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Industrial mix as a factor in the growth and variability of states' economies

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We use annual employment data for the states and the United States from 1969 to 1985 to estimate trend rates of growth and deviations from trend for the state economies. We calculate measures of growth and variability for each state that are net of the effect of the state industrial mix interacting with the national industrial growth rates and variabilities. We find great variety in the macroeconomic behavior of the regional state economies, and we present evidence that the industrial mix of an economy is one factor that helps explain differences in net growth rates and variabilities across the states.

JEL classification: R11; O40

1. Introduction

Differences in the growth and variability of regional economies in the United States have been documented and analyzed by many authors. Several approaches to the topic have been taken. For example, shift-share analyses provide descriptions of three components of regional growth [Dunn (1980)]. Business climate studies, such as Wasylenko and McGuire (1985), attempt to uncover cost factors relevant for explaining differences in regional growth rates. Altonji and Ham (1987) is an analysis of regional business cycles, which investigates the effects of aggregate, sectoral, and regional shocks on

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aggregate fluctuations. Recent research, such as Garcia-Milà and McGuire (1992), examines the linkage between public infrastructure and economic productivity by estimating region-wide production or cost functions. Finally, several recent studies investigate increasing returns and knowledge spillovers as engines of regional growth [see, for example, Krugman (1991)].

The present analysis differs from other work in that we focus on industrial composition as a possible, partial explanation for the macroeconomic differences we observe in state economies. We argue that, once the growth rates and variabilities of industries at the national level have been controlled for, the industrial composition or mix of an economy may exert an additional effect on an economy's growth and variability. Our explanation relies on the fact that industries are interrelated, that the relationships among industries differ, that agglomeration economies or knowledge spillovers may differ by industry, and that industries display different growth and variability characteristics.

Our work is most closely related to recent macroeconomic, empirical studies of the growth rates of U.S. cities and states. Barro and Sala-i-Martin (1991) examine data for the U.S. states and investigate whether state income per capita converges over time in accordance with the neoclassical growth model. Blanchard and Katz (1992) also examine U.S. states and find convergence in wage rates but not in employment growth rates over time. Glaeser et al. (1992) employ a data set on several large U.S. cities to test various theories of economic growth, such as knowledge spillovers across firms in the same industry or between firms in different industries in geographic proximity. The latter study uses a measure of the industrial composition of the city economy as an explanatory variable, but the emphasis of the study is not on the potentially different effects of various industrial compositions on growth.

In this paper, using industry-specific employment data for the states and the United States, we calculate growth and variability measures for the states that are net of the effects of the growth and variability of industries at the national level and net of the relative composition at the state level of fast- and slow-growth industries and stable and variable industries. We argue that an economy's *net* growth and variability may depend on its industrial composition – on the relative employment shares of certain industries – and we test whether industrial mix significantly affects these net measures of growth and variability.

The approach we take is related to, but differs from, typical shift-share studies and business location studies of regional or local economic growth. Shift-share studies isolate three components of a region's growth by algebraic calculation, with the competitive effect component describing the portion of growth due to some undetermined regional effect rather than national growth or industrial mix. We estimate a state growth residual effect that is comparable to shift-share's calculated competitive effect, but we go further than shift-share by offering industrial mix as one factor helping to explain the differences across regions in their competitive effects. Our approach differs from most business climate studies in that we focus on differences in state growth rates net of the growth rates of industries at the national level. Doeringer et al. (1987) are careful to focus on the local employment growth net of the effects of the interaction of local industrial mix and national industrial growth (in other words, they focus on the competitive effect in shift-share terms); however, they do not consider industrial mix as a possible explanation for the competitive effect.

Our results for growth are the most compelling. After controlling for a state's concentration of industries that grew relatively fast or slowly at the national level, one finding is that states with greater shares of employment in manufacturing had a slower net growth than states with greater shares of employment in the finance, insurance and real estate (FIRE) industry. One implication of this result is that many state industrial development policies, which tend to be aimed at manufacturing, may be misdirected and ineffective. This is a tentative conclusion and before strong policy conclusions can be drawn, further analysis is needed.

2. Towards a theory of the macroeconomics of industrial mix

There are several reasons why industrial mix may influence how an economy grows or cycles. In this section we suggest several possibilities that appear plausible in light of the way industries interrelate.

2.1. Growth

If an economy has a large share of an industry that relates closely with other industries, either through requiring many inputs from other industries or producing important inputs for other industries, the growth pattern of the industry may be transmitted to other industries and thus affect the growth of the overall economy. That is, if the particular industry is fast growing, its demand/supply pull will make the supplier/demander industries grow faster. The reverse argument would apply for a slow growing industry, as its demand/supply drag, given its importance in the state, would make the interrelated industries grow more slowly.

A second mechanism through which a specific industry could influence the growth of the economy is agglomeration economies. Agglomeration economies is defined as general cost savings or productivity increases resulting from a geographic concentration of firms. If agglomeration economies characterize a specific industry rather than all industries, then a state with a high share of employment in an industry exhibiting agglomeration economies will experience a higher growth rate relative to states with high concentrations of industries that do not exhibit agglomeration economies.[3]

Knowledge spillovers are a type of agglomeration economies that can be important in this context. If a specific industry devotes substantial investment in the types of R & D that have positive spillover effects on the productivity of other industries, a state with a high share of the R & D industry may have a higher overall level of productivity, and therefore a higher growth rate than other states. The spillover effects of R & D can be negative if a state has a large share of an industry that devotes very little investment in R & D or invests in R & D that is not transferable to other industries. In that case the relative lack of R & D spillovers will make the state grow slower than average.

2.2. *Variation (cycle intensity)*

The interrelatedness of industries is also important in explaining the variability of a state's economy. If a state has a large share of an industry that is highly interrelated with other industries through supply or demand of inputs, and the industry is highly variable, its variability could possibly be transmitted to related industries, making the cycle more intense. On the other hand, if the industry happens to be relatively stable, that stability is likely to be transmitted to industries that either provide or demand inputs from the stable industry, thus resulting in an economy that is less variable.

The intensity of the cycle in a state's economy may also be related to the breadth of the markets of the component industries of the state's economy. An industry that primarily produces goods and services to sell in the local market will not be able to look for alternative buyers outside the state when the local economy goes through a recession. On the other hand, if the goods and services of a majority of the state's industries are sold in the national market, these industries can sell their goods on alternative markets during a local recession, effectively diversifying the risks of local shocks. The variety across states in the contemporaneous correlation of state and national percentage deviations from trend during the period we analyze indicates that there is great opportunity for diversifying such risks.

There are at least two difficulties with the theories sketched here. First, as already noted, our proposed theory of the growth and variability of economies is not complete. Industrial mix is only one factor among many that may affect the macroeconomic behavior of economies. Second, alternative explanations for a link between industrial mix and growth or variability

[3] This industry-specific form of agglomeration economies is sometimes referred to as localization economies. See the discussion of agglomeration economies by Heilbrun (1987, pp. 15–18).

may be as compelling as our explanations involving interrelated industries, agglomeration economies, R & D spillovers, and the extent of the market. For example, if economies are open and workers migrate from one region to another, and if the more desirable region has an industrial mix that differs from the industrial mix of the less desirable region, then differential growth rates will be correlated with industrial mix but not caused by industrial mix. As another example, if, as is argued by Barro and Sala-i-Martin (1991), there is an inverse relationship between growth rates and initial income per capita, and the latter is related to industrial mix, then industrial mix could just be reflecting the historical development of the states rather than providing an alternative explanation of differential growth rates. Devising a complete model of the macroeconomics of regional economies is beyond the scope of the present paper. Instead, we hope to provide some compelling empirical evidence on the link between industrial mix and the growth and variability of regional economies.

3. The data and summary industry characteristics

Our data set contains annual employment levels for 45 states (five states were eliminated because of missing data) and the United States for each of ten industries from 1969 to 1985. The source for the data is the Bureau of Labor Statistics (BLS). We divide total private employment into the following ten industries; farming, construction, non-durable manufacturing, durable manufacturing, transportation and public utilities, wholesale trade, retail trade, FIRE (finance, insurance and real estate), services, and all other (primarily mining and agricultural services, forestry, and fisheries). Using these employment data, we describe the industrial composition of each economy by calculating the employment shares (averages over the time period) for each industry.

Our choice to use employment data rather than some measure of output, such as Gross State Product (GSP), was based on the availability of a well-documented data set. The Bureau of Economic Analysis has recently begun to generate GSP data by industry for the 50 states for several years. While these output data are the best available, they do not have the documentation and credibility of the employment data from the BLS. Our purpose is to explore relative growth rates and variabilities of different states and industries, which can be accomplished with employment or output data. The use of employment data is likely to exaggerate the changes in some industries, such as manufacturing, relative to what we would find using output data, and also to mask relative changes in labor productivity. But, output data are likely to be less convincing as a measure of activity for other industries such as services and FIRE.

In order to isolate the growth and cyclical components of employment for

Table 1

Growth rates, variability, and average employment shares of U.S. industries – 1969–1985.

	Growth (%)	Variability (%)	Share (%)
Farming	−10.9	1.99	4.48
Construction	38.3	5.03	6.04
Non-durable manufacturing	−2.9	2.35	9.54
Durable manufacturing	3.3	5.36	13.77
Transportation and public utilities	23.9	2.21	6.14
Wholesale trade	56.3	2.57	5.94
Retail trade	49.8	1.71	19.02
FIRE	92.6	1.87	7.64
Services	87.1	1.33	25.40
All other	131.3	4.38	2.02
Total employment	43.4	2.03	100

Note: Growth is the estimated trend rate of growth for the 17-year period, *variability* is the standard deviation of the residuals from the estimated log linear trend, and *share* is the average share of total employment over the 17-year period.

each state, for each industry and for the aggregate, we estimate log-linear time trends. Because we are interested in constructing a measure of variability as well as one for growth, we do not obtain the growth rates by calculating the percentage change in employment over the period as is done in traditional shift-share analyses. Instead, we estimate time trends, obtaining as by-products measures of variability through the residuals of the estimated equations. The estimating equations take the following form:

$$\ln E_i^s(t) = \alpha_i^s + \beta_i^s t + \varepsilon_i^s(t), \quad \text{for each } i \text{ and } s,\ t = 1, \ldots, 17, \tag{1}$$

$$\ln E^s(t) = \alpha^s + \beta^s t + \varepsilon^s(t), \quad \text{for each } s,\ t = 1, \ldots, 17, \tag{2}$$

$$\ln E_i(t) = \alpha_i + \beta_i t + \varepsilon_i(t), \quad \text{for each } i,\ t = 1, \ldots, 17, \tag{3}$$

where

$E_i^s(t)$ is employment of industry i in state s at time t,
$E_i(t)$ is employment of industry i in the United States at time t,
$E^s(t)$ is total employment in state s at time t,

with $i = 1, \ldots, 10$ (10 industries); $s = 1, \ldots, 45$ (45 states); and $t = 1, \ldots, 17$ (17 years).

From these estimated equations we extract a trend rate of growth for the 17-year period, and the standard deviation of the residuals, which gives us a summary measure of the percentage deviations from trend. Thus, each equation yields two pieces of information – growth and variability.

Tables 1 and 2 display descriptive statistics, which are somewhat compar-

Table 2

Growth, variability, and employment shares.
Coefficients of variation, maxima, and minima for 45 states.

	Growth	Variability	Share
Farming	1.64 OR 27.20% MS −35.16%	0.45 NH 8.65% TX 1.12%	0.72 ND 21.01% MA 0.56%
Construction	0.94 WY 178.12% MI −14.52%	0.34 WY 18.97% PA 4.52%	0.20 WY 10.47% NY 4.27%
Non-durable manufacturing	2.35 NV 126.52% WV −30.27%	0.44 WY 9.59% VA 1.93%	0.53 SC 24.09% NV 1.80%
Durable manufacturing	1.60 NV 243.99% WV −36.24%	0.39 ND 23.48% NJ 4.40%	0.45 MI 25.79% WY 2.42%
Transportation and public utilities	0.77 NV 120.17% NY −12.30%	0.28 WY 6.63% MD 2.20%	0.16 WY 8.75% NH 4.30%
Wholesale trade	0.52 WY 219.82% MI 9.59%	0.55 ID 14.40% PA 1.47%	0.17 GA 7.47% NV 3.48
Retail trade	0.54 NV 151.95% NY 7.53%	0.34 NV 6.14% TX 1.47%	0.08 NM 22.79% NC 16.58%
FIRE	0.46 NV 262.68% NY 26.98%	0.36 ND 7.24% PA 1.82%	0.20 NY 10.73% WV 4.83%
Services	0.39 AZ 185.48% MS 22.17%	0.37 NV 4.58% WV 0.73%	0.18 NV 48.41% NC 19.49%
All other	0.62 ND 299.17% SD 3.27%	0.55 WY 18.60% OH 2.16%	1.0 WY 14.39% NY 0.69%
Total employment	0.66 NV 163.19% PA 10.69%	0.32 WY 7.70% PA 1.87%	–

Note: See table 1 for definitions of growth, variability, and share.

able with the national growth and industrial mix components of shift-share analysis. The growth rates and variabilities of the 10 industries and total employment for the United States displayed in table 1 illustrate that industries nationally behave quite differently. The industrial composition of the United States as measured by the average employment share of each industry during the period illustrates each industry's relative importance in the economy. Total employment grew 43.4% between 1969 and 1985. Farming employment actually declined, while employment in the two manufacturing industries remained almost constant. The FIRE and services industries experienced very rapid growth during this period, nearly doubling in size.

Total employment in the United States varied 2.03% around trend during the period. Not surprisingly, services was the most stable industry, while construction and durable manufacturing were the most variable industries during the period. Of the 10 industries, services and retail trade were the most important in terms of having the greatest shares of total employment. The two manufacturing industries taken together account for almost one-quarter of total employment. The 'all other' industry is quantitatively unimportant at 2.02%, and thus is given little attention in our analysis.

Industries do behave differently by these measures in the different states. To get a picture of the cross state variability, in table 2 we display, by industry, the coefficients of variation (defined across the 45 states in the sample), the minimum value and the maximum value for each of three variables – the employment growth rate, the employment variability, and the average employment share. As shown in table 2, the coefficient of variation of the states' total employment growth rates is 0.66, with the growth in total employment over the period ranging from 10.69% in Pennsylvania to 163.19% in Nevada. As evidence that these differences are not only due to the differences in industrial mix across the states, we note that there are wide ranges of variation across states industry by industry.

For the variability measure the differences across states are not so great as for the growth rates, although they are still important, especially in some industries such as wholesale trade. The coefficients of variation for the various industry employment shares indicate that industrial composition varies across states, with the differences being especially important for farming and the two types of manufacturing.

We have documented in this section that industries nationally behave quite differently, and that across the states, industries differ in their growth, variability, and share. The remainder of the paper explores the relationship between growth and variability, and the industrial composition of state economies.

4. Regional economic growth and industrial mix

A first question to consider is whether these differences in the growth behaviors of state economies arise simply because one state has a greater share of its employment or output in a relatively fast-growth industry than does another state. The empirical evidence presented below indicates that, once state industrial mix and national industrial growth behavior have been controlled for, great differences remain in state employment growth rates.

To construct a measure of growth that is net of national industrial growth and the state's industrial mix we rely on the estimated trends of eqs. (1), (2), and (3). We define one plus the growth rate over the period 1969–1985 for industries and states as follows:

$G_i^s = \exp(\beta_i^s 16)$, for industry i in state s,
$G^s = \exp(\beta^s 16)$, for total employment in state s,
$G_i = \exp(\beta_i 16)$, for industry i in the United States.

We define our measure of net state growth, what we call the state growth residual, as follows:

state growth residual for state s

$$= \frac{\sum_{i=1}^{10} G_i^s E_i^s(1) - \sum_{i=1}^{10} G_i E_i^s(1)}{\sum_{i=1}^{10} G_i^s E_i^s(1)}, \quad \text{for } s = 1, \ldots, 45,$$

where $E_i^s(1)$ is the level of employment in state s in industry i in period 1 (1969).

The first term in the numerator is an estimate of total actual employment at the end of the period – the sum over the 10 industries of the estimated employment in each industry at the end of the period in the state. The second term in the numerator differs from the first only in that the growth rates used to calculate the final period industry employment levels are those of the national industries rather than of the state industries. This second term is similar to the sum of the national growth and industrial mix components of traditional shift-share analysis.[2] Finally, we divide by the estimated value of total employment to obtain a percentage growth residual. Thus, the state growth residual is a measure of the difference between a state's actual growth and what we would expect to see if the state's industries behaved like the nation's.

The state growth residual is similar to the competitive effect defined in the shift-share literature.[3] It differs from the competitive effect because we calculate the growth rates in a slightly different form in order to obtain the cyclical components at the same time. Also, we aggregate over all industries and present the results in percentage terms, which is not commonly done in shift-share analysis.

Table 3 displays in the first column the estimated percentage growth of total employment for each state over the entire period, and in the second column the state growth residual for each state. The value of −32.3 for New York for the state growth residual indicates that New York's level of employment in 1985 was 32.3% less than we would have expected if New York's industries had grown at their corresponding estimated national growth rates. The coefficient of variation of 5.6 indicates that, once state

[2]For traditional shift-share analysis we refer to Dunn (1960).

[3]We refer to the competitive effect as defined originally by Dunn (1960), and not the reformulation of Esteban-Marquillas (1972), in which he separates growth differentials from industry specialization effects.

Table 3
State growth description, 1969–1985.

	Percentage growth	State growth residual
Alabama	31	−6.1
Arizona	136	34.3
Arkansas	38	1.1
California	82	18.3
Colorado	121	31.9
Connecticut	39	−1.4
Florida	112	27.7
Georgia	55	8.7
Idaho	65	14.8
Illinois	15	−23.1
Indiana	17	−15.3
Iowa	22	−13.7
Kansas	48	3.8
Kentucky	34	−4.2
Louisiana	56	3.5
Maryland	46	−1.4
Massachusetts	37	−6.7
Michigan	14	−21.4
Minnesota	51	5.6
Mississippi	24	−9.7
Missouri	28	−9.7
Montana	49	2.5
Nebraska	33	−6.3
Nevada	163	37.0
New Hampshire	89	25.2
New Jersey	32	−6.6
New Mexico	93	18.6
New York	12	−32.3
North Carolina	37	3.3
North Dakota	48	5.8
Ohio	12	−23.5
Oklahoma	71	13.7
Oregon	61	10.7
Pennsylvania	11	−26.8
South Carolina	42	6.1
South Dakota	31	−6.5
Tennessee	35	−0.97
Texas	93	23.3
Utah	102	26.0
Vermont	58	9.1
Virginia	59	9.5
Washington	81	19.5
West Virginia	15	−30.4
Wisconsin	34	−2.1
Wyoming	116	28.6
Mean	54	3.1
Standard deviation	36.2	17.4
Coefficient of variation	0.67	5.6

Table 4

Correlations of industry growth rates with state growth residuals.

Farming	0.227	Retail trade	0.892
Construction	0.901	FIRE	0.884
Non-durable manufacturing	0.737	Services	0.828
Durable manufacturing	0.751	All other	0.493
Transportation	0.890	Total employment	0.941
Wholesale trade	0.767		

industrial mix and national industry growth rates are controlled for, there is much variability across the states in residual growth.[4]

It is interesting to note that there is a high correlation (0.941) between the growth rates and the state growth residuals displayed in table 3. This indicates that fast-growing states grow even faster than expected once we account for the national growth of their industrial mix, and, similarly, slow-growing states grow slower than expected under the same measure. This raises the question of whether the growth rates of *all* industries in a state are highly correlated with the state growth residual.

To investigate this question, we present in table 4 the correlations between the growth rates for each industry and the state growth residual. The figures displayed indicate that, except for farming and all other, the correlations between the industry growth rates and the state growth residual are positive and quite high, indicating that, in general, those states that grew faster than expected had relatively fast-growing industries. The reverse is true for states with a negative state growth residual.

The fact that several of the correlations are not close to one indicates that not all of the differences observed in the state growth residual can be attributed to fast-growing states having all their industries growing faster than the average. Thus, not all industries appear to be equally affected by whatever causes differential state growth rates.

Statistical test

Although the state growth residual presented in table 3 seems to indicate that once industrial mix and the national growth rates of industries are accounted for, important differences still exist across states, we want to test for the statistical significance of these differences. If the differences in total employment growth rates across the states could be accounted for completely

[4]The mean for the state growth residual presented in table 3 differs from zero for two reasons. One is that it is a mean over 45 states, while the values for total employment we use to estimate national growth rates by industry are based on all 50 states. The other reason is that we compute a simple mean rather than a weighted average with the weights being the size of each state.

by industry growth differences at the national level and the industrial mix of each state, we would expect the following relationship to hold:

$$G^s = \sum_{i=1}^{10} G_i S_i^s + \eta^s, \quad s = 1, \ldots, 45,$$

where S_i^s is the average share of employment in industry i in state s over the period, and where η^s is a random variable with mean zero and constant variance for all s, reflecting the approximation errors of estimated values of the growth rates at state and national levels. Thus, if a state is merely a microcosm of the nation, we could obtain the growth rate of total employment in the state by calculating a weighted average of the national industry growth rates where the weights are the industry shares in the state (the state industrial mix).

Under the assumption that observed growth differences are all due to the industry growth differences at the national level and differences in the industrial mixes of states, a regression with state total employment growth rates as the dependent variable and the product of the industry growth rates at the national level times the industry shares for the state as explanatory variables, should yield estimated coefficients which are not statistically different from one.

The equation we estimate is

$$G^s = \sum_{i=1}^{10} \beta_i (G_i S_i^s) + \eta^s, \quad s = 1, \ldots, 45. \tag{4}$$

Under the null hypothesis that state growth residuals are not important, $\beta_1 = \beta_2 = \cdots = \beta_{10} = 1$. The alternative hypothesis is that at least one of the β_i's is different from one.

In table 5 we display the results of estimating eq. (4) by ordinary least squares (OLS). The null hypothesis is clearly rejected, with an F-statistic of 9.585, which is significant at a 5% significance level.[5] Thus, we reject the notion that differences in state growth rates are merely a reflection of the differences in state industrial mix combined with national industry growth rates.

Given that the null hypothesis is rejected, it is interesting to analyze the estimated β_i's in order to test which of the β's are significantly greater than one and which are less than one. A β_i greater that one would suggest that states with large shares of industry i tend to grow faster than the average. The opposite could be said for those industries with β_i's less than one.

[5] These results, and those presented below, should be taken with some caution since the estimation has not explicitly taken into consideration that the growth rates are estimated values and potentially subject to measurement error.

Table 5

Estimation results.

	Estimated coefficient (1)	Standard errors (2)	t-statistic for $\beta_i = 1$ (3)
Farming	−0.130	1.030	−1.097
Construction	10.031	2.880	3.136
Non-durable manufacturing	−0.448	0.846	−1.711
Durable manufacturing	−0.725	0.740	−2.329
Transportation and public utilities	−9.558	3.958	−2.667
Wholesale trade	−0.097	3.129	−0.351
Retail trade	0.466	1.755	−0.304
FIRE	4.085	1.884	1.638
Services	1.559	0.442	1.266
All other	1.364	0.895	0.407
R^2	0.785		
Number of observations	45		

Note: Dependent variable is growth rate of total employment. Independent variables are shares of employment times national growth rates in each of ten industries. See eq. (4).

Column 3 of table 5 displays the t-statistics for the null hypothesis that $\beta_i = 1$ for each industry. For the alternative hypothesis that β_i is greater than one, the null hypothesis is rejected at a 5% significance level for the construction industry, and at a 10% significance level for the FIRE industry. FIRE was a fast-growth industry during this period. If FIRE provides service inputs to many other industries, then this result of a positive relationship between growth and FIRE's share is consistent with one of our explanations of regional growth. In particular, firms located in a state with a strong financial services sector may have access to more investment opportunities and better credit conditions than firms located in states where the financial network is not well developed; these differences may be explained in part by the ease of credit risk evaluation of potential customers by financial institutions, which may result in faster and less expensive credit decisions.

None of the industrial mix explanations of growth that we suggest seems to apply to construction. It is likely that the share of employment in construction is picking up a regional effect – the fast-growth regions during this period probably had large shares of their employment in construction. This demand-side explanation is also potentially applicable to certain subsectors of the FIRE industry.

For the alternative hypothesis that β_i is smaller than one, the null hypothesis is rejected at a 5% significance level for the two manufacturing industries and for transportation and public utilities. For the latter industry the result is consistent with an R & D explanation – that the level of R & D in the transportation and public utilities industry is low and non-transferable and, thus, having a large concentration of the industry pulls down the relative growth rate of the entire economy.

The result for the manufacturing industry is consistent with our explanation of the effects on growth of having a high concentration of employment in a slow-growing industry that is strongly interrelated with other industries as a demander of inputs. This result and our proposed explanation are consistent with a result of Murphy and Topel (1987) who analyze unemployment data for males over a similar time period and find that demand shocks to unemployment in manufacturing have a positive spillover effect on total and industry-specific unemployment.

In summary, we find that states with concentrations of certain industries – FIRE and construction – are favored with unexpectedly high employment growth, while states with concentrations of other industries – transportation and public utilities and manufacturing – experience unexpectedly low employment growth.

5. Economic variability and industrial mix

We have decomposed the evolution of employment along time for each state and industry into two components – the trend rate of growth and the variability around the trend. We are interested in analyzing if the variability (or the intensity of the cyclical component) of the states is a mirror of the national variability once industrial mix is taken into account.

For this purpose we construct a statistic for each state – the state variation residual – which relates the observed variability of a state with the variability that would be expected if the state varied according to its industrial mix and the industries' variabilities at the national level.

Our measure of variability is the standard deviation over time of the percentage deviations from trend growth. Let V_i^s, V_i, and V^s be the standard deviations over the years 1969–1985 of the estimates for ε_i^s, ε_i, and ε^s, respectively, from eqs. (1), (2), and (3).

We define our measure of net state variation, what we call the state variation residual, as follows:

$$\textit{state variation residual} = \sum_{i=1}^{10} V_i^s S_i^s - \sum_{i=1}^{10} V_i S_i^s, \text{ for each } s = 1, \ldots, 45.$$

The first term is the estimated variability of the state. The second term represents the variability we would have observed if each industry in the state had varied like the corresponding national industry.

The state variation residual is a statistic that is not free of aggregation effects given that its definition involves variances of variables at different levels of aggregation. In our data it is the case that the variance of the percentage deviations from trend for a specific industry at the national level (V_i) is smaller than most of the corresponding variances for the states. Because of this aggregation effect, the state variation residual is positive for all observations and care must be taken in interpreting the results.

In table 6 we display the estimated variation of total employment for each state (that is, V^s for $s=1,\dots,45$), and the state variation residual. The figures in column 1 indicate, for example, that total employment in Alabama, with a standard deviation of percentage deviations from trend of 2.73%, was relatively stable during this period compared with the average level of variability of 3.25%. Once Alabama's relative concentration of variable and stable industries is accounted for, Alabama is still relatively stable, as indicated by its state variation residual (displayed in column 2) with a value below the average. On the other hand, Wyoming's economy was much more variable – a state variation residual of 6.11 – than we would have expected if Wyoming's industries displayed the same variability as the industries did nationally over this period. The coefficient of variation for the state variation residual variable is 0.63, indicating that, once industrial mix and national industry variation are controlled for, state economies (and their component industries) display considerable differences in their cyclical behavior.

To determine whether industrial mix can account for some of the differences in the variability patterns observed across states, we estimate OLS regressions with the state variation residual as the dependent variable, and the industry share variables as explanatory variables. We concentrate on industrial shares because our goal is to isolate the effects of different industrial compositions, as opposed to other state-specific characteristics that are likely to affect state variability. Because we do not develop a theoretical model, we do not have a well-defined alternative hypothesis to test. Instead, to infer something about the robustness of our results, we specify several simple regressions that differ only in terms of which share variables are included as explanatory variables.

Table 7 summarizes the results of our estimation. In each regression we include a variable that is a measure of the size of the state – the total employment in the first year of the sample. This size variable controls for the negative effect that aggregation has on variance. We find strong evidence of a positive effect of the share of the 'all other' industry (primarily mining, agricultural services, forestry and fisheries) on the intensity of the variability of a state. This industry is highly cyclical and provides basic inputs to many other industries. Thus, this result is consistent with the theory outlined above – the interrelatedness of industries – for why industrial mix may matter.

We also find consistent evidence that the share of services is positively related to the amount of variation in a state. While services' share is only significant at a 10% significance level in regression 4 of table 7, it is highly

Table 6

State variability description, 1969–1985 (figures are percentages).

	Variability of total employment	State variation residual
Alabama	2.73	1.34
Arizona	3.81	2.41
Arkansas	2.96	1.48
California	2.73	0.88
Colorado	2.77	1.55
Connecticut	2.85	0.77
Florida	3.69	2.22
Georgia	2.82	1.45
Idaho	5.25	3.92
Illinois	2.33	0.61
Indiana	3.40	1.21
Iowa	3.49	2.19
Kansas	2.71	1.75
Kentucky	3.20	1.68
Louisiana	3.43	2.05
Maryland	2.30	0.46
Massachusetts	3.25	1.30
Michigan	4.06	1.75
Minnesota	2.69	1.07
Mississippi	3.29	2.06
Missouri	2.23	0.38
Montana	3.40	2.76
Nebraska	2.50	1.32
Nevada	5.66	4.20
New Hampshire	3.51	1.63
New Jersey	2.90	0.83
New Mexico	3.04	2.15
New York	3.18	1.10
North Carolina	2.45	0.79
North Dakota	3.08	2.63
Ohio	2.88	0.66
Oklahoma	2.92	1.93
Oregon	4.81	2.73
Pennsylvania	1.87	0.19
South Carolina	2.44	1.61
South Dakota	2.70	2.18
Tennessee	2.84	1.19
Texas	2.32	0.91
Utah	3.36	2.10
Vermont	2.68	1.61
Virginia	2.09	0.57
Washington	4.46	2.42
West Virginia	4.27	2.95
Wisconsin	3.07	1.15
Wyoming	7.70	6.11
Mean	3.25	1.74
Standard deviation	1.04	1.10
Coefficient of variation	0.32	0.63

Table 7

Variability regression results

	Regression 1	Regression 2	Regression 3	Regression 4
Constant	−0.009	0.019	−0.010	0.006
	(0.77)	(4.43)	(1.33)	(0.66)
Farming share	0.054	0.015	0.055	–
	(1.88)	(0.59)	(2.14)	
Non-durable manufacturing share	−0.004	−0.051	–	−0.027
	(0.14)	(1.93)		(0.94)
Services share	0.080	–	0.082	0.048
	(2.53)		(3.30)	(1.75)
All other share	0.231	0.192	0.234	0.212
	(5.02)	(4.16)	(5.89)	(4.58)
Total employment	−0.000000002	−0.000000002	−0.000000002	−0.000000002
	(2.39)	(2.65)	(2.41)	(3.46)
R^2	0.65	0.60	0.65	0.62
Number of observations	45	45	45	45

Notes: The numbers in parentheses are t-statistics. Dependent variable is the state variation residual defined in the text.

significant in the other two specifications in which it is included. Because the service industry tends to sell to a local market it is unable to diversify the risks of a downturn in the local economy. Thus, this result is also consistent with the explanations put forth above for why industrial mix might have an effect on the intensity of cycles of a state.

6. Conclusions and future research

In this paper we use annual employment data on U.S. states from 1969 to 1985 to document three characteristics of regional economies – the trend rate of growth, the variability around trend, and the industrial mix. We calculate measures of growth and variability for each state that are net of the effect of the state industrial mix interacting with the national industrial growth rates and variabilities. We postulate that a state's industrial mix might be one factor in explaining the differences across the states in their net growths and net variabilities.

Our results for the net rates of growth are the most compelling. After controlling for the mix of fast- and slow-growing industries, we find that there are great differences in the net growth rates of the states. This indicates that state economies are not microcosms of the national economy, differing only because of differences in industrial composition. Furthermore, we find that the differences in net growth rates are statistically significant and are correlated with concentrations of certain industries. In particular, our results indicate that the net growth rate is greater in states with higher concentrations of employment in the construction and FIRE industries and lower in states with higher concentrations of employment in the manufacturing and transportation and public utilities industries. These findings have policy implications since many states focus their economic development programs on manufacturing industries. Our results indicate that these programs may be misguided.

Our goal in this paper is to highlight some characteristics of the macroeconomics of regional economies, and to search for explanations for the differences observed. While we present and explore empirically some tentative explanations for the differences we find in growth and variability – explanations that revolve around the industrial compositions of the economies – we are far from a complete understanding of the macroeconomic behavior of regional economies. In future work we hope to explore further the relation between economic growth and industrial mix. In particular, we are interested in investigating the growth rates of specific industries and their relation to industrial mix, and in exploring the differences between employment and income growth rates and their relation to industrial mix.

References

Altonji, Joseph G. and John C. Ham, 1987, The collective impact of sectoral shocks on aggregate employment fluctuations, in: Peter T. Chinloy and Ernst W. Stromsdorfer, eds., Labor market adjustments in the Pacific Basin (Kluwer-Nijhoff, Boston).

Barro, Robert J. and Xavier Sala-i-Martin, 1991, Convergence across states and regions, Brookings Papers on Economic Activity 1, 107–182.

Blanchard, Olivier Jean and Lawrence F. Katz, 1992, Regional evolutions, Brookings Papers on Economic Activity 1, 1–75.

Doeringer, Peter B., David G. Terkla and Gregory C. Topakian, 1987, Invisible factors in local economic development (Oxford University Press, New York/Oxford).

Dunn, Edgar S., Jr., 1960, A statistical and analytical technique for regional analysis, Papers and Proceedings of the Regional Science Association 6, 97–112.

Dunn, Edgar S., Jr., 1980, The development of the U.S. urban system, vol. I (The Johns Hopkins University Press, Baltimore).

Esteban-Marquillas, J.M., 1972, A reinterpretation of shift-share analysis, Regional Science and Urban Economics 2, no. 3, 249–255.

Garcia-Milà, Teresa and Therese J. McGuire, 1992, The contribution of publicly provided inputs to states' economies, Regional Science and Urban Economics 22, no. 2, 229–241.

Glaeser, Edward L., Hedi D. Kallal, José A. Scheinkman and Andrei Shleifer, 1992, Growth in cities, Journal of Political Economy 100, no. 6, 1126–1152.

Heilbrun, James, 1987, Urban economics and public policy, 3rd edn (St. Martin's Press, New York).

Krugman, Paul, 1991, Geography and trade (MIT Press, Cambridge, MA).

Murphy, Kevin M. and Robert H. Topel, 1987, The evolution of unemployment in the United States: 1968–1985, NBER Macroeconomics Annual.

Wasylenko, Michael and Therese McGuire, 1985, Jobs and taxes: The effect of business climate on states' employment growth rates, National Tax Journal 38, no. 4, 497–511.