for 38 mutually exclusive industrial sectors at the two- and three-digit SIC code level, as well as the aggregate employment counts for both the Detroit MSA and the United States.[6] Government and other public sector data were not analyzed, but the exclusion of "public goods" sectors in this analysis was not considered to be a serious problem by the author.

The model employed is similar to that used by Coulson and Rushen (1995) to examine the responsiveness of the Boston economy to changes in defense spending by the federal government at the disaggregated level. In the case of Boston special attention was given to the effects of defense spending on the Boston area economy. For Detroit, special attention is given to the automotive industry which is the city's largest manufacturing sector, yielding a dual regime approach. This dual regime approach differentiates the model used here from previous approaches by Rushen and Coulson (1995) and Rushen (1995) in a very important way. Special attention is given to each sector's relation to the automotive industry, rather than assuming a general uniform relationship of all sectors to this industry, which provides the researcher with a descriptively more realistic model. Chinitiz (1961) uses the City of Pittsburgh and New York City (and others) to compare a city with a dominant industry (Pittsburgh with steel) to a more diversified city. Chinitz asserts that the wage level in the region's dominant industry affects the wage rate of other industries. This model takes this assertion further by quantitatively determining which local sectors are most closely related to the

[4]In Coulson (1993) and Coulson and Rushen (1995), the Bernanke decomposition technique was used, allowing for causal restrictions and tests for over-identification in their models. In Rushen (1995), the Choleski decomposition technique was used, which has no restrictions on the causal ordering (much like the standard shift-share model) and was therefore just identified.

[5]Data was seasonally adjusted and was used without later revisions being incorporated.

[6]Sufficiently long time-series for more detailed levels of disaggregation were not available. The author did test several of these detailed, short-lengthed samples that were in group 2. While results of these sample regressions were even more robust than those for the two- and three-digit industries, the author omitted these as their small number of degrees of freedom brought their validity into question. Also, sample periods do differ among sectors and the national and local economy data series.

dominant local industry, and then attempting to qualify how this would affect the structure of a VAR model. In doing so, the researcher is able to incorporate the best elements of previous work by Coulson and Rushen (1995) and Rushen (1995) while addressing the issue of the relation of an industry to its secondary base as first examined in Mc Donough and Sihag (1991). However, unlike Mc Donough and Sihag (1991), I use these relations ex-ante to determine the causal restrictions on the system of equations for each industry based on its relation to the dominant industry.

The most general form of the model shows the change in employment in a single sector of the metropolitan economy as

$$(1) \qquad \Delta E_{1t} = N_t + A_t + NI_t + DE_t + DI_t$$

where ΔE is change in employment, the subscript 1 represents the industrial sector being examined, and t is the time subscript. The national growth and industry mix effects are represented by N and NI respectively. The A is the automotive industry effect; DE and DI are the aggregate share and idiosyncratic effects for the city of Detroit. Special attention is given to the automotive industry due to its prominence in southeast Michigan. It is, therefore, treated as a second base effect to the area economy after the national growth effect.

Equation 1 is then converted into a structural VAR framework using first difference logs.[7] This becomes a five simultaneous equation system in which current employment in a sector is a function of employment in that sector during the previous time period plus any current unexpected shocks to employment. Each of the five effects is represented by an equation, and the equation for each of the shocks (national, automotive, etc.) and how it relates to the entire system of equations. This transformation of equation 1 into a dynamic system of equations allows one to observe the effects of unexpected shocks to different sectors on the local economy over time and yields a general form time-series model of changes in employment for the Detroit MSA:

$$(2) \qquad \begin{bmatrix} n \\ a \\ n_1 \\ e \\ e_1 \end{bmatrix}_t = A(B) \begin{bmatrix} n \\ a \\ n_1 \\ e \\ e_1 \end{bmatrix}_{t-1} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \end{bmatrix}_t$$

[7]This is done to eliminate any deterministic trends from the data. The remaining value then is the unexpected change in, or shock to, employment observed in that time period. In short, only the unexpected changes in, or deviations from, employment trends are used for the model's computations. Because only the unexpected changes in employment, i.e., deviations from trends, are used for this analysis, all of the movements or changes in employment at all levels are shocks by definition. Also, while any time-series analysis is sensitive to the choice of period to be evaluated, because the model framework has been changed to a time-dynamic one, many of the classic problems of the shift-share model, such as sensitivity to choice of beginning and end points, have been eliminated.

where n and e are total national and Detroit MSA employment (respectively), a is national automotive industry employment, and n_1 and e_1 are industry employment for the nation and Detroit respectively. Because the Shift-Share model has been transformed into a time-series model, a lag structure must be specified. A(B) is a 5x5 lag polynomial matrix of finite order.[8] The vector u_{it} is the vector of i.i.d. (0,1) residuals for I = 1 to 5. This reduces to:

(3) $$X_t = A(B)X_{t-1} + u_t ,$$

where the vector of residuals u_t takes the form:

(4) $$u_t = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \end{bmatrix} = W \begin{bmatrix} \alpha \\ \beta \\ \gamma \\ \delta \\ \zeta \end{bmatrix}$$

or more simply:

(5) $$u_t = W\phi_t.$$

The decomposition matrix, W, is a 5x5 lower triangular matrix.[9] The coefficients, α, β, γ, δ, ζ are the unexpected employment shocks that correspond to the employment levels n, a, n_1, e, and e_1 respectively. The diagonal elements of this matrix are unitary in value, while the lower off-diagonal elements of this matrix are non-unitary in value.[10]

I assume, due to the data being run in logged first differences, that there is no co-integration between local and national industry employment levels.[11] Therefore, the use of difference data in a VAR framework will not be problematic.[12]

For this paper two different sets of restrictions are placed on the decomposition matrix based on whether an industry is in the related or non-related group of industries. Industries in group 1 are the least or non-related to the automotive industry. These are business sectors that are more affected by the impact of automotive industry shocks on the automotive companies' employees than on the automotive companies proper. Therefore, equation 1 can be rewritten as:

[8]Optimal lag lengths, in months, were computed separately for each industrial sector as well as aggregate employment for the Detroit MSA and the United States using the Akaike lag selection criteria. This was chosen as the Akaike information criteria will, on average, choose longer optimal lag lengths than the Schwartz information criteria. Lags were computed separately for each sector to more accurately capture the nature of each industry examined and are listed in Tables 2, 5, and 7.

[9]As per Coulson and Rushen (1995).

[10]In converting the shift-share model from an accounting identity to a time-series framework, the assumption of the unitary value of the off-diagonal elements of the covariance matrix becomes invalid. See Coulson (1993).

[11]This is based on the results of Brown, Coulson, and Engle (1990) for a cross section of U. S. Cities, and Coulson (1993) for the City of Philadelphia.

[12]As a precaution, the Detroit MSA and national automotive employment series were tested and found not to be co-integrated even at a 1.0 percent significance level using Table 3 in Engle and Yoo (1987).

(1.1) $\Delta e_1 = \Delta n + (\Delta a - \Delta n) + (\Delta n_1 - \Delta n) + (\Delta e - \Delta a) + (\Delta e_1 - \Delta e - \Delta n_1 + \Delta n)$

where n, a, n_1 , e, and e_1 are as they were defined in equation 2. Converting the accounting identity in equation 1.1 to a time-series model format for these industries gives a decomposition matrix of the form:

(6.1)
$$W = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ w_{21} & 1 & 0 & 0 & 0 \\ w_{31} & 0 & 1 & 0 & 0 \\ w_{41} & w_{42} & 0 & 1 & 0 \\ w_{51} & w_{52} & w_{53} & w_{54} & 1 \end{bmatrix}$$

This yields:

(7.1)
$$u_{1t} = \alpha_t$$
$$u_{2t} = w_{21}\alpha_t + \beta_t$$
$$u_{3t} = w_{31}\alpha_t + \gamma_t$$
$$u_{4t} = w_{41}\alpha_t + w_{42}\beta_t + \delta_t$$
$$u_{5t} = w_{51}\alpha_t + w_{52}\beta_t + w_{53}\gamma_t + w_{54}\delta_t + \zeta_t$$

For group 1 industries, the decomposition matrix has zero restrictions imposed on the [3,2] and [4,3] positions.[13] This is justified for the [3,2] position as national employment in non-related industries will not be directly affected by employment shocks to the automotive industry. Because these sectors are not directly dependent upon the automotive industry, movements in employment levels in the automotive industry will not have an impact at the national level, nor visa versa. The [4,3] position coefficient is zero because Detroit MSA total employment shouldn't be affected by movements in national industry employment beyond those that directly affect employment in the local industry. Put another way, only the impact of the national industry on the local sector, as reflected by the [5,3] coefficient, will have an impact on MSA employment and there are no other spill-overs from the national industry into the local economy. For these sectors, local economic fluctuations will be more important to the local industry than will national employment fluctuations in that industry. This form of the model is over-identified as it has 15 variances, but only 8 w_{ij} coefficients and 5 shocks (variances).[14]

[13]The zero restriction on the [3,2] coefficient in the decomposition matrix is responsible for the absence of the β variable in the third line of equation 7.1. Similarly, the zero restriction on the [4,2] coefficient causes the exclusion of γ in the fourth line of equation 7.1.

[14]Most VAR models to date have been either just-identified, or even under-identified. The VAR format used by the author to examine the impact of unexpected employment movements in a city with one prominent manufacturing sector allows the author to test for over-identification of the decomposition matrix for those industries that are either unrelated or related to the automotive sector. This allows for an additional objective test of the validity of the author's assumed causal orderings and model structure.

Group 2 industries are those most related to the automotive industry. For these industries equation 1 can be rewritten:

(1.2) $\Delta e_1 = \Delta n + (\Delta a - \Delta n) + (\Delta n_1 - \Delta a) + (\Delta e - \Delta a) + (\Delta e_1 - \Delta e - \Delta n_1 + \Delta a).$

Because the automotive effect is important for these industries, movements in automotive employment levels have more impact here than in 1.1. Therefore, the decomposition matrix has an assumed zero value for the [4,3] position.[15] This gives a decomposition matrix of the form:

(6.2)
$$W = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ w_{21} & 1 & 0 & 0 & 0 \\ w_{31} & w_{32} & 1 & 0 & 0 \\ w_{41} & w_{42} & 0 & 1 & 0 \\ w_{51} & w_{52} & w_{53} & w_{54} & 1 \end{bmatrix}$$

This yields the following five simultaneous equations:

(7.2)
$$u_{1t} = \alpha_t$$
$$u_{2t} = w_{21}\alpha_t + \beta_t$$
$$u_{3t} = w_{31}\alpha_t + w_{32}\beta_t + \gamma_t$$
$$u_{4t} = w_{41}\alpha_t + w_{42}\beta_t + \delta_t$$
$$u_{5t} = w_{51}\alpha_t + w_{52}\beta_t + w_{53}\gamma_t + w_{54}\delta_t + \zeta_t.$$

In this form, due to the economic relationship of these sectors to the automotive industry, the level of employment at the national level is assumed to be affected by shocks to the automotive industry. For example, one would expect that changes in the U. S. automotive industry's employment levels will directly affect employment levels in the American steel industry at a national level. Therefore, the [3,2] coefficient is assumed to have a non-zero, non-unitary value. However, the [4,3] position is zero as national industry shocks are assumed to have no effect on metropolitan employment levels. This form of the model is over-identified with 15 variances, but only nine parameters and five shocks.

The automotive industry was not included in this group but given the exactly identified 4x4 decomposition matrix:

[15]The zero restriction on the [4,2] coefficient causes the exclusion of γ in the fourth line of equation 7.2.

(6.3)

$$W = \begin{bmatrix} 1 & 0 & 0 & 0 \\ w_{21} & 1 & 0 & 0 \\ w_{31} & w_{32} & 1 & 0 \\ w_{41} & w_{42} & w_{43} & 1 \end{bmatrix}$$

The decomposition matrix for the Detroit automotive industry is a 4x4 just identified matrix because the automotive industry and national industry are the same in the third equation for a 5x5 configuration.[16] Therefore, the γ coefficient (national industry employment shock) is omitted as it is identical to the β coefficient (automotive industry employment shock). This form of the decomposition matrix has 4 shocks and 6 parameters, and 10 variables, making it just-identified. No omission could be justified, so the decomposition matrix cannot be tested for over-identification. This yielded equation 7.3:

(7.3)

$$u_{1t} = \alpha_t$$
$$u_{2t} = w_{21}\alpha_t + \beta_t$$
$$u_{3t} = w_{31}\alpha_t + w_{32}\beta_t + \delta_t$$
$$u_{4t} = w_{41}\alpha_t + w_{42}\beta_t + w_{43}\delta_t + \zeta_t.$$

Finally, the aggregate area economy was examined to determine the big picture impact of national automotive employment shocks on the Detroit MSA. This was done using the following 3x3 just-identified version of the model:

(6.4)

$$W = \begin{bmatrix} 1 & 0 & 0 \\ w_{21} & 1 & 0 \\ w_{31} & w_{32} & 1 \end{bmatrix}$$

This converted to:

(7.4)

$$u_{1t} = \alpha_t$$
$$u_{2t} = w_{21}\alpha_t + \beta_t$$
$$u_{3t} = w_{31}\alpha_t + w_{32}\beta_t + \delta_t.$$

This version of the model was run for the Detroit MSA to show the relative size of the overall impact of the automotive industry on the region. Historically, the automotive industry comprised over 16 percent of total employment in Detroit. It and the related industries that supported it represented a substantial

[16]Such a form is unsolvable due to perfect multi-collinearity between the national automotive industry and national industry data series.

portion of total Detroit metropolitan employment. Therefore, it is important to see the overall impact of shocks to the national automotive industry on the city as well as their effects on the individual sectors.

IV. RESULTS

The results of the 38 industry and one aggregate MSA simulations are presented by group in the next three sub-sections of the paper. Group 1 results are presented first, followed by group 2, and then the results for the Detroit automotive industry and the aggregate MSA are presented. Overall, simulation results indicated that the chosen modeling framework adequately captured the effects of unexpected employment changes on the Detroit MSA.[17] All but two sectors from group 2, instruments and FIRE (finance, insurance, and real estate), converged within 20 iterations. For all of the sectors that did converge, the idiosyncratic shock was found to be large and significant.[18] Also, all but five of the sectors that were successfully modeled and tested, paper and allied products and railroad transportation from group 1, and metal forgings and stampings, metal working machines, and business services from group 2, were found to be over-identified.

A. GROUP 1

Group 1 comprised the 21 industries that were least related to the automotive industry.[19] Table 1 contains the elements of the decomposition matrix, W, for each of these industries and the significance level of the X^2_2 test for over identification.[20] Except for the food stores sector, all 21 industries in group 1 have [2,1], [3,1], [4,1], and [4,2] decomposition matrix elements that are negative and significantly different from zero at the 5 percent level. This implies a good modeling match for these sectors. It also supports the author's choice of restricting the value of the [3,2] element to zero for non-related sectors. The last four coefficients of the decomposition matrix, [5,1], [5,2], [5,3], and [5,4], were significantly different from zero considerably less often than the first four. However, the fifth line of equation 7.1 represents all of the factors that effect the local economy and contains the greatest degree of heterogeneity across local sectors. Therefore, it is expected that the fit of these variables should be less.

Table 1 also contains the significance levels for the X^2_2 tests on the over-identifying restrictions. Of the twenty-one sectors in group 1, only two, paper &

[17] The average R2 statistics for the equation groups for each industry ranged from 0.482 to 0.957, indicating good fit for each system of equations and in general.
[18] This result is characteristic of this type of model. Standard errors on the impulse response functions are generated via Monte Carlo simulations as described in Coulson and Rushen (1995) and Rushen (1995).
[19] Based on a cut-off level of $0.0025 on Table 3 in Young et al. (1984), pp. 66-72. The 1997 tables were chosen as these better reflect the nature of inter-industry relations prior to the large changes in the nation's manufacturing industries during the 1980s. The author acknowledges that this may be seen as a rather small cut-off level. However, the national input-output tables are based on national averages that do not account for regional specific concentrations and specialization in key industries. The author asserts that intermediate goods sectors located in areas with a heavy concentration of industries that use their product are more likely to see much stronger relations to that industry than the national average. Therefore, these sectors will see their output representing a greater share of the product's cost than companies located far away from such industries.
[20] The coefficients on the elements of the decomposition matrix, W, represent the magnitude of the cross-variable effects that generate the variance decomposition for the sector being examined.

TABLE 1
Elements of the Decomposition Matrix, Group 1

Industry	[2,1]	[3,1]	[4,1]	[4,2]	[5,1]	[5,2]	[5,3]	[5,4]	SL X^2_2
Mining (10-14)	-7.118*	-2.241*	-1.121*	-0.134*	-5.711*	0.311	-0.176	0.071	0.413
Heavy Construction (16)	-5.825*	-3.157*	-1.004*	-0.140*	2.747	0.383	-0.876*	-2.177*	0.176
Food & Kindred Products (20)	-6.364*	-0.811*	-1.102*	-0.137*	-1.680*	-0.078	0.314	0.501	0.594
Apparel & Other Textiles (22,23)	-6.652*	-1.681*	-1.360*	-0.108*	4.731	0.353	-1.490	0.085	0.245
Lumber & Wood Products (24)	-6.297*	-1.461*	-0.925*	-0.122*	-2.542	-0.022	-0.194	-0.866	0.822
Furniture & Fixtures (25)	-6.041*	-1.774*	-1.029*	-0.135*	-0.912	0.124	-0.034	0.036	0.604
Paper & Allied Products (26)	-5.286*	-0.760*	-1.012*	-0.124*	-0.468	0.027	-1.115*	-0.271	0.039!
Printing & Publishing (27)	-6.717*	-0.385*	-1.076*	-0.131*	-2.129*	-0.018	-0.290	0.311	0.266
Construction Machinery (353)	-5.309*	-1.067	-0.987*	-0.132*	-0.814	0.185	-0.463*	-0.034	0.607
Special Industrial Machinery (355)	-3.208*	-1.278*	-1.149*	-0.128*	1.584	0.393	-1.317	-1.687	0.853
Miscellaneous Manufacturing Industries (39)	-6.003*	-1.035*	-1.091*	-0.148*	-0.997	0.308*	-0.393	-1.703*	0.725
Railroad Transportation (40)	-6.883*	-1.065*	-0.889*	-0.136*	0.278	-0.022	-0.914*	0.486	0.048!
Gen. Merchandise Stores (53)	-5.326*	-0.542*	-1.157*	-0.147*	0.667	-0.038	-0.482*	-0.309	0.522
Food Stores (54)	-6.209*	-0.157	-0.854*	-0.150	-0.244	0.127*	-0.269	-0.801*	0.495
Apparel & Accessory Stores (56)	-6.522*	0.684*	-1.137*	-0.124*	1.211	0.079	-0.987*	-0.705*	0.186
Furniture Stores (57)	-6.787*	-0.665*	-0.920*	-0.129*	-0.168	0.028	0.175	-0.691*	0.679
Miscellaneous Retail (59)	-5.640*	-0.915*	-1.072*	-0.137*	0.091	0.025	-0.146	-0.318	0.121
Hotel & Other Lodgings (70)	-5.3648	-0.318	-1.006*	-0.153*	0.023	0.025	-0.571*	-0.432	0.343
Personal Services (72)	-6.682*	-0.326	-0.968*	-0.141*	-0.324	0.057	-1.061*	-0.361	0.1258
Legal Services (81)	-5.765*	-0.308*	-0.926*	-0.136*	0.603	0.063	-0.212	-0.662*	0.343
Health Services (80)	-9.595*	-0.118*	-0.902*	-0.121*	-0.169	0.007	-0..329	-0.028	0.077

For Group 1 [3,2], [4,3] are restricted to zero.
Note that the different sample period lengths will mean that critical values are not identical across sectors.
*Indicates the coefficient is significantly different from zero at the 5% level.
SLX^2_2 columns lists significance levels for the test statistic.
!Indicates that the sector is not over-identified at a 5% test level.
NA Indicates that the model sector failed to converge for this industry after 20 iterations.

allied products, and railroad transportation, could reject the restrictions on the covariance matrix, which can be attributed to Type I error.[21] The author takes this as further support for the chosen restrictions on the covariance matrix for group 1 industries.

The F-Statistics on the DI variable for group 1 industries (Table 2) indicate that, for the most part, neither the national shocks nor the automotive industry shocks had significant impact on the idiosyncratic shock. Only the idiosyncratic shock for printing and publishing was affected by the national shock at the ten percent level. The idiosyncratic shock for only hotels & other lodgings was significantly affected by both automotive and metropolitan shocks at the five percent level. Neither automotive nor metropolitan shocks were found to be significant in any other case in group 1. The national industry and the idiosyncratic shocks had significant impacts in five and six cases respectively.

TABLE 2

F Statistics on DI and Industry Lags for Group 1

Industry	α	β	γ	δ	ζ	Lags
Mining	1.081	0.537	0.468	0.521	1.920*	15
Heavy Construction	0.724	1.408	0.649	0.599	2.340*	14
Food	0.947	1.379	1.033	1.160	1.366	23
Apparel & Other Textiles	0.632	0.898	1.143	0.884	4.819*	16
Lumber & Wood	0.947	0.867	0.719	0.837	0.806	20
Furniture & Fixtures	0.560	0.722	0.679	1.151	1.333	13
Paper & Allied	0.992	0.650	0.673	1.021	1.588+	22
Printing & Publishing	1.598+	1.213	0.975	0.918	0.693	19
Construction Machines	0.806	0.590	1.564+	0.558	0.854	15
Special Industrial Machines	1.602	0.132	1.380	0.035	1.038	1
Miscellaneous Manufacturing Industries	0.936	1.341	1.937*	1.107	1.873*	13
Railroad Transportation	0.467	1.014	1.125	0.995	0.766	13
Gen. Merchandise Stores	1.143	0.585	2.080*	0.786	2.894*	15
Food Stores	1.253	1.303	0.869	1.122	1.867*	13
Apparel & Accessory Stores	1.406	0.857	1.993*	0.798	0.982	15
Furniture Stores	1.390	0.855	1.465	1.112	1.273	18
Miscellaneous Retail	1.347	0.728	1.129	0.593	1.384	16
Hotels & Other Lodgings	1.081	1.819*	1.651	2.572*	0.779	13
Personal Services	0.659	0.760	1.484	1.065	1.699+	15
Legal Services	0.680	0.691	2.567*	1.151	1.343	15
Health Services	0.639	0.162	3.676*	0.456	1.726	4

+Indicates significance at 10%.
*Indicates significance at 5%.
Lags = length in months.

As seen in Table 3, the idiosyncratic shock is the largest source of unexpected employment fluctuations in these industries. At one month, the idiosyncratic shock accounts for at least 77 percent, and usually more than 90 percent, of

[21]Of interest here is that relatively few VAR models to date have been of a structure that allowed for over-identifying restrictions, let alone that have been found to be over-identified. In the case of the effects in changes in defense spending on employment levels in the Boston MSA, Coulson and Rushen find their restricted system to be over-identified, but had a higher rate of rejection, 5 rejections for 22 industries at a 5.0 percent level (Coulson and Rushen, 1995, pp. 88-89).

the variance of DI.[22] In addition to being very large, the idiosyncratic shock is also significant for all group 1 industries. After the idiosyncratic shock, the national industry shock was significant for five industries, though only substantive in magnitude for four of these.[23] Shocks from the national and metropolitan economies were found to be substantive and significant for one and two sectors respectively, while the automotive shock was not found to be significant for any sector. At 36 months, the level of insulation from automotive industry shocks that unrelated sectors enjoyed at one month has fallen considerably. For the majority of group 1 industries, the idiosyncratic shock can only account for 60 to 70 percent of the variance of DI, though it is still the largest source of variance for DI and is significant across all industries. National and local economy shocks are substantive and significant for 9 and 15 local sectors respectively, while national sector shocks are substantive and significant for 14 group 1 industries. The automotive industry is substantive and significant for 7 group 1 industries.

TABLE 3

Variance Decomposition of DI for Group 1

	1 month					36 months				
Shock to:	N	A	NI	D	DI	N	A	NI	D	DI
Mining	1.121	1.32	0.45	0.00	97.11*	7.69*	4.48	5.55	3.03	79.26*
Heavy Construction	0.34	0.10	4.02	2.73	92.82*	5.92	8.49*	5.60*	7.72*	72.29*
Food	0.86	0.01	0.46*	1.25	97.42*	8.85*	7.50	8.14*	10.36*	65.14*
Apparel & Other Textiles	1.02	0.90	1.23	0.00	96.85*	5.98	1.71	8.21	8.62*	75.49*
Lumber & Wood	3.41	0.56	0.11	0.86	95.05*	9.90*	4.94*	6.84*	8.20*	70.12*
Furniture & Fixtures	0.01	0.89	0.00	0.00	99.10*	4.70	2.85	4.22	8.08*	80.42*
Paper & Allied	1.59	0.00	2.28	0.23	95.90*	8.00*	7.23*	12.24*	11.43*	61.09*
Printing & Publishing	7.68*	0.19	0.18	1.14	90.80*	13.88*	10.62*	7.23*	7.09*	61.18*
Construction Machines	0.05	1.45	4.70	0.00	93.81*	7.45*	5.93*	14.00*	6.41*	66.21*
Special Industrial Machines	0.57	0.66	1.93	2.73	94.11*	3.37	0.80	1.86	2.70	91.27*
Miscellaneous Manufacturing Industries	2.25	0.14	0.53	4.30	92.78*	6.84*	2.98	8.22*	9.47*	72.49*
Railroad Transportation	0.00	0.24	12.30*	0.86	86.60*	4.51	3.72	13.60*	5.16	73.02*
Gen. Merchandise Stores	0.31	1.71	5.91*	0.96	91.12*	6.94*	7.09*	10.55*	8.37*	67.07*
Food Stores	1.78	0.01	0.82	6.38*	90.99*	8.08*	4.77*	4.73*	8.70*	73.73*
Apparel & Accessory Stores	0.17	0.05	19.10*	3.21	77.48*	6.81*	3.58	28.31*	5.85*	55.46*
Furniture Stores	1.78	0.94	0.19	3.21	93.89*	12.34*	5.47*	8.66*	7.58*	65.95*
Miscellaneous Retail	0.58	0.10	0.19	1.11	98.08*	12.49*	4.25	6.33*	5.73	71.21*
Hotels & Other Lodgings	0.46	0.17	3.21	0.68	95.47*	8.34*	9.09*	8.30*	12.05*	62.22*
Personal Services	1.18	0.01	20.28*	0.85	77.69*	3.65	3.57	23.35*	8.92*	60.50*
Legal Services	0.18	0.38	0.74	8.74*	89.97*	4.13	2.66	14.19*	11.76*	67.27*
Health Services	0.47	0.05	0.76	0.05	98.68*	1.61	1.09	6.21	0.92	90.17*

Sums may not add to 100 % due to rounding.
*Is significant at the 5 % level.

B. GROUP 2

Group 2 comprises the 16 industries most closely related to, but not including, the automotive industry in Detroit. Table 4 contains the elements of the decomposition matrix and the significance levels for the X^2_1 tests for these indus-

[22]The variance decomposition is the percentage breakdown by source of unexpected movements in employment levels in the industry in question.
[23]For the variance decomposition, substantive is considered to be 5.0 percent or more.

tries. Before any discussion of the elements of the decomposition matrix, it must be pointed out that the results for two sectors, instruments and FIRE, must be disregarded as these sectors failed to converge after 20 computational iterations of the model. Therefore, the number of industries that comprise group 2 is reduced to 14 for purpose of analysis. Of the remaining 14 sectors, the breakdown of significance for the decomposition matrix was similar to group 1. Except for the [3,1] coefficient for metal forgings and stampings, the [2,1], [3,1], [4,1], and [4,2] coefficients were found to be significantly different from zero for all of the industries in this group. The [5,1] coefficient was only significant for one sector (miscellaneous fabricated metal products). However, the [5,2], [5,3], and [5,4] coefficients were significant for seven, eleven, and nine sectors respectively.[24] As for the automotive industry, the coefficient on the [3,2] spot was significantly different from zero for 10 of the 14 sectors, or approximately 71 percent of the group 2 sectors.

TABLE 4

Elements of the Decomposition Matrix, Group 2

Industry	[2,1]	[3,1]	[3,2]	[4,1]	[4,2]	[5,1]	[5,2]	[5,3]	[5,4]	SL X^2_1
Construction (15,17)	-5.175*	-3.576*	0.069*	-1.053*	-0.141*	-0.696	0.123	-0.429*	-1.313*	0.404
Paints & Allied (285)	-6.083*	-1.245*	-0.005	-1.223*	-0.133*	0.133	0.174	-1.217*	-0.710	0.241
Rubber & Plastics (30)	-8.178*	-2.237*	-0.014	-0.963*	-0.121*	-0.178	-0.106	-0.494*	-0.918*	0.553
Stone, Clay, & Glass(32)	-9.607*	-1.583*	-0.013	-1.052*	-0.122*	-2.303	0.101	-0.338	-1.121*	0.588
Primary Metals (33)	-5.576*	-1.203*	-0.076*	-0.831*	-0.138*	0.698	-0.165*	-0.702*	-0.525*	0.999
Cutlery, Hardware, & Hand Tools (342)	-4.958*	-0.811*	-0.115*	-1.175*	-0.140*	1.847	-0.338	-1.004	0.362	0.096
Screw Machine Products (345)	-9.316*	-1.123*	-0.025*	-0.946*	-0.124*	-0.472	0.161*	-0.436*	-0.330	0.474
Metal Forgings & Stampings (346)	-5.463*	-0.487	-0.468*	-0.999*	-0.140*	-0.884	-0.310*	-0.843*	-2.043*	0.021!
Miscellaneous Fabricated Metal Products (349)	-5.361*	-1.683*	-0.200*	-0.913*	-0.127*	4.305*	-0.722*	-2.076*	-0.525	0.289
Metal Working Machines (354)	-5.722*	-0.385*	-0.030*	-1.023*	-0.137*	0.569	0.077*	-0.905*	-0.712*	0.020!
General Industrial Machines (356)	-6.203*	-1.007*	-0.027*	-1.041*	-0.137*	-1.277	0.132	-0.877*	-0.530	0.124
Electronics (36)	-8.395*	-1.375*	-0.029*	-0.981*	-0.122*	1.098	0.082	-0.637*	-0.845*	0.276
Instruments (38)	-2.242	-0.490	0.521	-0.630	-0.881	-0.184	-0.049	-0.124	-0.044	NA
Auto Dealers & Services (55)	-4.466*	-0.423*	-0.033*	-1.191*	-0.127*	-0.211	0.101*	-0.869*	-0.623*	0.774
FIRE (60-67)	-1.257	-0.077	0.717	-0.453	0.441	-0.146	0.098	-0.184	-0.368	NA
Business Services (73)	-6.677*	-0.849*	-0.003	-1.131*	-0.132*	0.380	0.121*	-0.394	-0.955*	0.046!

For Group 2 the [4,3] is restricted to zero.
Note that the different sample period lengths will mean that critical values are not identical across sectors.
*Indicates the coefficient is significantly different from zero at the 5% level.
SL X^2_1 columns lists significance levels for the test statistic.
!Indicates that the sector is not over-identified at a 5% test level.
NA Indicates that the model sector failed to converge for this industry after 20 iterations.
FIRE is Financial, Insurance, and Real Estate.

The restrictions on the covariance matrix were rejected for three of the fourteen sectors in group 2. These three sectors were metal forgings and stampings, metal working machines, and business services. While this is more than could be reasonably attributed to Type I error for this group, this result is not overly

[24]Actually a greater frequency of significance for these coefficients than for group 1.

troubling. For two of these sectors, metal forgings and stampings and metal working machines, the cause of this rejection is likely due to large movements in those industries at the national level. Between 1979 and 1984, the fabricated metals industry in Detroit, especially those sub-sectors that were associated with the automotive industry, underwent a massive contraction and subsequent relocation. This would obviously have a great impact on the metal working machinery industry in Detroit as well.[25] If this is taken into account, then the remaining single rejection of the restrictions on the decomposition matrix by business services does fall within the range of Type I error.

The breakdown on the F-Statistics for DI for group 2 industries (see Table 5) is comparable to those for group 1 industries. As in the case of group 1 industries, the national industry and idiosyncratic shocks have the most impact on DI for group 2 industries, but for a greater proportion of these industries than in group 1. National, automotive, and metropolitan shocks also have significant impact on DI for a greater number of sectors for group 2 industries than in group 1.

TABLE 5

F Statistics on DI, and Industry Lags for Group 2

Industry	α	β	γ	δ	ζ	Lags
Construction	1.080	0.908	1.273	1.282	1.343	23
Paints & Allied	1.354	0.514	0.703	1.534	1.332	11
Rubber & Plastics	0.646	9.586*	3.373*	10.852*	5.675*	2
Stone, Clay, & Glass	2.569*	1.464	1.499	1.431	2.939*	5
Primary Metals	0.968	1.496+	1.364	1.988*	2.191*	23
Cutlery, Hardware, & Hand Tools	1.810*	0.971	0.493	1.842*	1.790*	24
Screw Machine Products	2.325+	0.591	0.419	1.592	0.951	3
Metal Forgings & Stampings	0.939	0.955	0.715*	1.004	1.771*	16
Miscellaneous Fabricated Metal Products	0.574	0.960	1.688+	1.332	2.504*	15
Metal Working Machines	1.650+	0.984	2.193*	2.268*	2.264*	16
General Industrial Machines	0.816	0.627	1.265	1.297	2.202+	4
Electronics	0.880	1.375	4.794*	0.785	0.918	2
Instruments	1.041	0.386	1.312	1.300	2.342*	5
Auto Dealers & Services	1.903*	0.662	2.024*	0.528	0.785	14
FIRE	0.641	1.085	1.917*	1.228	2.281*	13
Business Services	0.595	1.403	0.927	0.882	1.320	13

+Indicates significance at 10%.
*Indicates significance at 5%.
Lags = length in months.
FIRE is Financial, Insurance, and Real Estate

As was the case in group 1, the idiosyncratic shock is the largest source of unexpected changes in employment for most group 2 industries (see Table 6). At one month, the idiosyncratic shock was significant and substantive for all of the 14 industries that converged. For most of these industries, the idiosyncratic shock accounted for between 70 and 90 percent of the variance of DI with the exception of metal forgings and stampings (40.87 percent). After the idiosyncratic shock, the

[25]This suggests that for these two industries a non-restricted (i.e., no zero restriction is imposed on the [4,3] coefficient), just-identified model structure may have been a better choice, though this would not have allowed for over-identification testing.

national economy shock was substantive and significant for seven industries, while the national industry and metropolitan shocks were significant and substantive for 4 and 4 sectors respectively.[26] At one month, automotive industry shocks are significant and substantive for five of the industries in group 2. Of these five industries, the automotive industry accounted for more than 10 percent of the variance of DI for primary metals, screw machine products, metal forgings and stampings, and miscellaneous fabricate metals. At 36 months, more of the cause of the variance of DI had shifted away from the idiosyncratic shock to other sources. The national shock was significant and accounted for more than 10 percent of the variance of DI for 9 industries. The national industry and metropolitan shocks were significant and substantive for 8 of the group 2 industries each. The automotive industry shocks to DI were substantive and significant for 10 industries, and accounted for more than 10 percent of the variance of DI for a fifth industry, cutlery, hardware, & hand tools, as well.

TABLE 6
Variance Decomposition of DI for Group 2

	1 month					36 months				
Shock to:	N	A	NI	D	DI	N	A	NI	D	DI
Construction	8.29*	0.08	1.66	5.72*	84.24*	11.19*	7.29*	11.92*	15.67*	53.94*
Paints & Allied	1.40	0.32	4.02	0.86	93.40*	6.41	2.33	7.10*	9.14*	75.02*
Rubber & Plastics	6.32*	6.14*	2.36	1.57*	83.62*	10.04*	9.93*	3.23	7.00*	69.80*
Stone, Clay, & Glass	9.14*	0.24	0.26	3.01	87.36*	11.21*	2.45	2.44	5.34	78.66*
Primary Metals	5.45*	14.26*	5.94*	1.48	72.87*	18.02*	14.21*	12.30*	9.60*	45.87*
Cutlery, Hardware, & Hand tools	0.05	2.33	1.76	0.09	95.78*	15.47*	13.05*	6.55*	19.51*	45.42*
Screw Machine Products	9.16*	11.99*	1.28	0.46	77.12*	17.48*	11.54*	1.39	4.53	65.06*
Metal Forgings & Stampings	16.13*	32.75*	5.75	4.51	40.87*	14.29*	25.99*	9.69	12.30	37.72*
Miscellaneous Fabricated Metal Products	5.84	32.15*	16.44*	0.21	45.37*	7.02	24.35*	17.13*	9.73	41.77*
Metal Working Machines	1.78	1.13	12.99*	7.26*	76.84*	22.91*	7.85*	12.09*	10.39*	46.77*
General Industrial Machines	2.74	0.09	2.36	0.64	94.18*	5.75	0.23	3.65	4.03	86.34*
Electronics	0.90	0.51	1.82	3.47	93.31*	8.26*	0.57	6.25*	4.68	80.24*
Instruments	0.02	1.53	5.15	0.07	93.23*	0.71	40.28*	48.13*	1.93	8.94
Auto Dealers & Services	7.19*	0.03	13.31*	5.81*	73.66*	14.25*	7.34*	24.86*	8.72*	44.83*
FIRE	0.20	56.66*	0.30	7.58	35.25	0.61	52.13*	15.05	12.00	20.21
Business Services	1.84	0.01	0.93	7.39*	89.89*	6.35	7.23*	5.24	10.79*	70.40*

Sums may not add to 100% due to rounding.
*Is significant at the 5 % level.
FIRE is Financial, Insurance, and Real Estate.

C. THE DETROIT AUTOMOTIVE INDUSTRY AND AGGREGATE EMPLOYMENT

The automotive industry and the aggregate metropolitan area forms of the model were just-identified, hence no test of restrictions. As seen in the decomposition matrix on Table 7, only the [4,1] and [4,3] elements were not significant for the automotive industry. For the aggregate case only the [3,2] element failed its

[26]For rubber and plastic products the metropolitan shock is significant, but not substantial.

significance test. In Table 8, the F-Statistics are only significant on metropolitan and sector-specific shocks for the automotive industry case, and for metropolitan shocks for the aggregate case. Finally, Table 9 shows the variance decomposition for the automotive industry and the aggregate Detroit economy. Shocks from all sources are large and significant in both cases. For the automotive industry, the idiosyncratic shock accounts for only 27.80 percent of the variance of DI, while the automotive industry accounts for 43.57 percent at one month. At 36 months, the automotive industry and the idiosyncratic shocks were still generated the largest shocks to DI, and accounted for more of the variance in the local automotive industry. For the Detroit MSA as a whole, local economic shocks accounted for almost half of the variance of DI, while the automotive industry accounted for about a quarter of this variance.

TABLE 7

Elements of the Decomposition Matrix, Automotive and Aggregate

Industry	[2,1]	[3,1]	[3,2]	[4,1]	[4,2]	[4,3]
Automotive (371)	-5.781*	-1.090*	-0.135*	1.059	-0.436*	-2.431
Aggregate	-6.193*	-1.012*	-0.133	—	—	—

For Aggregate [4,1], [4,2], and [4,3] are restricted to zero.
Note that the different sample period lengths will mean that critical values are not identical across sectors.
*Indicates the coefficient is significantly different from zero at the 5% level.
For both Automotive and Aggregate cases, the matrix is just-identified; therefore no χ^2_i is given.

TABLE 8

F Statistics on DI , and Industry Lags for Automotive and Aggregate

	α	β	γ	δ	ζ	Lags
Automotive	0.979	0.757	—	2.069*	2.415*	14
Aggregate	0.904	1.280	—	1.649*	—	21

+Indicates significance at 10%.
*Indicates significance at 5%.
Lags = length in months.

TABLE 9

Variance Decomposition of DI for Automotive

	1 month				36 months			
Shock to:	N	A	D	DI	N	A	D	DI
Automotive	15.58*	43.57*	13.05*	27.80*	14.76*	35.55*	20.80*	28.89*
Aggregate	30.62*	23.88*	45.50*	—	33.43*	23.51*	43.07*	—

Sums may not add to 100% due to rounding.
*Is significant at the 5 % level.

V. DISCUSSION

At a regional level, the results indicate that the negative impact on the Detroit MSA of hardships faced by the nation's automotive industry in the late 1970s and early 1980s was not of the magnitude that is popularly believed. While not a necessarily surprising finding to regional economists, the fact that this model and the chosen restriction regimes can yield such a result lends credibility and support for its use. Results for the group 1 industries were similar to those for Coulson (1993) and Coulson and Rushen (1995). These local serving, non-export oriented industries were most sensitive to changes that were specific to that local industry. In virtually every group 1 industry approximately 90 percent or more of the initial unexpected changes in employment in each of these industries was due to factors internal to that industry. Nor was this a short-lived phenomenon. For most group 1 industries, three years after the initial shock to an industry's employment level, more than 70 percent of any subsequent employment fluctuations were also due to factors specific to the local industry. Also, while of a much smaller magnitude than the local industry-specific shocks, unexpected employment fluctuations at the aggregate metropolitan level were an important determining factor for employment fluctuations in local industries.

Similar results were had for most group 2 industries. In fact, all but the local automotive industry, and those industries most closely associated with it, were fairly immune to unexpected employment fluctuations in the national automotive industry. Over time, this immunity was eroded at a much faster rate than in group 1, due in part to the heavier concentration of manufacturing industries in this group. For the local automotive industry and those sectors most closely related to it, the unexpected changes in the national automotive industry represented real disrupting forces to their workforce, which in many cases were not mitigated over time. These sectors were also more susceptible to the long-term impact of unexpected employment fluctuations at the national and national industry levels, due mainly to a greater proportion of manufacturing industries in this group. Overall, the impact of the erratic movements in the national automotive industry's employment levels on the Detroit MSA were sizable, though not overwhelming, and relatively stable over time, though its impact varied considerably more across different industries over time.

VI. CONCLUSION

These results indicate that in the case of a dual base regional VAR, multiple restriction regimes for the decomposition matrix, based on the industry's relation to the secondary base, provide a good modeling structure. In the case of a city with a prominent manufacturing sector, treating this sector as the secondary base allows the researcher to directly take into account the importance of that sector in the causal ordering. In the case of Detroit MSA, the large proportion the region's employment base that the automotive industry comprised made it a natural second economic base. Due to the nature of the automotive industry and its relation to other local manufacturing industries, special treatment was given to sectors that were more closely associated with the automotive industry. Unlike McDonough and Sihag, the classification of the relation of the industry to the second economic base of the model was incorporated into the modeling procedure rather than left to be determined by the outcome of the empirical analysis. The use of ex-ante classification of these relations represents a next step in the development of these models, and the coefficients of the decomposition matrices indicate that such an approach is appropriate in this case. Also, the zero restrictions embedded in the decomposition matrix by the causal ordering allows for tests of the accuracy of the causal order employed. In this paper, only five of the 35 restricted cases rejected the proposed restriction regimes used in this paper. When the special cases of metal forgings and stampings and metal working machines are accounted for, the number of rejections falls to three, which could be due to Type I error.

The results also show that the model can capture the dynamic nature of changes in the responses of different industries to such shocks overtime. For most group 1 and group 2 industries, the immediate impact of shocks to the national automotive industry are quite small. After three years, shocks to the automotive industry and other national shocks percolate through the model as they capture larger shares of the variance decomposition in more industries in both groups. This means that the model can also detect and quantify how the local industries become more susceptible to employment shocks from internal and non-internal sources over time, particularly shocks to regionally important industries at the national level. In the case of Detroit, as time passed, these sectors became more susceptible to shocks to the national automotive industry, as impact of these shocks are felt more in cities with higher concentrations of employment in this industry.[27]

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[27]These are different from the results that Rushen found for the Flint MSA. In the case of Flint, the automotive industry shock was the largest at one month and then dissipated somewhat over time. However, in the case of Flint, the automotive industry, i.e., General Motors Corp., represented a much larger portion of a much smaller and less diversified economy's employment base, accounting for 62.2 percent of the variance decomposition for the aggregate case at one month (Rushen 1995, pp. 619-621).

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