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Working Paper 6180

NBER WORKING PAPER SERIES

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Working Paper 6 180
http://www.nber.org/papers/w6180

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02 13 8
September 1997

We thank Marianne Baxter, William Easterly, Robert King, Lam Pritchett, Shang-Jin Wei and participants of seminars at the World Bank, the University of Virginia and the 1995 AEA meetings for helpful suggestions. This paper is part of NBER's research program in International Finance and Macroeconomics. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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NBER Working Paper No. 6180
September 1997
JEL Nos. E30, E32, E37
International Finance and Macroeconomics

ABSTRACT

We examine whether the aggregate U.S. business cycle is driven mainly by geographical shocks (affecting all sectors within a state), or by sectoral shocks (affecting the same sector in all states). We find that, at the level of an individual sector in an individual state, shocks to output growth are driven by the sector, not by the state: textiles in Texas move more with textiles elsewhere in the U.S. than with other sectors in Texas. But shocks to sector growth rates exhibit a lower correlation *across* sectors compared to the correlation of shocks to state growth rates *across* states. As a result, geographical shocks gain greater importance at higher levels of aggregation. Finally, we find that changes in the volatility of the aggregate U.S. business cycle reflect, to a roughly comparable degree, both changes in the *volatility* of state and sector business cycles, and changes in their *correlation* across sectors and states.

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1 Introduction

News stories about the "California Depression" or the "Rust Belt Revival" suggest that, at a disaggregated level, geographical location is of prime importance in explaining output movements. Yet reports of the "*resurgence* of the electronics industry" or of the "housing industry collapse" suggest that it is the sector, rather than location, which matters.[1] At a more aggregate level, the U.S. business cycle might reflect the changing fortunes of regions, or of sectors. Much of the business cycle literature to date has focused on the sectoral dimension: whiie a small literature examines comovements between sectorally disaggregated activity and national output[2], the geographical dimension of business cycles has attracted relatively little attention.[3]

This emphasis on sectoral explanations might reflect an implicit assumption that differences across states arise mainly from "exogenous" differences in their sectoral composition.[4] Put differently. were all states to adopt the same "portfolio" of industries, little if any geographical differences might remain: Michigan differs from Kentucky only because Michigan has a higher esposure to the automobile sector — and is thus subject to the "automobile shock" — while Kentucky has a higher exposure to the tobacco industry — and is thus subject to the "tobacco shock." By symmetry, of course, the case can equally be made in reverse: heterogeneity across sectors might reflect nothing more than their geographical location and would disappear were sectors equally dispersed across states. Thus the automobile sector differs from the tobacco sector only because it is located in Michigan, and is subject to the "Michigan shock," while tobacco is located in Kentucky, and is therefore subject to the "Kentucky shock."

Both views have merit. Fiscal policy changes at the state level [Gramlich (1987)], shifts in the allocation of military installations across states, local weather conditions, improvements in local infrastructure, local inter-dependencies of the banking system [Samolyk

[1]Inasmuch as particular sectors are concentrated in particular states, the stories become more difficult to distinguish, an important issue taken up below.

[2]Jimeno (1992), Kandil (1995), Krol (1992), Lebow (1993), Lilien (1982), Long and Plosser (1987), Norrbin and Schlagenhauf (1988, 1991), *inter alia*.

[3]Exceptions include Blanchard and Katz (1992), Norrbin and Schlagenhauf (1988), Prasad and Thomas (1994) and Kollmann (1995).

[4]Over the longer term, location choice, and hence sectoral composition, is of course itself endogeneous.

(1994)] and a host of other state level factors will tend to create geographically correlated supply and demand movements, particularly for non-traded goods. On the other hand, technological advances and shifts in sector-specific tastes will affect production for the same sectors across the United States.'

We use a disaggregated dataset on state-sector output for the Gnited States to examine the relative importance of sectoral versus geographical factors at various levels: shocks to the growth rate of an individual sector in an individual state, shocks to entire states and sectors, and, ultimately, shocks to aggregate output.

The distinction between geographical and sectoral shocks is of some importance for stabilization policy. If aggregate business cycles primarily reflect large output movements in some states — affecting most sectors within those states — then the efficacy of geographically undifferentiated counter-cyclical policies at the federal level will be limited and stabilization policy should be targeted at specific states [Gramlich (1987)].[6] On the labor market side, geographical shocks place a premium on spatial mobility, most likely within the same sector. If, instead, the aggregate cycle largely reflects the booms and busts of individual sectors. then broadly based fiscal policies — be they state or federal — would not be fully efficient: and cross-sectoral labor mobility — quite likely within the same state — would provide an alternative adjustment mechanism.[7]

We proceed in three steps. We begin at the most disaggregated level with the shock to the growth rate of an individual sector in an individual state — say chemicals in California — which we term the *individual-micro* shock. We then define the *sector-micro* shock as a weighted average (across all states) of the absolute *value* of the individual-micro shocks in that sector. The sector-micro shock thus aims to capture the size of the "typical" (absolute) shock affecting that sector, regardless of its geographical location. Analogously, we define a *state-micro* shock as the weighted average (across all sectors) of the absolute value of the individual-micro shocks in that state. The state-micro shock aims to capture the size of

[5]Some authors equate geographical shocks with "demand" movements and sectoral shocks with "supply" movements. While of some intuitive appeal, the correspondence is not exact: a product specific taste shock is an example of a demand movement showing up as a sectoral shock; a change in the quality of transportation infrastructure is an example of a supply shock with a geographical component. For our purposes, there is no need to identify geographical (sectoral) shocks with demand and supply movements.

[6]The fiscal transfer system to states partially fulfills this role [Sala-i-Martin and Sachs (1992)].

[7]See Blanchard and Katz (1992) on labor market adjustment patterns.

the "typical" (absolute) shock affecting that state, regardless of the particular sector.

We examine two issues at this level. First, are there marked differences of these micro shocks across states and across sectors? Second, are individual micro shocks more correlated along the geographical dimension — the textile sector in California moving with the chemicals sector in California — or more correlated along the sectoral dimension — the textile sector in California moving with the textile sector in Texas?

Moving up one level of aggregation, we consider the properties of state *shocks* — defined as the (output weighted) sum of the *actual* (rather than absolute) micro shocks to sectors in that state. The state shock is thus the average shock to the state, taking account of "diversification" across sectors. Likewise, the *sector* shock is defined as the (output weighted) sum of the actual micro shocks to that sector across all states — that is, taking account of "diversification" of the sector across various states. Again, two issues are of interest. First, does the size of state and sector shocks vary across states and sectors? Second, are there differences between the correlation of state shocks across states and the correlation of sector shocks across sectors? Finally, we turn to the aggregate U.S. business cycle and relate its volatility to the properties of the underlying state and sectoral shocks.

We find that, at the micro level of an individual sector in a particular state, it is the sector which matters. Output of chemicals in California is driven more by the US chemicals business cycle than by the California business cycle. As the focus moves up to higher levels of aggregation, however, the geographical dimension gains greater importance. While shocks to sectors are larger than the corresponding shocks to states (because the underlying micro shocks are more correlated within a sector than within a state, thus aggregation across sectors within a state provides more "diversification" than aggregation across states within the same sector), the correlation of sector shocks *across* sectors is lower than the correlation of state shocks across states. At the national level, therefore, shocks to states have considerable explanatory power for the *aggregate* business cycle.

2 Micro Shocks

Our results are based on the BEA sectoral-state database containing state output series from 1963 to 1991 for thirty-four sectors, deflated by the US sectoral output deflators.[8] The basic unit is the individual-micro shock to the growth rate of sector i in state s at time t, denoted Λ_t^{is}. The appropriate way of modeling the time series behavior of sectoral and aggregate output continues to be the subject of a lively debate. For robustness, we select two alternative measures of the shock. The first measure is the residual of an autoregression (AR) of the current output growth rate, A log y^{is}, on a constant, and it's own lag: $\Lambda_t^{is} \equiv$ A log $y_t^{is} - (\mu^{is} + \rho^{is} \Delta \log y_{t-1}^{is})$. The second, less restrictive measure is the cyclical component of a Hodrick-Prescott (HP) decomposition of output growth. In practice, the low persistence of growth rates means that the two series are very similar, and are indeed very similar to the growth rate itself.

We begin by examining the magnitude of these shocks along the sectoral and geographical dimensions. Next we consider how individual micro shocks are related to micro shocks in the same sector versus micro shocks in the same state.

2.1 Magnitude

The first two columns of Table 1 report the sector micro shocks, $\{\Gamma^i\}_{i=1}^{34}$, for the AR and for the HP measures. Each represents the "typical" absolute growth shock to that sector averaged across states and, for any period, is calculated as a weighted average over all states, s = 1, . .., 50 of the absolute value of the shock Λ_t^{is} . The weight attached to the growth shock to sector i in state s is the ratio of output in the sector in the state, y_t^{is}, to U.S. output in that sector:

[8](1) Agriculture, (2) mining, (3) construction, (4) lumber and wood products, (5) furniture and fixtures, (6) stone, clay and glass products, (7) primary metal sectors, (8) fabricated metal products, (9) non-electrical machinery, (10) electric and electronic equipment, (11) motor vehicles and equipment, (12) other transportation equipment, (13) instruments and related products, (14) miscellaneous manufacturing sectors, (15) food and kindred products, (16) tobacco products, (17) leather products, (18) textile mill products, (19) apparel and other textile products, (20) paper and allied products, (21) printing and publishing, (22) chemicals and allied products, (23) petroleum and coal products, (24) rubber and miscellaneous plastic products, (25) transportation, (26) communications, (27) electric, gas and sanitary services, (28) wholesale trade, (29) retail trade, (30) finance, insurance and real estate, (31) services, (32) federal civilian government, (33) federal military government and (34) state and local government.

Table 1: **Within-Sector and Within-State Shocks**

	Within-Sector					Within-State			
	Sector-Weights		US-Weights			State-Weights		US-Weights	
	AR (1)	HP (2)	AR (3)	HP (4)		AR (5)	HP (6)	AR (7)	HP (8)
Agriculture	**0.095**	0.102	0.085	0.091	Alabama	0.044	0.045	0.045	**0.045**
Mining	0.060	0.056	0.081	0.079	Alaska	0.120	0.130	0.091	**0.094**
Construction	0.057	0.064	0.055	0.062	Arizona	0.055	0.055	0.060	**0.059**
Lumber, Wood	0.074	0.077	0.073	0.076	Arkansas	0.053	0.052	0.051	0.050
Furniture	0.078	0.076	0.076	0.074	California	0.035	0.035	0.038	0.038
Stone, Glass	0.067	0.067	0.068	0.069	Colorado	0.043	0.041	0.048	0.046
Primary Metals	0.097	0.097	0.102	0.102	Connecticut	0.043	0.044	0.049	0.049
Fabri. Metals	0.067	0.065	0.068	0.066	Delaware	0.070	0.067	0.075	0.074
NE Machinery	0.070	0.069	0.072	0.072	Florida	0.042	0.040	0.053	0.050
Elect. Equip.	0.079	0.076	0.086	0.084	Georgia	0.044	0.045	0.046	0.047
Motor Vehicles	0.148	0.148	0.165	0.163	Hawaii	0.046	0.046	0.058	0.058
Trans. Equip.	0.091	0.095	0.107	0.114	Idaho	0.060	0.062	0.067	0.067
Instruments	0.084	0.090	0.101	0.101	Illinois	0.040	0.040	0.041	0.041
Other Indust.	0.087	0.085	0.093	0.091	Indiana	0.051	0.052	0.044	0.045
Food	0.039	0.039	0.040	0.039	Iowa	0.055	0.057	0.057	0.058
Tobacco	0.055	0.048	0.059	0.058	Kansas	0.052	0.053	0.050	0.050
Textile Mills	0.062	0.060	0.074	0.072	Kentucky	0.049	0.047	0.048	0.046
App., Textiles	0.052	0.051	0.056	0.054	Louisiana	0.055	0.052	0.055	0.053
Paper	0.069	0.068	0.068	0.066	Maine	0.049	0.049	0.055	0.055
Printing, Pub.	0.033	0.033	0.035	0.034	Maryland	0.037	0.039	0.047	0.049
Chemicals	0.060	0.058	0.063	0.061	Massachuss.	0.039	0.040	0.052	0.053
Petro., Coal	0.113	0.112	0.125	0.125	Michigan	0.060	0.060	0.050	0.050
Rubber,Plastic	0.078	0.075	0.078	0.077	Minnesota	0.043	0.043	0.049	0.049
Leather	0.077	0.076	0.077	0.075	Mississippi	0.063	0.061	0.057	0.055
Transport	0.046	0.046	0.046	0.046	Missouri	0.042	0.042	0.042	0.042
Communication	0.030	0.027	0.030	0.027	Montana	0.062	0.061	0.052	0.051
Utilities	0.042	0.040	0.043	0.040	Nebraska	0.050	0.051	0.054	0.052
Wholesale Tr.	3.033	0.032	0.034	0.032	Nevada	0.045	0.044	0.056	0.053
Retail Trade	0.031	0.031	0.031	0.031	N. Hampshire	0.053	0.054	0.055	0.055
Finance	0.029	0.028	0.029	0.028	New Jersey	0.037	0.037	0.043	0.043
Other Services	0.017	0.017	0.017	0.017	New Mexico	0.045	0.044	0.053	0.052
Fed. Civ. Gov.	0.034	0.033	0.038	0.037	New York	0.033	0.033	0.039	0.039
Fed. Mil. Gov.	0.038	0.039	0.039	0.039	N. Carolina	0.044	0.043	0.048	0.047
Sta/Loc. Gov.	0.017	0.016	0.017	0.016	N. Dakota	0.087	0.086	0.066	0.065
					Ohio	0.045	0.045	0.040	0.040
					Oklahoma	0.047	0.045	0.049	0.048
					Oregon	0.049	0.049	0.056	0.055
					Pennsylvania	0.037	0.036	0.036	0.036
					Rh. Island	0.049	0.049	0.054	0.054
					S. Carolina	0.047	0.046	0.053	0.051
					South Dakota	0.056	0.059	0.057	0.058
					Tennessee	0.046	0.045	0.047	0.046
					Texas	0.042	0.040	0.042	0.041
					Utah	0.048	0.046	0.049	0.048
					Vermont	0.052	0.053	0.055	0.055
					Virginia	0.039	0.039	0.043	0.042
					Washington	0.048	0.048	0.050	0.050
					W. Virginia	0.047	0.047	0.051	0.050
					Wisconsin	0.042	0.042	0.043	0.043
					Wyoming	0.068	0.068	0.054	0.055
Average	0.062	0.062	0.066	0.065	Average	0.050	0.050	0.051	0.051
Maximum	0.148	0.148	0.165	0.163	Maximum	0.120	0.130	0.091	0.093
Minimum	0.017	0.016	0.017	0.016	Minimum	0.033	0.033	0.036	0.036

$$\Gamma^i \equiv \frac{1}{27}\sum_{t=1965}^{1991}\Gamma_t^i \equiv \frac{1}{27}\sum_{t=1965}^{1991}\sum_{s=1}^{50}\frac{y_t^{is}}{Y_t^i}Abs(\Lambda_t^{is}) = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{s=1}^{50}\frac{y_t^{is}}{\sum_{s=1}^{50} y_t^{is}}Abs(\Lambda_t^{is}) \qquad (1)$$

where the notation Y_t^i indicates aggregate U.S. output of sector i in period t, and I” is the average over the entire sample, 1965-91.

Correspondingly, columns 5-6 report the state micro shocks, $\{\Gamma^s\}_{s=1}^{50}$. In state s and time t, the state micro shock is simply the “typical” growth shock to sectors in that state, averaged across sectors. For any period, it is calculated as a weighted average over all sectors, $i = 1, \dots, 34$ of the absolute value of the shock Λ_t^{is}. The weight attached to the growth shock to sector i in state s is the ratio of output in the sector in the state, y_t^{is}, to state output.

$$\Gamma^s \equiv \frac{1}{27}\sum_{t=1965}^{1991}\Gamma_t^s \equiv \frac{1}{27}\sum_{t=1965}^{1991}\sum_{i=1}^{34}\frac{y_t^{is}}{Y_t^s}Abs(\Lambda_t^{is}) = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{i=1}^{34}\frac{y_t^{is}}{\sum_{i=1}^{34} y_t^{is}}Abs(\Lambda_t^{is}) \qquad (2)$$

It bears emphasizing that these “micro shocks” are quite different from the average shock to the entire sector or state — which we calculate below, and term the sector and state shocks respectively. By taking the absolute value of the shock before averaging in (1) and (2), no allowance is made for negatively correlated shocks within a sector (or state) off-setting each other, thus permitting a look at the typical size of shocks, independent of their sign. It should also be noted that the state and sector micro shocks contain a common component and are thus not uncorrelated. The common component arises from two sources. First, every individual-micro shock comprises the “national” shock common to all micro-shock observations. As we will see below, the national shock is, however, not quantitatively important.

The second source of co-movement derives from the fact that every observation has both a state and a sector dimension. To take an extreme case, suppose that a particular sector in a particular state accounts both for the entire state output and the entire (national) sector output. In that case, the state and the sector shocks would be perfectly correlated. In practice, the overlap is much smaller but is nevertheless present, inducing some correlation.[9]

[9]Conceptually, the individual-micro shock can be written as $\Lambda_t^{i,s} = n_t + u_t^i + v_t^s + \epsilon_t^{i,s}$ where u_t^i and v_t^s are *uncorrelated*. However, as every observation belongs to both a sector and a state, these uncorrelated

Three sectors are subject to particularly large micro-shocks: agriculture, petroleum and durables (notably motor-vehicles) — presumably reflecting the importance of weather disturbances, oil price movements, and swings in consumer sentiment and credit conditions. At the opposite end of the spectrum, services and the public sector exhibit significantly below-average micro-shocks. Overall, the typical micro-shock is larger for sectors producing durables, than for sectors producing non-durables, and for sectors producing traded, as opposed to non-traded, goods. Turning to states: sectors in Alaska — clearly an outlier — are subject to the largest micro-shocks. At the other end of the distribution no outliers are found, though the largest states, New York and California, exhibit the smallest micro-shocks — a finding to which we return below. A comparison shows that the distribution of state-micro shocks is significantly tighter than the distribution of sector-micro shocks. Since the results are quite similar for the AR and the HP measures of the micro-shock (reflecting the low persistence of shocks), below we report results only for the AR measure: except in the summary tables.

Since the state shocks are based on the *state-output* weighted shocks to the individual sectors in the state, differences across states can reflect one of two factors. First, it might be that the same sector receives different shocks in different states. For instance, Californian agricultural output may, perhaps because of greater weather-sensitivity of local crops; on average be more volatile than output of Kansas agriculture. Second, it might be that the output in the same sector is subject to similar shocks regardless of location, but that output volatility differs across sectors. In the latter case there would be differences in state aggregates purely as a result of differences in sectoral composition (and hence weighting of the micro-shocks). For instance, if Kansas produces mainly agriculture, and the agricultural sector exhibits high volatility, then a large Kansas micro shock (relative to California) might simply reflect the large weight of agriculture in state output, $(y^{ag,Kan}/Y^{Kan})$ used to calculate the state micro shock, rather than an autonomous "Kansas shock."

shocks cannot be identified without imposing some additional restriction (in the extreme case mentioned above, the shock can, with equal justification, be attributed to the sector or to the state). Our preference is to avoid imposing such additional restrictions. As a result, our measures do not refer to "pure" sector or state effects (conditional on identifying restrictions) but rather to weighted averages of sector, state and national factors. As our main interest lies in exploring the systematic differences between the *set* of sector and the *set* of state shocks, and as the "leakage" factors are roughly constant across the relative dimensions, rankings are unlikely to be affected. We return to these issues in the ANOVA subsection below.

A priori, an analogous argument can of course be made about differences between the sector-micro shocks. Just as a large shock to Kansas might reflect the combination of a large (US-wide) shock to agriculture and a large weight of agriculture in Kansas output, the shock to agriculture in the U.S. may reflect the combination of a large shock to California (say an early frost) and the large weight of the Californian agricultural sector in national agricultural output.

In the former case, part of the variation across states would merely be a reflection of differences in the sectoral composition of state output — rather than autonomous geographical shocks; in the latter case: part of the variation across sectors would merely be a reflection of differences in the spatial composition of sectors — instead of autonomous sectoral shocks.

Weighting-induced differences certainly appear to be a possibility as both the geographical dispersion of sectors, and the sectoral diversification of states vary significantly. Herfindahl indices of concentration reveal tobacco, motor vehicles, and mining to be the most geographically concentrated sectors; while Alaska, Louisiana, and Nevada are the most sectorally concentrated states.

To examine whether weighting matters, we recompute the state-micro using the share of the sector in *U.S.* output rather than the share of the sector in *state* output. Likewise, we recompute the sector-micro shocks using the share of the state in U.S. output rather than the share of the state in sector output. Columns 3-4 and 7-8 of Table 1 report the results for the US weighted micro-state and micro-sector shocks. For one sector — agriculture — the U.S.-weighted micro-shock is more than 0.1 below the sector-weighted micro-shock, in seven sectors, the U.S.-weighted shock is actually larger than the state-weighted shock by more than 0.1 (with the mining and instruments sector showing the largest increases). On the state side, the micro-shock for seven states — Alaska, Indiana, Michigan, Montana, North Dakota, Ohio and Wyoming — is lower by more than 0.1 for the US -weighted shocks, while for sixteen states the state micro shock would actually be more than 0.1 points larger using US-weights.

Overall, the results reveal that while weighting affects results, controlling for differences in the sectoral composition of state output and the spatial composition of sectoral output does not eliminate either the intra-state, or the intra-sector differences, nor does it affect the overall comparison between sector and state shocks. The finding that differences in sectoral composition cannot fully account for geographical heterogeneity matches conclusions by Jimeno [1992] and Clark [1995] for more aggregated datasets.

This conclusion of course depends on the assumption that the individual micro shocks, Λ_t^{is}, are themselves independent of the size of the sector, and thus of the weighting scheme used. This may not be the case. For instance, to the extent that individual firms suffer idiosyncratic shocks, aggregation generates diversification effects, in consequence, the volatility of a given sector across states might be expected to decrease in the absolute size of the sector. To control for this possibility, we regress the absolute size of the micro shock Λ_t^{is} on the size of the sector. The regression results indeed suggest a slight negative correlation. To examine whether this correlation is sufficiently large to affect the interpretation of results, we recompute the statistics based on "size-adjusted" shocks (computed by removing the size-effect predicted by the regression) but find only minor differences to the original series. The assumption that the volatility of a given sector in a given state can, to a first approximation, be taken as independent of the absolute size of the sector in the state thus seems acceptable. Summing up these results, the evidence quite strongly suggests that neither differences across sectors, nor differences across states, can be fully explained by composition effects. Put differently, the results suggest the presence of both autonomous geographical and sectoral shocks.

Table 2 examines the stability of the size of the micro shocks over time. The table reports, for both shock measures, the median shock (across the states and across the sectors) for five year subsamples. The size of the typical micro-shock has varied within a fairly narrow range — increasing gradually until the early 1980s, then declining again — while the *relative* ranking of state and sector micro shocks has remained the same across the subsamples.

2.2 Comovements

Is the shock to a particular sector in a particular state determined by what happens to the sector elsewhere in the United States, or by what happens to other sectors in the same state? We begin examining the relative importance of state — versus sector — effects by comparing the average *intra-sector* correlations between the (actual, not absolute) micro-shocks to a particular sector in all states — each computed as the average of the 1'225

Table **2: Median Micro-State and Micro-Sector Shocks**

Shock	Type	Weights	Full Sample	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989
State	HP	State	0.046	0.036	0.045	0.052	0.053	0.051
State	HP	u s	0.050	0.040	0.049	0.056	0.055	0.051
State	AR	State	0.047	0.041	0.049	0.046	0.057	0.044
State	AR	u s	0.050	0.045	0.052	0.050	0.059	0.046
Sector	HP	Sector	0.062	0.040	0.053	0.065	0.068	0.060
Sector	HP	u s	0.066	0.048	0.060	0.076	0.068	0.058
Sector	AR	Sector	0.061	0.047	0.062	0.063	0.073	0.058
Sector	AR	u s	0.068	0.055	0.069	0.069	0.073	0.056

below-diagonal elements of the 50*50 correlation matrix of shocks to the given sector in all fifty states — with the *intra-state* correlations (each computed as the average of the 561 below-diagonal elements of the 34*34 correlation matrix of shocks to all thirty-four sectors within a given state). As a robustness check, we compute both the simple average of the 1225 (561) bilateral correlations for each sector (state), and an output weighted measure.[10]

Table 3 reports the average correlations. The results are quite similar across the various measures, so we focus on the (equally-weighted) AR measure: depicted in the two panels of Figure 1. The correlation of the shocks to the same sector across different states is strikingly larger and more dispersed, compared to the correlation of shocks to different sectors within the same state: California textiles tend to move with Texas textiles, rather than with California chemicals. Indeed, more than one-third of the *intra-sector* correlations are statistically significant (at the 10 percent level or higher) whereas none of the *intra-state* correlations are statistically significant.

The distribution of the average intra-state correlation is fairly bunched. Micro shocks to different sectors within North Dakota are almost uncorrelated, at 0.06, while shocks to sectors within Michigan, at 0.32, exhibit the highest correlations; most intra-state correlations fall in a narrow range of 0.10 to 0.25. In contrast, intra-sector correlations span a considerably wider range. At one end of the scale: shocks to tobacco and agriculture — subject to local weather shocks — exhibit almost no correlation across states. At the other end, shocks to transport and retail trade — both highly dependent on other sectors — exhibit correlations above 0.7 across states.

To examine these co-movements more formally, we regress the shock to sector i in state j on the output-weighted average shock to sector i in all states *ezcept* state j and on the output-weighted average of the shock to state j in all sectors *ezcept* sector i to explore which piece of information is more useful in explaining the growth shock to an particular sector in a particular state: knowing what happened to the sector elsewhere or what happens to other sectors in the same state? The results are reported in table 4, listing the *orthogonal* contribution of the state and the sector variable to the R^2 of this regression — averaged

[10] The weight attached to the correlation between sector i and sector j in state s is equal to the sum of the output in those two sectors in the state, rescaled so that weights add up to unity. Likewise, the weight attached to the correlation of the shock to a particular sector in state r and state s is equal to the sum of the output of the sector in the two states, again rescaled so that weights add up to one.

Figure 1

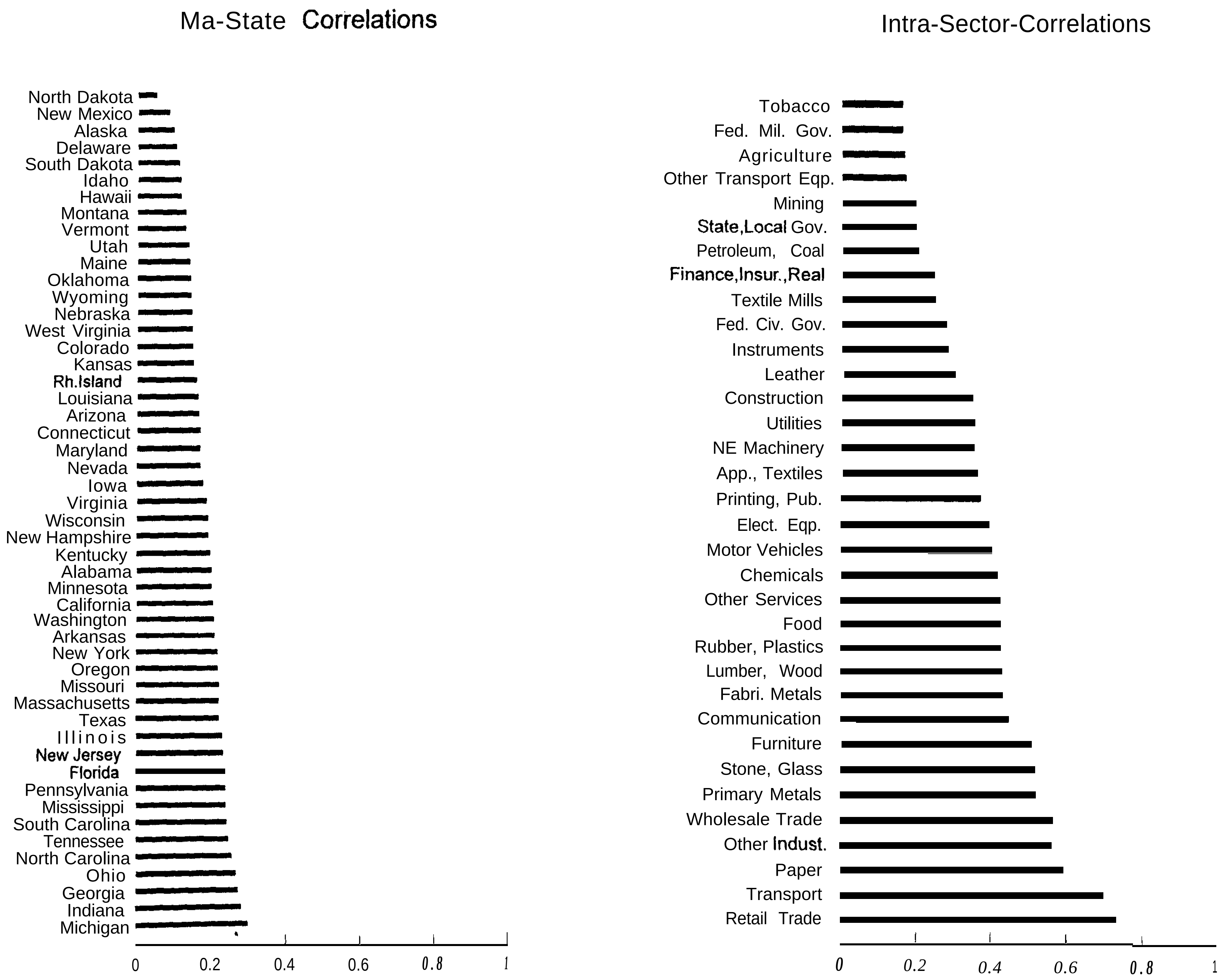

Ma-State Correlations
North Dakota
New Mexico
Alaska
Delaware
South Dakota
Idaho
Hawaii
Montana
Vermont
Utah
Maine
Oklahoma
Wyoming
Nebraska
West Virginia
Colorado
Kansas
Rh.Island
Louisiana
Arizona
Connecticut
Maryland
Nevada
Iowa
Virginia
Wisconsin
New Hampshire
Kentucky
Alabama
Minnesota
California
Washington
Arkansas
New York
Oregon
Missouri
Massachusetts
Texas
Illinois
New Jersey
Florida
Pennsylvania
Mississippi
South Carolina
Tennessee
North Carolina
Ohio
Georgia
Indiana
Michigan
0
0.2
0.4
0.6
0.8
1
Intra-Sector-Correlations
Tobacco
Fed. Mil. Gov.
Agriculture
Other Transport Eqp.
Mining
State,Local Gov.
Petroleum, Coal
Finance,Insur.,Real
Textile Mills
Fed. Civ. Gov.
Instruments
Leather
Construction
Utilities
NE Machinery
App., Textiles
Printing, Pub.
Elect. Eqp.
Motor Vehicles
Chemicals
Other Services
Food
Rubber, Plastics
Lumber, Wood
Fabri. Metals
Communication
Furniture
Stone, Glass
Primary Metals
Wholesale Trade
Other Indust.
Paper
Transport
Retail Trade
0
0.2
0.4
0.6
0.8
1

Table 3: **Average *Intra*-State and *Intra*-Sector Correlations**

State	Average Correl. AR Shocks Equal Weights	Average Correl. AR Shocks State Weights	Average Correl. HP Shocks Equal Weights	Sector	Average Correl. AR Shocks Equal Weights	Average Correl. AR Shocks State Weights	Average Correl. HP Shocks Equal Weights
Average	0.18	0.17	0.18	Average	0.38	0.42	0.37
Maximum	0.32	0.31	0.28	Maximum	0.73	0.75	0.73
Minimum	0.05	0.05	0.04	Minimum	0.16	0.09	0.11

across sectors or states — as well as the overall R^2.[11]

Controlling for the shock to the same sector in other states, including the shock to other sectors in the same state raises the explained variance by less than 5 percentage points. In contrast, controlling for the shock to other sectors in the same state: including the shock to the same sector in other states raises the explained variance by almost 25 percentage points. The contribution of the shock to other sectors in the same state (column 2) is broadly similar across the different states (ranging between 0.04 to 0.10) while the contribution of the shock to the same sector in other states differs widely across the various sectors (column 4). For retail trade, almost one-half of the variance is explained by movements of retail trade in other states, while less than 8 percent of the variance in finance, insurance and real-estate can be explained by movements in other states.

[11] The orthogonal component contribution of the state variable is calculated as the increase in the R^2 obtained by adding the state variable to a regression already containing the sector variable; the orthogonal contribution of the sector variable is computed analogously as the increase in the R^2 obtained by adding the sector variable to a regression already containing the state variable.

Columns 3 and 6 report the overall R^2 of the individual regressions, again averaged across states or sectors. These R^2s measure the extent to which output movements at the state-sector level can be explained jointly by shocks to the same sector in other states and by shocks to other sectors in the same state. As such, they provide a joint measure of geographical and sectoral linkages. Sectors in Alaska are seen to be *the* most independent, while almost 60 percent of shocks to sectors in Ohio are explained by shocks to the same sector in other states and to other sectors in Ohio. Across sectors, tobacco is the least linked, while more than 77 percent of retail trade shocks can be explained by state and sector linkages.

At the individual micro level, the answer to the question posed in the introduction is thus unambiguous: What matters for an individual sector in an individual state is what happens to the same sector in other states, not what happens to other sectors in the same state. The findings are consistent with two explanations. First, they might reflect a greater incidence of shocks which similarly affect the same sector in all states, compared to shocks which similarly affect all sectors within a state. Second, they might reflect the presence of leading firms/states in a given sector passing an idiosyncratic shock on to other firms in that sector through vertical linkages. By construction; our data do not permit a distinction between cross-sectionally correlated "exogenous" shocks and propagated shocks *within* the year.

Granger causality tests, however, provide some insight about temporal linkages. We estimate two sets of Granger-tests, each using one lag. The first asks whether the output shock in a given sector in a given state Granger-causes the output shock in the same *sector* in other states. Transport, electrical equipment and communication are the three sectors with the greatest number of significant Granger-causal links between the same sector in different states[12] The second set of tests examines whether the output shock in a given sector in a given state Granger-causes the output. shock in other sectors in the same *state*. The evidence here is even weaker. Maine, Florida and Arizona top the list, with around three percent of all causality tests significant.[13] Overall, the evidence for important linkages

[12] For the transport sector, Massachusetts is the leading state, Granger-causing almost a third of the transport shocks in other states. For Electrical equipment and communication, Idaho and Indiana are the leading states, again Granger-causing shocks in the same sector in about a third of the other states.

[13] The leading sectors in these three states are state/local government in Maine, construction in Florida

over time, wither within sectors across states, or within states across sectors is thus rather limited.

Figure 2 provides the answer to a slightly different question, which has been examined by a number of previous authors for more aggregated datasets: what fraction of the individual-micro shock to a specific sector in a specific state can be attributed to a sector-independent state effect (common to all sectors in the state), to a state-independent sector-effect (common to the same sector in all states) and to a residual idiosyncratic effect? As discussed above, the question cannot be answered without imposing additional restrictions, since every observation belongs both to a state and to a sector. We follow the previous literature in achieving identification through the choice of an (arbitrary) reference point, agriculture in Alabama. Given the reference point, the orthogonal sector contribution can be estimated as the increase in the R^2 obtained by including sector dummies (except for agriculture) to a panel regression already including state dummies (except for Alabama). The orthogonal state contribution is analogously computed as the increase in the R^2 obtained by adding state dummies to a panel regression already including sector dummies. The figure plots these orthogonal contributions. In all but a few years, sector shocks have greater explanatory power than state shocks. Over the entire period, the average orthogonal explanatory power of sector dummies amounts to 0.119, exceeding the explanatory power of the state dummies at 0.080 by almost fifty percent.

These results for the United States differ markedly from earlier findings for cross country studies. Thus Stockman (1988) finds sector and geographical shocks to be of roughly equal importance for a sample of OECD economies; Helg et al. (1995) conclude that "more variance of output innovations is explained at the country, rather than the industry level"; Costello (1993), examining productivity growth, finds a higher correlation across industries within one country than across countries within one industry; and Borensztein and Ostry (1994) looking at the output decline in eastern Europe, find a predominance of geographic over industry shocks. Our finding of more prominent sectoral shocks in the U.S., however, are matched by other studies of subnational sectoral and geographic activity [Norrbin and Schlagenhauf (1988), Prasad and Thomas (1994), Kollmann (1995)]. The available evidence thus suggests an interesting reversal of the relative importance of geographic and sectoral

and primary metals in Arizona, each Granger-causing about 15% of the other sectors in the respective state.

Figure 2
Fraction of Variance Explained
Orthogonal Sector and State Components

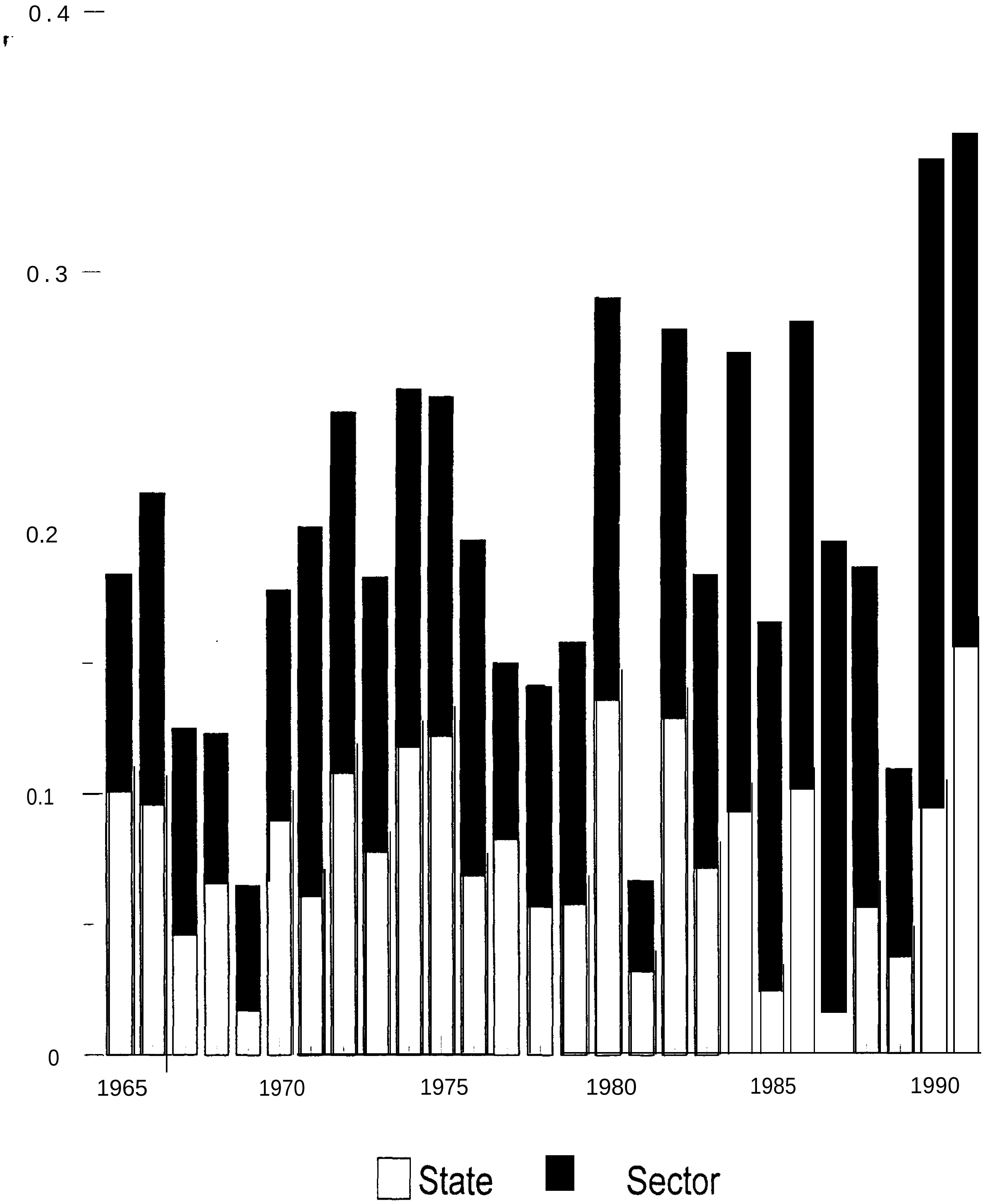


Table **4: Determinants Of Micro Shocks**

States

	Orthogonal Contribution Sector (1)	Orthogonal Contribution State (2)	R^2 (3)
Alabama	0.268	0.035	0.486
Alaska	0.071	0.066	0.158
Arizona	0.160	0.063	0.363
Arkansas	0.271	0.027	0.466
California	0.414	0.025	0.604
Colorado	0.184	0.052	0.354
Connecticut	0.226	0.034	0.417
Delaware	0.151	0.030	0.239
Florida	0.225	0.059	0.484
Georgi	0.270	0.038	0.550
Hawaii	0.151	0.052	0.223
Idaho	0.161	0.051	0.266
Illinois	0.318	0.019	0.557
Indiana	0.285	0.039	0.589
Iowa	0.335	0.026	0.428
Kansas	0.327	0.037	0.452
Kentucky	0.267	0.026	0.471
Louisiana	0.246	0.031	0.324
Maine	0.253	0.027	0.355
Maryland	0.289	0.037	0.468
Massachusetts	0.248	0.042	0.462
Michigan	0.195	0.060	0.531
Minnesota	0.273	0.022	0.454
Mississippi	0.302	0.027	0.478
Missouri	0.309	0.029	0.524
Montana	0.201	0.034	0.267
Nebraska	0.265	0.038	0.353
Nevada	0.145	0.077	0.305
New Hampshire	0.219	0.055	0.429
New Jersey	0.308	0.041	0.534
New Mexico	0.188	0.048	0.256
New York	0.311	0.033	0.514
North Carolina	0.283	0.038	0.557
North Dakota	0.159	0.048	0.213
Ohio	0.292	0.033	0.620
Oklahoma	0.250	0.069	0.365
Oregon	0.244	0.046	0.469
Pennsylvania	0.347	0.020	0.608
Rh.Island	0.256	0.029	0.389
South Carolina	0.214	0.045	0.469
South Dakota	0.202	0.025	0.235
Tennessee	0.283	0.036	0.553
Texas	0.342	0.055	0.506
Utah	0.207	0.043	0.328
Vermont	0.202	0.035	0.324
Virginia	0.299	0.012	0.489
Washington	0.239	0.059	0.429
West Virginia	0.249	0.022	0.353
Wisconsin	0.337	0.024	0.561
Wyoming	0.164	0.099	0.280
Average	0.248	0.040	0.422
Maximum	0.414	0.099	0.620
Minimum	0.071	0.012	0.158

Sectors

	Orthogonal Contribution Sector (4)	Orthogonal Contribution State (5)	R^2 (6)
Agriculture	0.123	0.045	0.179
Mining	0.140	0.077	0.235
Construction	0.220	0.060	0.443
Lumber, Wood	0.307	0.031	0.463
Furniture	0.215	0.031	0.583
Stone, Glass	0.274	0.054	0.596
Primary Metals	0.373	0.024	0.563
Fabri. Metals	0.148	0.050	0.501
NE Machinery	0.229	0.050	0.435
Elect. Equip.	0.211	0.061	0.451
Motor Vehicles	0.218	0.024	0.450
Other Trans. Eq.	0.151	0.057	0.226
Instruments	0.210	0.055	0.343
Other Indust.	0.393	0.022	0.573
Food	0.381	0.022	0.458
Tobacco	0.102	0.028	0.131
Textile Mills	0.255	0.015	0.369
App., Textiles	0.229	0.026	0.447
Paper	0.392	0.016	0.608
Printing, Pub.	0.144	0.048	0.387
Chemicals	0.326	0.026	0.473
Petroleum, Coal	0.157	0.039	0.209
Rubber, Plastics	0.207	0.027	0.492
Leather	0.248	0.022	0.320
Transport	0.399	0.024	0.734
Communication	0.331	0.035	0.441
Utilities	0.306	0.027	0.362
Wholesale Trade	0.410	0.051	0.620
Retail Trade	0.467	0.045	0.775
Fin.Ins.,Real Es.	0.075	0.061	0.224
Other Services	0.156	0.063	0.482
Fed. Civ. Gov.	0.276	0.031	0.312
Fed. Mil. Gov.	0.228	0.035	0.264
State,Local Gov.	0.144	0.052	0.228
Average	0.248	0.040	0.422
Maximum	0.467	0.077	0.775
Minimum	0.075	0.015	0.131

shocks between the sub-national and the national level.

It bears emphasizing that this reversal cannot be simply explained by the absence of a formal role for national policy shocks in the evidence presented above. As the shocks are calculated separately for each state-sector pair (no control for an overall annual average is included), any national shock would be part of every single state-sector shock series. If such national shocks were indeed the dominant driving force, we would not observe differences between the sector and the state decompositions, nor would we observe sizable differences between individual states and sectors — *in* stark contrast to our results.

To some degree, the greater importance of common sectoral shocks for the intra-national compared to inter-national data may reflect structural factors, in particular lower artificial and natural trade barriers within the United States, easing the geographic transmission of sectoral shocks. A second possibility is that the reversal reflects the different levels of aggregation. The possibility is of interest since, due to more restricted data availability, the national studies referred to above employ rather more aggregated data than used here. Costello (1993). for example, examines shocks to five major industries, while Stockman (1988) and Borensztein and Ostry (1994) study shocks to ten sectors: compared to the thirty-four sectors examined here. To the extent that the correlation of geographic shocks *across* space differs from the correlation of sector shocks across sectors. a move from shocks to disaggregated sectors in disaggregated spatial units to shocks to more aggregated sectors in more encompassing spatial units will by itself affect the relative volatility of geographic versus sectoral shocks. To examine this issue in more detail, we now turn from the micro-shocks to state and sector level shocks.

3 State and Sector Shocks

The evidence presented thus far can be usefully summarized by aggregating micro shocks along the state or sectoral dimensions. The average state shock is simply the absolute value of the (weighted) average of (actual, not absolute) shocks to sectors in that state. Thus, in contrast to the previous section, we now allow for positive and negative shocks *within* the state to cancel each other.

$$\Theta^s = \frac{1}{27}\sum_{t=1965}^{1991}\Theta_t^s = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{i=1}^{34}\frac{y_t^{is}}{Y_t^s}\Lambda_t^{is} = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{i=1}^{34}\frac{y_t^{is}}{\sum_{i=1}^{34} y_t^{is}}\Lambda_t^{is} \quad (3)$$

The average sector-level shock is defined analogously:

$$\Theta^i = \frac{1}{27}\sum_{t=1965}^{1991}\Theta_t^i = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{s=1}^{50}\frac{y_t^{is}}{Y_t^i}\Lambda_t^{is} = \frac{1}{27}\sum_{t=1965}^{1991}\sum_{s=1}^{50}\frac{y_t^{is}}{\sum_{s=1}^{50} y_t^{is}}\Lambda_t^{is} \quad (4)$$

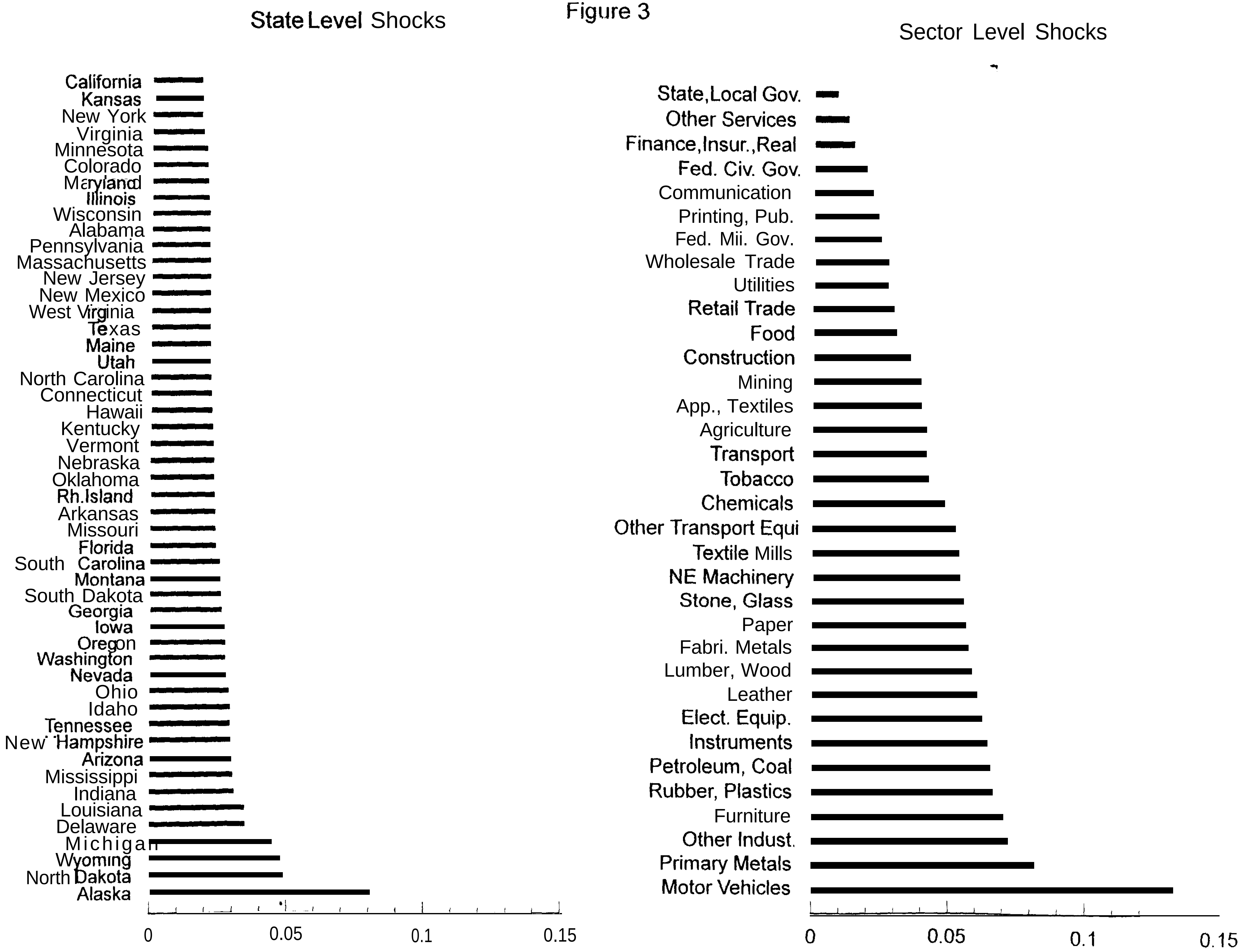
We begin by examining the magnitude of these shocks — relating them to the results above on the sectoral and geographical dimension of the micro shocks — and then turn to the correlations between state shocks and between sector shocks.

3.1 Magnitude and Relation to Micro Shocks

These average shocks (for the AR measure) are plotted, sorted by size and on identical scales, in Figure 3. State shocks fall within a quite narrow range — from 0.017 for California to 0.048 for North Dakota — with Alaska an outlier at 0.080. In contrast, the sector shocks are considerably larger and much more dispersed: ranging from a shock of 0.008 for state and local government to 0.133 for motor vehicles. Overall, the average sector-level shock (0.047) is almost twice as large as the average state-level shock (0.026) with the difference significant at the one percent level.

The figure of course only provides a different view of the results presented above: the low intra-state correlation of shocks to different sectors implies a high incidence of off-setting shocks, hence the absolute value of the state shock based on actual micro-shocks is substantially lower than the value of the state-micro shock based on the absolute values of the micro-shocks. In contrast, the substantial correlation of shocks to the same sector across states implies limited offsetting, hence the micro-sector shock and the absolute value of the sector-shock are comparable. Put differently, the aggregate state shock is reduced by "diversification" across sectors to a greater extent than the aggregate sector shock is reduced by diversification across states. Turning to individual states and sectors, the magnitude of the state and sector shocks reflects both the size of the micro shocks (table 1) and the intra-state and intra-sector correlations (Figure 1).

Figure 3


State Level Shocks
California
Kansas
New York
Virginia
Minnesota
Colorado
Maryland
Illinois
Wisconsin
Alabama
Pennsylvania
Massachusetts
New Jersey
New Mexico
West Virginia
Texas
Maine
Utah
North Carolina
Connecticut
Hawaii
Kentucky
Vermont
Nebraska
Oklahoma
Rh.Island
Arkansas
Missouri
Florida
South Carolina
Montana
South Dakota
Georgia
Iowa
Oregon
Washington
Nevada
Ohio
Idaho
Tennessee
New Hampshire
Arizona
Mississippi
Indiana
Louisiana
Delaware
Michigan
Wyoming
North Dakota
Alaska
0
0.05
0.1
0.15
Sector Level Shocks
State,Local Gov.
Other Services
Finance,Insur.,Real
Fed. Civ. Gov.
Communication
Printing, Pub.
Fed. Mii. Gov.
Wholesale Trade
Utilities
Retail Trade
Food
Construction
Mining
App., Textiles
Agriculture
Transport
Tobacco
Chemicals
Other Transport Equi
Textile Mills
NE Machinery
Stone, Glass
Paper
Fabri. Metals
Lumber, Wood
Leather
Elect. Equip.
Instruments
Petroleum, Coal
Rubber, Plastics
Furniture
Other Indust.
Primary Metals
Motor Vehicles
0
0.05
0.1
0.15

3.2 Comovement of State and Sector Shocks

Next we consider the inter-state and inter-sector correlation of the average sector and state shocks with a view to determining their importance in explaining aggregate output movements.[14] For each sector, i, we calculate the (weighted) average of the correlations between the output-weighted actual shock to sector i with each of the thirty-three other sectors. Similarly, for each state, s, we calculate the output-weighted average of the correlations between the output weighted actual shock to state s with each of the forty-nine other states.[15]

Analogously to the computation of the *intra*-state and *intra*-sector correlations, we weigh observations by the sum of the outputs of the two states (sectors) rescaled to ensure that weights add up to unity. Table 5 (analogous to table 3) reports the aggregate statistics for the various measures. Again, as there are no substantial differences, we focus on Figure 4 which shows the correlations based on state- and sector-weighted AR shocks.

Across the entire sample, state shocks display an average correlation of around 0.50 with other state shocks, close to seventy percent of these correlations are significantly different from zero at the five percent level. Sector shocks, in contrast, have a much lower average correlation of around 0.30 with close to forty percent of the correlations significantly different from zero at the five percent level.[16] As a result, sectoral aggregation diversifies away sector shocks to a greater extent than geographical aggregation diversifies away state shocks. The higher the level of aggregation, therefore, the greater the role of geographical shocks.[17]

Most of the correlations of states with other states lies within the range of 0.3 to

---

[14] The independent interest of the results rests on the definition of the average state-level and sector-level shock as the sum of state-sector shocks weighted, respectively, by output weights in total *state* and total *sector* output. If state-sector shocks are instead weighted relative to *US* output, the sum of all state shocks would, by definition, be equal to the sum of all sector shocks. Thus, a lower average state shock would automatically imply a higher average correlation.

[15] $CORR^i = \frac{1}{33}\sum_{g=1,i\neq g}^{34} w^{ig} Corr(\theta^i, \theta^g)$ where $\theta_t^i = \sum_{s=1}^{50} \frac{y_t^{is}}{\sum_{s=1}^{50} y_t^{is}} \Lambda_t^{is}$.

Similarly, $CORR^s = \frac{1}{49}\sum_{g=1,s\neq g}^{50} w^{sg} Corr(\theta^s, \theta^g)$ where $\theta_t^s = \sum_{i=1}^{34} \frac{y_t^{is}}{\sum_{i=1}^{34} y_t^{is}} \Lambda_t^{is}$

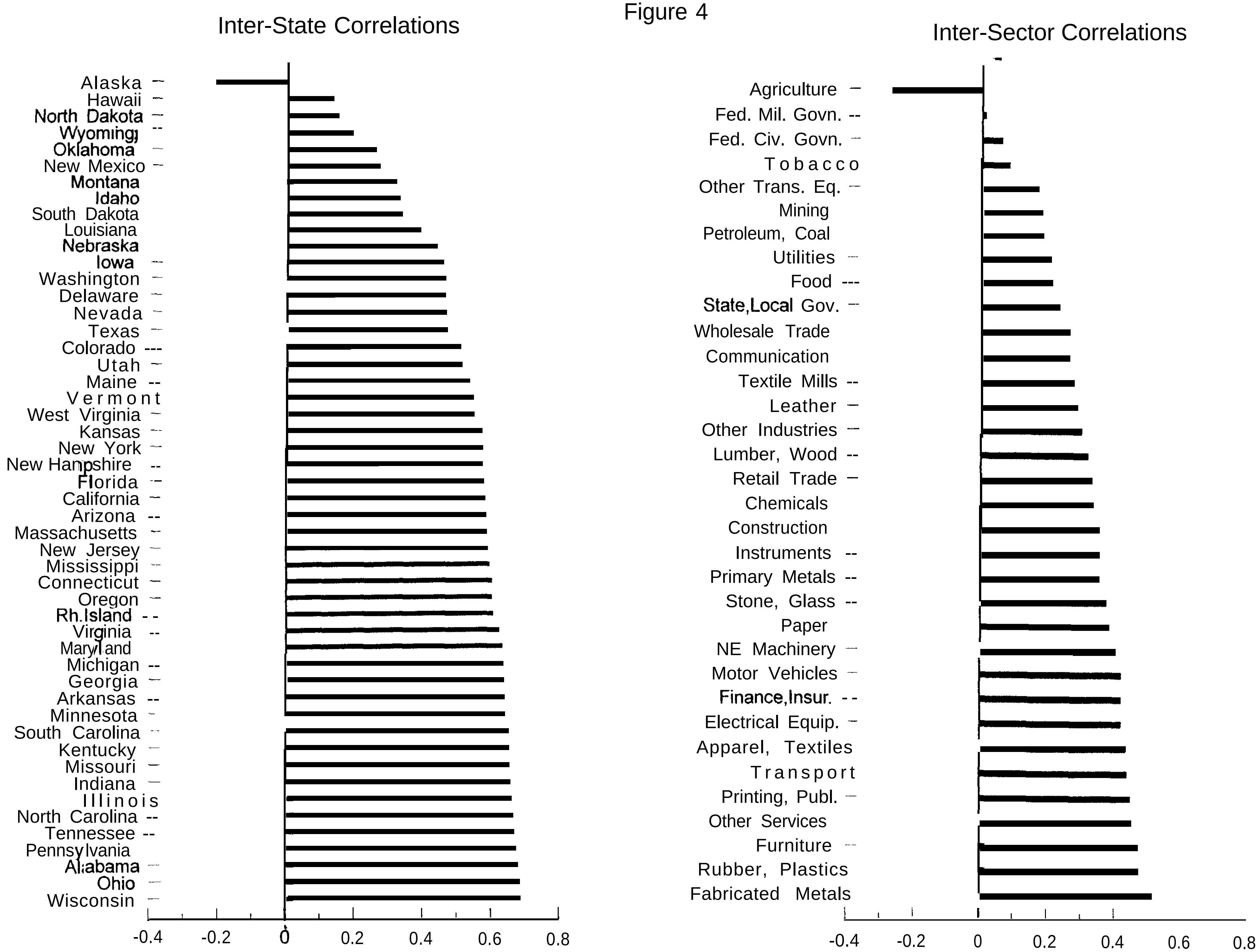
[16] The fairly low correlation across sectors provides an explanation for our earlier finding that states with small aggregate shocks tend to be fairly large and diversified across sectors.

[17] The low correlation of sectoral shocks on the *national* level is well documented, see for example Lebow (1993).

Table 5: **Average Inter-State and Inter-Sector Correlations**

	Average Correlation of State Shocks across States				Average Correlation of Sector Shocks across Sectors			
	State-Weight HP Shock	US-Weight HP Shock	State-Weight AR Shock	US-Weight AR Shock	Sector-Weight HP Shock	US-Weight HP Shock	Sector-Weight AR Shock	US-Weight AR Shock
Average	0.49	**0.54**	**0.51**	**0.58**	**0.27**	**0.28**	**0.30**	**0.30**
Median	**0.54**	**0.60**	**0.57**	**0.62**	**0.30**	**0.32**	**0.32**	**0.32**
Maximum	**0.67**	**0.72**	**0.69**	**0.74**	**0.50**	**0.50**	**0.52**	**0.52**
Minimum	**-0.33**	**-0.31**	**-0.21**	**-0.24**	**-0.16**	**-0.22**	**-0.27**	**-0.31**

Figure 4


Inter-State Correlations
Alaska
Hawaii
North Dakota
Wyoming
Oklahoma
New Mexico
Montana
Idaho
South Dakota
Louisiana
Nebraska
Iowa
Washington
Delaware
Nevada
Texas
Colorado
Utah
Maine
Vermont
West Virginia
Kansas
New York
New Hampshire
Florida
California
Arizona
Massachusetts
New Jersey
Mississippi
Connecticut
Oregon
Rh.Island
Virginia
Maryland
Michigan
Georgia
Arkansas
Minnesota
South Carolina
Kentucky
Missouri
Indiana
Illinois
North Carolina
Tennessee
Pennsylvania
Alabama
Ohio
Wisconsin
-0.4
-0.2
0
0.2
0.4
0.6
0.8
Inter-Sector Correlations
Agriculture
Fed. Mil. Govn.
Fed. Civ. Govn.
Tobacco
Other Trans. Eq.
Mining
Petroleum, Coal
Utilities
Food
State,Local Gov.
Wholesale Trade
Communication
Textile Mills
Leather
Other Industries
Lumber, Wood
Retail Trade
Chemicals
Construction
Instruments
Primary Metals
Stone, Glass
Paper
NE Machinery
Motor Vehicles
Finance,Insur.
Electrical Equip.
Apparel, Textiles
Transport
Printing, Publ.
Other Services
Furniture
Rubber, Plastics
Fabricated Metals
-0.4
-0.2
0
0.2
0.4
0.6
0.8

0.6, only Alaska is negatively correlated with other states. Across sectors, the average correlation with other sectors ranges from a negative correlation for agriculture and near zero correlations of the Federal Military and Civilian Government to significant positive correlations for Furniture, Rubber and Metals. The wide variation of inter-state correlations is of some interest, going back to our earlier discussion of propagation channels. While a complete exploration of the cross-sectional differences in correlations is beyond the scope of this paper, we briefly explore two potential determinants of above average correlations: proximity and similarity.

Bilateral correlations might be expected to depend upon the distance between states for at least two reasons. First, a substantial literature has established a sturdy negative link between bilateral distance and trade. To the extent that propagation partly takes place via trade linkages: more distant states-should exhibit lower correlations. Second, to the extent that some geographical shocks (such as the weather) can affect several states in a region: we would again expect a negative link between distance and correlation. In addition to distance, one might expect more similar states to exhibit higher bilateral correlations.

Table 6 examines whether distance (measured as the log of the distance, in miles, between state capitals) and measures of similarity indeed have explanatory power for the cross-sectional dispersion of correlations. We include four measures of similarity. The first and second proxy for the similarity of the sectoral composition of output and exports, computed as the sum of the absolute differences of the output (export) shares across all sectors. The output data are the same as those underlying the shocks. The export data were taken from the 1993 commodity flow survey issued by the Bureau of Transportation, and exclude services. For both measures, a larger value implies greater dissimilarity. As additional controls for size and performance, we include the logs of the sum of value added per worker in manufacturing, the log of the product of growth rates of the two states and the log of the state output levels. The results, reported on the left side of table 6, indicate that the correlation increases in proximity as well as in the similarity of output and trade.[18]

The right hand side of table 6 reports the results of a similar exercise for the bilateral correlations of sector shocks. We include three explanatory variables as well as dummies for capital goods and for non-capital intermediate inputs. First, the sum of the bilateral

[18] The t-statistics are only approximate as the dependent variable is itself estimated.

Table **6: Determinants Of State And Sector Correlations**

State				Sector			
Variable	Coef.	t-stat.		Variable	Coef.	t-stat.	
Constant	-3.18			Constant	0.28		
ln(Distance)	-0.08	-10.87	***	IO-Coef	0.23	3.58	***
Y-Dissimilarity	-0.39	-7.71	***	Herfindahl	-3.47	2.00	**
T-Dissimilarity	-4.82	-6.76	***	Size	5.21	0.77	
Joint Productivity	0.25	11.00	***	Capital Goods	0.15	1.36	
Joint Growth	1.56	4.01	***	Inputs	0.13	1.77	*
Size State A	0.02	3.48	***				
Size State B	0.01	3.24	***				
0 bservations	982				561		
R2	0.539				0.05		

input-output coefficients, measuring the production chain linkages between two sectors. Second, the product of the sector Herfindahl indices, to examine whether sectors that are geographically very dispersed, and hence less likely to be subject to idiosyncratic geographic shocks, exhibit a higher correlation. Third, the product of the shares in U.S. output of the two sectors, measuring whether large sectors exhibit higher comovements. The results suggest that input-output linkages between two sectors raise the correlation between the sector shocks. and hence that shocks are partly transmitted via vertical production chain linkages. A second effect is the geographic dispersion: the correlation between shocks to sectors declines in the degree of geographic concentration, reflecting the importance of share geographic shocks. Finally, the size of sectors does not appear to affect the correlation. Ceteris paribus. sectors producing intermediate inputs exhibit higher correlations, though the effect is not significant.

3.3 The Aggregate Business Cycle

By definition. changes in the volatility of the aggregate business cycle may reflect either changes in the typical *size* of shocks affecting states and sectors, or changes in the correlation of these shocks across sectors and states. Table 7 throws some light on the importance of these two factors. The table reports, for the AR measure of the U.S.-weighted state shock and the sector-weighted sector shock, both the typical size and the correlation across sectors and states for five-year sub-periods.

The table suggests that the post-1970 increase and the post 1985 decrease in the volatility of the aggregate business cycle reflect both an increase in the volatility of the business cycle on the state and sector level — captured by the average size statistic — and a greater synchronicity of these cycles — captured in the correlation statistic.

Our results can best be summarized by computing four measures of the shock to the growth rate of U.S. output, graphed in Figure 5. The first measure is the absolute output-weighted shock to U.S. output — the focus of traditional aggregate business cycle analysis. The second and third measures are the sums of the output-weighted (absolute) average state and sector shocks. The fourth measure is the sum of the output-weighted micro shocks to individual state-sector pairs. Each of these measures weight each individual shock identically — they differ solely in the stage at which the aggregation is done (the absolute

Figure 5
Measures of the Shock to U.S. Output

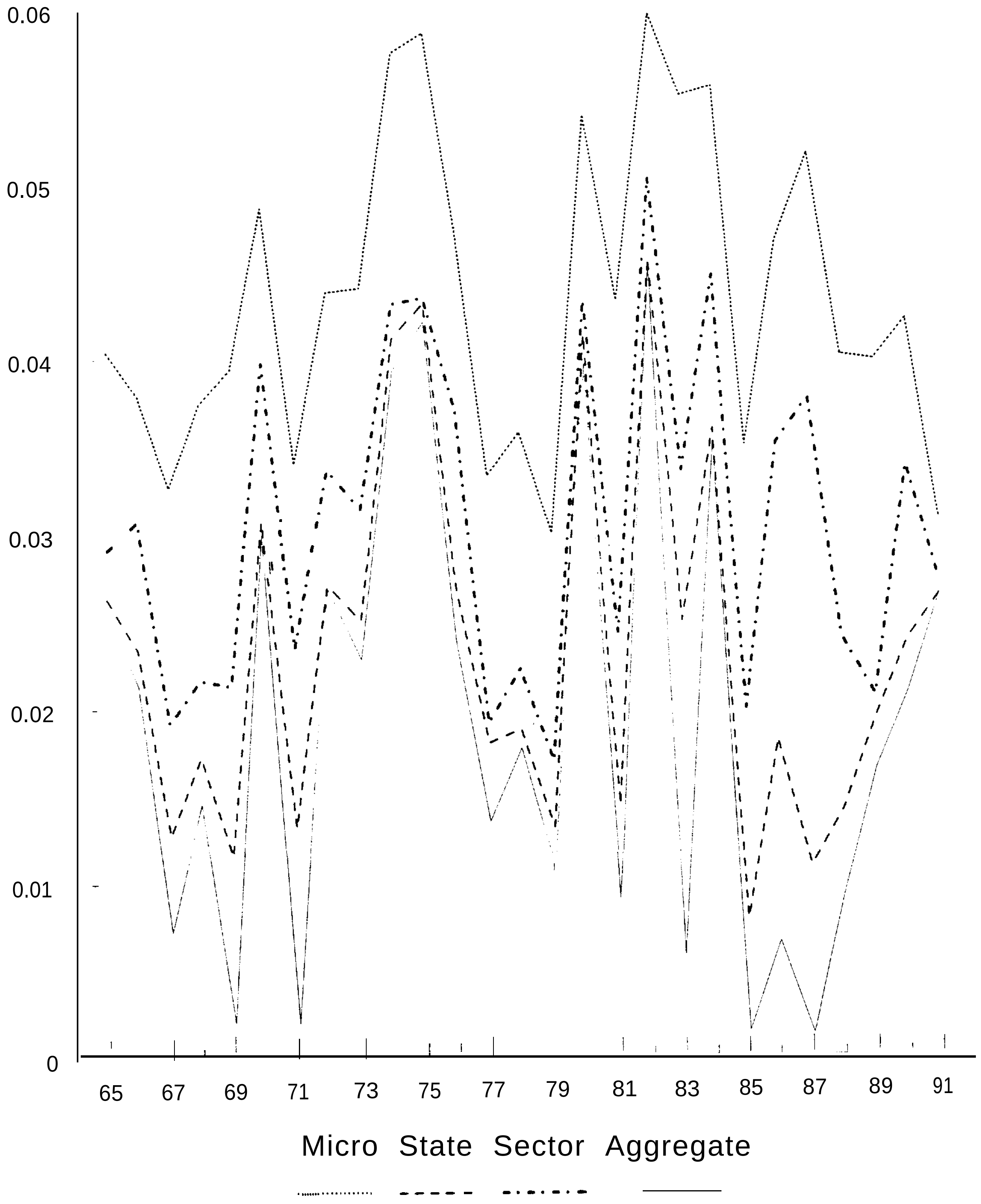


Table **7: Shocks: Size Versus Correlation**

Period	State Shocks				Sector Shocks				Share of Top Three	
	State-Weight		U.S.-Weight		Sector-Weight		U.S.-Weights			
	Size	Corr.	Size	Corr.	Size	Corr.	Size	Corr.	Sector	State
Full Sample	0.025	0.574	0.024	0.624	0.046	0.316	0.044	0.319	0.359	0.399
1965-1969	0.020	0.385	0.019	0.450	0.036	0.223	0.036	0.270	0.377	0.378
1970-1974	0.029	0.729	0.026	0.761	0.053	0.369	0.052	0.377	0.366	0.386
1975-1980	0.027	0.716	0.025	0.788	0.045	0.393	0.043	0.385	0.359	0.394
1980-1985	0.033	0.689	0.032	0.747	0.060	0.366	0.057	0.394	0.352	0.410
1986- 1990	0.018	0.357	0.016	0.401	0.040	0.188	0.038	0.119	0.348	0.417

value is taken), and thus on the extent of "diversification" permitted. The first measure allows diversification both within and across states and sectors. The second and third measure permit diversification within, but not across, sectors and states (and corresponds to the "state" and "sector" shocks). The fourth measure allows for no canceling of shocks: it measures the impact of all individual shocks and corresponds to the "micro" shocks above.

By virtue of the less than perfect correlation — within and across states and sectors — the size of the shock decreases as we move from the micro to the aggregate level. Moreover, as shown above, the sector shock is larger than the state shock because micro shocks are more correlated within a sector than within a state.

The differences across these alternative shock measures have a direct bearing on stabilization policies aimed at containing the employment consequences of shocks. If labor is completely mobile across sectors and states, the shock to U.S. output is the appropriate focus of stabilization policy. If labor mobility is restricted, however, stabilization of aggregate output goes only a small way towards reducing employment swings. To the extent that labor cannot move across sectors — perhaps because of sector-specific human capital

— sectoral stabilization policy is more effective; to the extent that labor is restricted to a particular state, geographical stabilization is required. If there are costs to mobility along both dimensions, then stabilization policy might be most effective on the micro level of individual sectors in individual states — textiles in Texas, rather than textiles or Texas.

4 Conclusion

This paper asks a simple question: What drives the business cycle, geographical or sectoral shocks? It turns out that the answer depends very much on the level of aggregation.

At the level of an individual sector in a particular state, it is the sectoral dimension which dominates. The fate of the textile sector in Texas is determined by the fate of textiles in the U.S., not by the business cycle of Texas. In consequence of the greater correlation along the sector than along the state dimension, the average absolute shock to sectors exceeds the average absolute shock to states. Put differently: there is more diversification across sectors within a state than across states within a sector. To a reasonable approximation, therefore, most shocks at a disaggregated level can be attributed to sector-specific disturbances such as technology or sector-specific taste shocks.

At the level of the aggregate U.S. business cycle, the relative importance of sector and state shocks depends upon both their average size and on their correlation *across* sectors and states. While sector shocks are larger, they are less correlated across sectors: California tends to move with Oregon more than chemicals move with textiles. As a result, sectoral aggregation "diversifies away" shocks to sectors to a greater extent than geographical aggregation diversifies away shocks to states. Therefore, shocks to states have considerable explanatory power for movements of aggregate output.

By extension, changes in aggregate business cycle volatility can also be attributed to one of two causes: changes in the average size of shocks hitting the components of aggregate output, and changes in the bunching of these shocks. A priori, it is perfectly possible for the volatility of aggregate output to change while the volatility of state and sector output remains constant. In the data, we find that the two elements have moved together over the last thirty years: the early 1970s saw a sizable increase in both the average size of shocks to sectors and states, and their correlation across states and sectors; the late 1980s saw a decline in both. Looking forward, the explanation of these changes in the average size of shocks and their geographical and sectoral correlation poses an interesting research challenge.

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