Is Risk Sharing in the United States A Regional Phenomenon?

By Bent E. Sorensen and Oved Yosha

Regions within the United States routinely experience economic fluctuations that differ from those of other regions. For example, in the past few years, falling wheat prices have slowed growth in the value of total output in Kansas. Such developments can pose concerns for policymakers because macroeconomic tools like monetary policy affect all regions, not just specific regions. Fortunately, several mechanisms help insulate regional income and consumption from region-specific output fluctuations. Diversification of asset ownership across regions, made possible by national capital markets, smoothes regional income and, in turn, consumption. The federal tax system also helps protect regional income and consumption from region-specific changes in output. Finally, adjustments to saving further insulate consumption from variation in output. In effect, each of these mechanisms mitigates the effect of region-specific economic fluctuations by pooling risks across regions—by providing *risk sharing*.

Although earlier research has documented the pattern of risk sharing for the United States as a whole, patterns may differ across broad regions of the nation.[1] Eastern states, for example, may benefit more from income smoothing through capital markets due to their proximity to Wall Street. Moreover, geographic distance may affect whether and how risk is shared. For instance, it may be easier for Kansas residents to own property, such as a farm or hotel, in Colorado than in Massachusetts. Similarly, business owners in Kansas are more likely to obtain loans in Missouri than in New York. In this case, geography may affect the ability of risk sharing to mitigate region-specific fluctuations in output. Because geography matters, this article examines whether risk sharing occurs more in some regions than in others and whether risk sharing is greater within large regions of the United States than between regions.

The first section of the article presents the conceptual framework of risk sharing and develops a method for estimating the amount of risk sharing provided by different mechanisms. The second section reports estimates of risk sharing patterns within and across a set of large U.S. regions. These estimates reveal some important regional differences. Moreover, the estimates indicate there is more overall risk sharing within regions than between regions. The risk sharing provided by capital markets and the federal tax system is essentially the same within

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and across regions, implying that these are nationwide mechanisms. In contrast, risk sharing through saving adjustments is more local, occurring just within regions.

I. RISK SHARING: CONCEPTS AND MEASUREMENT

Risk sharing reduces the volatility of regional income and consumption. Suppose, for example, that risks are shared within a particular group of states. The pooling of risks essentially makes the income and consumption of an individual state depend on the output of the group rather than solely on the state's own output. Because the total output of a group is generally less variable than that of a single state, risk sharing lowers the volatility of state-level income and consumption.[2]

The potential for risk sharing appears to be considerable. Chart 1 compares growth in output per capita for an illustrative group of states to growth in the nation's output per capita, using gross state product (GSP) to measure state output and gross domestic product (GDP) as the measure of national output. As shown in the chart, just as output is generally more volatile for a single state than for a group of states, growth in state output is generally more variable than growth in the nation's output. And, as expected, smaller states or states heavily dependent on a single industry—Maine or Louisiana, for example—have more volatile GSP growth than larger, more economically diverse states such as California and Florida.[3]

A conceptual framework

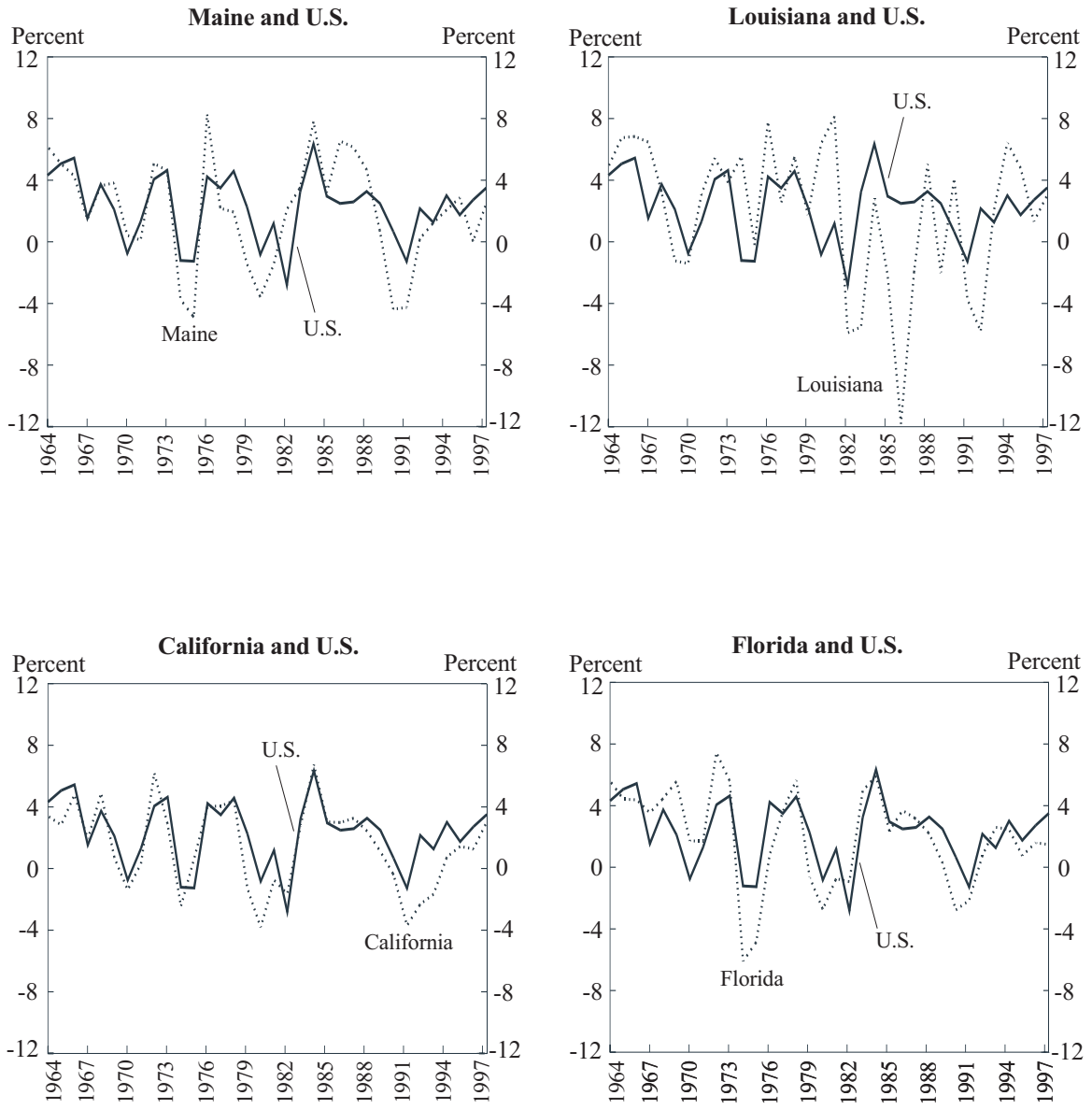
Three mechanisms allow regions, such as states, to share region-specific risk. One mechanism is capital market income smoothing—simply referred to as *income smoothing* in this article—which results from interstate ownership of productive assets. Interstate ownership of assets makes state-level income smoother than state output, in the sense that a state's income will be partly insulated from fluctuations in its output. By smoothing income, interstate ownership of assets also helps insulate state-level consumption spending from fluctuations in output.

For example, suppose farmers in Corn Belt states hold much of their savings in investment portfolios that are heavily invested in assets in other states, such as California. Through their savings portfolios, these Corn Belt residents may own considerable amounts of property and stock of firms in Silicon Valley. In a drought year, crop output may drop severely, but the income of Corn Belt residents will typically fall less than output if part of their income comes from investments in Silicon Valley. Conversely, in an exceptionally good crop year, the overall income of Corn Belt states generally will rise by less than the increase in their output.

Financial instruments such as stocks, options, and futures, as well as standard insurance policies against natural disasters, facilitate this type of smoothing. Well-functioning and accessible capital markets are essential for diversification of ownership and the income smoothing it provides. Of course, the individual who purchases derivative securities, or insurance, will not have state-level income smoothing in mind. But in the case of a statewide economic downturn or calamity (for example, flooding), the less volatile income of individuals will also render state-level income less volatile (if large numbers of individuals have purchased flood insurance).

A second mechanism that provides risk sharing is federal disposable income smoothing—or simply *disposable income smoothing*—which results from the system of federal taxes and transfer payments. Because the federal tax code is progressive, residents of states that do well in a given year make higher than average tax payments to the federal government. As a result, disposable income rises relatively less than income. Transfers, of which social security and Medicare benefits are the largest by far, tend to

Chart 1
OUTPUT GROWTH IN SELECTED STATES AND THE NATION



Note: State data are annual percent changes in GSP per capita. U.S. data are annual percent changes in GDP per capita.

vary little with state output and therefore contribute to reducing the volatility of disposable income in a state.[4] Thus, taxes and transfers at least partly insulate a state's disposable income from fluctuations in its income.[5] In turn, disposable income smoothing helps reduce the volatility of state-level consumption.

The third mechanism for risk sharing is *consumption smoothing*, which involves making adjustments to the saving rate and to wealth portfolios through borrowing and lending or buying and selling assets. For example, when oil prices fall, Oklahomans can save a smaller fraction of their disposable income or sell real estate and financial wealth to New Yorkers, allowing them to reduce their consumption more moderately despite their unusually low oil revenues. Oklahomans may also borrow from other states, directly or through financial institutions, to smooth their consumption. Such behavior makes the state's consumption less volatile than its disposable income.

In principle, each of these three mechanisms can provide risk sharing. Their relative effectiveness, though, depends on the persistence of fluctuations in state output. If state-specific booms and recessions are short-lived, income smoothing, disposable income smoothing, and consumption smoothing are all viable (and virtually equivalent). For example, income from a mutual fund can help a worker smooth a drop in wages caused by a temporary layoff. In this case, portfolio diversification provides a form of insurance against income fluctuations. Even in the absence of mutual fund income, the worker might be able to smooth consumption by borrowing on a credit card. As a result, in the face of temporary fluctuations in state output, either diversification of ownership portfolios or borrowing and lending can smooth consumption spending in the state.

If changes in state output are long-lasting, however, they cannot be smoothed through saving adjustments. Only income smoothing and disposable income smoothing can insulate income and consumption from long-lasting changes in output. If a worker's wage income drops permanently—due to physical disability, for instance—neither changes in the rate of saving nor borrowing will allow the worker to maintain the same standard of living. Only alternative income sources such as mutual funds or some other form of insurance can allow the worker to maintain his previous level of spending.

Measuring the risk sharing achieved through the three mechanisms

The measurement of how much risk sharing is achieved in practice is based on the concept of full risk sharing. If income smoothing through capital markets allows risks to be fully shared among a group of states, generally accepted economic theory indicates that the income of every state is a fixed fraction of the pooled income of the group.[6] This has several important implications. First, because a state's income is dependent on only the pooled income of the group of states, the income of a state depends on its output only to the extent that changes in its output affect the group's income. Second, risk sharing cannot diversify away fluctuations of the pooled income of the group.[7] Income smoothing reduces income volatility by pooling the individual risks faced by states, effectively making the average of those risks equal zero. But risk sharing cannot mitigate volatility due to groupwide risks because there is no way to diversify away such risks.

The third implication of full risk sharing through income smoothing is that the income of all the states in the group will grow at the same rate—at the rate the pooled income grows. Moreover, because income is fully insulated from state-specific fluctuations in output, disposable income and consumption are also fully insulated from these fluctuations. As a result, each state's disposable income and consump-

tion will grow at the rates of disposable income and consumption for the group. These growth rate implications of full risk sharing are essential for measuring the amount of risk sharing achieved in practice.[8]

In the event full risk sharing is not achieved through income smoothing, it may be achieved in conjunction with disposable income smoothing and consumption smoothing. For example, the combined smoothing provided by capital markets and federal taxes and transfers may be necessary to achieve full risk sharing. Then the growth rate of each state's income would differ, but each state's disposable income would grow at the same rate. As long as some combination of mechanisms yields full risk sharing, the consumption of all the states in the risk sharing group will grow at the same rate.

Of course, risk sharing may not be full in practice. But the properties of full risk sharing lead to simple regressions that measure, for a given risk sharing group, how much smoothing actually takes place through each mechanism. These regressions are estimated using data over time and across states on output, income, disposable income, and consumption.[9]

The regressions estimated for a given risk sharing group measure the average fraction of state-specific output fluctuations absorbed by each risk sharing mechanism. State-specific output fluctuations are defined as fluctuations in state output per capita minus fluctuations in the group's pooled output per capita. More precisely, state-specific output growth (of state *i* in year *t*) is measured as $\Delta gsp_{it} - \Delta gsp_t$, where Δgsp_{it} denotes the growth rate of state *i*'s GSP per capita and Δgsp_t denotes the growth rate of the group's aggregate GSP per capita. The reason for using state-specific growth rates is that risk sharing cannot smooth fluctuations in the pooled output of the group. Therefore, to measure the amount of risk that is shared among states, aggregate output fluctuations must be removed from the state-level fluctuations to isolate smoothable output fluctuations.

In addition to state-specific growth rates of GSP, the regressions use state-specific growth rates of state income, state disposable income, and state consumption, all in per capita terms. State-specific income growth, $\Delta si_{it} - \Delta si_t$, is the growth rate of income per capita in state *i* relative to the growth rate of income per capita for the entire risk sharing group. The state-specific growth rates of disposable income and of consumption are defined in the same way and are denoted $\Delta dsi_{it} - \Delta dsi_t$ and $\Delta c_{it} - \Delta c_t$ respectively.

Measuring income smoothing. An estimate of the amount of income smoothing provided by capital markets is obtained from the coefficient β_I in the following regression:[10]

$$(\Delta gsp_{it} - \Delta gsp_t) - (\Delta si_{it} - \Delta si_t) =$$

$$\alpha_I + \beta_I (\Delta gsp_{it} - \Delta gsp_t) + \varepsilon_{it}. \qquad (1)$$

To see why, suppose that income smoothing yields full risk sharing, causing the income of all the states in the risk sharing group to grow at the same rate. Then state-specific income growth, $\Delta si_{it} - \Delta si_t$, is always zero, and the variable on the left side of equation (1) equals just state-specific GSP growth. In this case, equation (1) simplifies to a regression of state-specific GSP growth on itself, and the coefficient β_I equals one. At the other extreme, if there is no income smoothing, changes in state GSP lead to identical changes in state income. Then state-specific income growth equals state-specific GSP growth, making the variable on the left side of equation (1) equal zero. In this case, equation (1) simplifies to a regression of a variable that is always zero on state-specific GSP growth, so the coefficient β_I equals zero. In general, β_I will be between zero and one, with more interstate income smoothing yielding a larger coefficient.

To illustrate, consider a one-percentage-point increase in $\Delta gsp_{it} - \Delta gsp_t$, the variable on the right side of regression equation (1). If capital markets smooth an average of 40 percent of state-specific fluctuations in GSP, 60 percent of the increase in $\Delta gsp_{it} - \Delta gsp_t$ will pass through to income growth. Then $\Delta si_{it} - \Delta si_t$ will increase 0.6 percentage point. The difference between state-specific GSP and income growth, the variable on the left side of equation (1), then rises 0.4 percentage point. In this case, β_I, which measures the fraction of state-specific fluctuations in GSP growth smoothed on capital markets, equals 0.4.

Measuring disposable income smoothing. Similarly, an estimate of the amount of disposable income smoothing is obtained from the coefficient β_{DI} in the regression

$$(\Delta si_{it} - \Delta si_t) - (\Delta dsi_{it} - \Delta dsi_t) =$$

$$\alpha_{DI} + \beta_{DI}(\Delta gsp_{it} - \Delta gsp_t) + \varepsilon_{it}. \qquad (2)$$

This regression captures the extent to which disposable income responds less to fluctuations in GSP than does income. The lower response of disposable income to fluctuations in GSP growth is a consequence of the smoothing effect of federal taxes and transfers.

The regression is best understood by returning to the example given earlier. Consider a one-percentage-point increase in $\Delta gsp_{it} - \Delta gsp_t$ and suppose that 40 percent of state-specific fluctuations in GSP growth are smoothed on capital markets, so that $\Delta si_{it} - \Delta si_t$ increases 0.6 percentage point. If federal taxes and transfers smooth an average of an additional 10 percent of state-specific fluctuations in GSP growth, the total smoothing of disposable income provided by capital markets and federal taxes and transfers is 50 percent. As a result, state-specific growth in disposable income, $\Delta dsi_{it} - \Delta dsi_t$, increases 0.5 percentage point. Then the difference between state-specific income and disposable income growth, the variable on the left side of equation (2), rises 0.1 percentage point. Therefore, the coefficient β_{DI} is 0.1, corresponding to the fraction of GSP fluctuations absorbed by disposable income smoothing.[11]

Measuring consumption smoothing. An estimate of the amount of consumption smoothing is obtained from the coefficient β_C in the regression

$$(\Delta dsi_{it} - \Delta dsi_t) - (\Delta c_{it} - \Delta c_t) =$$

$$\alpha_C + \beta_C(\Delta gsp_{it} - \Delta gsp_t) + \varepsilon_{it}. \qquad (3)$$

This regression captures the extent to which consumption responds less to fluctuations in GSP than does disposable income. The estimate of β_C corresponds to the fraction of state-specific fluctuations of GSP growth that is absorbed by consumption smoothing. Continuing the earlier example, if consumption smoothing absorbs an additional 20 percent of fluctuations in GSP, the total smoothing of consumption provided by capital markets, federal taxes and transfers, and saving adjustments is 70 percent. In this case, a one-percentage-point rise in state-specific GSP growth causes state-specific consumption growth, $\Delta c_{it} - \Delta c_t$, to increase 0.3 percentage point, while state-specific growth in disposable income, $\Delta dsi_{it} - \Delta dsi_t$, rises 0.5 percentage point. Then the variable on the left side of equation (3) increases 0.2 percentage point, yielding β_C = 0.2.

Measuring the overall departure from full risk sharing. Because income smoothing, disposable income smoothing, and consumption smoothing may not yield full risk sharing, it is important to measure the departure from full risk sharing. The coefficient β_U in the following regression provides this estimate:[12]

$$(\Delta c_{it} - \Delta c_t) =$$
$$\alpha_U + \beta_U(\Delta gsp_{it} - \Delta gsp_t) + \varepsilon_{it} \qquad (4)$$

The coefficient β_U measures the average fraction of state-specific fluctuations of GSP growth that is unsmoothed, that is, not absorbed through any smoothing mechanism. If risk sharing is full, state-specific consumption growth equals aggregate consumption growth. In this case, the variable on the left side of equation (4) equals zero, so $\beta_U = 0$. But if risk sharing is not full, changes in state-specific output lead to changes in state-specific consumption, and $\beta_U > 0$. In the example above, the three risk sharing mechanisms smooth a total of 70 percent of state-specific GSP fluctuations. As a result, a one-percentage- point rise in state-specific GSP growth causes state-specific consumption growth to increase 0.3 percentage point. Thus, $\beta_U = 0.3$.

By construction, the regressions described in this section provide a complete decomposition of state-specific fluctuations in GSP growth. The fluctuations are divided into the fractions smoothed by each of the three smoothing mechanisms and the fraction not smoothed. In particular, the coefficient estimates satisfy $\beta_I + \beta_{DI} + \beta_C + \beta_U = 1$.[13]

II. ESTIMATES OF RISK SHARING PATTERNS

The regressions described in the last section yield estimates of the patterns of risk sharing. After describing some of the data used in the regressions, this section compares the patterns of risk sharing within large U.S. regions to patterns within the United States as a whole. The patterns differ along some important dimensions. For example, states in the central United States achieve less income smoothing through capital markets and rely relatively more on consumption smoothing, while the opposite is true for eastern states.

To determine whether risk sharing is impeded by geographic distance, this section also examines the patterns of risk sharing across large regions of the United States. In this analysis, the basic regression methodology is modified simply by replacing an individual state with a larger region, such as the east, and the risk sharing group consists of all the U.S. regions. If the coefficients are lower in the regressions using large regions that span the entire United States than in the regressions using states within particular regions, distance is a barrier to risk sharing. The regression results show that there is no consumption smoothing across larger regions, while income smoothing and disposable income smoothing are independent of distance.

Data

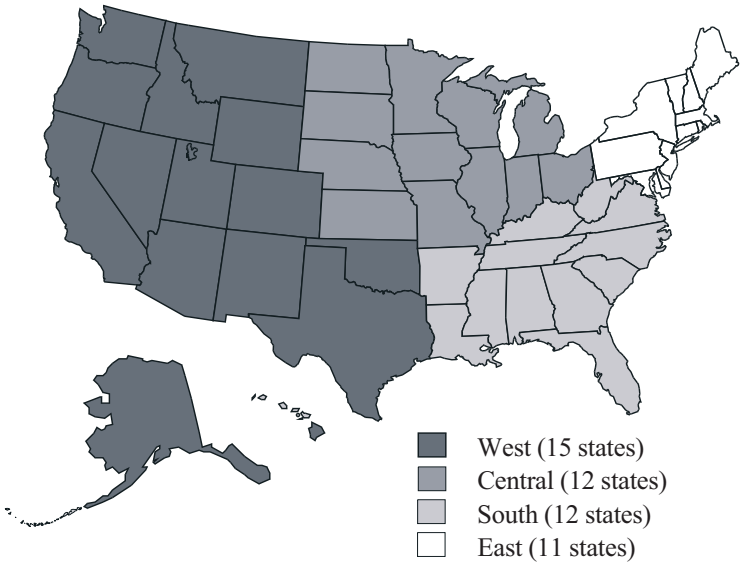
This section defines state income, disposable income, and consumption – variables for which data are not published directly – and the broad regions used in the analysis. The appendix describes the data in greater detail.

The variable state income is an estimate of the total income that the residents and government of a state would have at their disposal if there were no federal government (Asdrubali, Sorensen, and Yosha).[14] Disposable state income is simply defined as state income minus federal taxes, plus federal transfers.[15] Because the construction of the state income series from the underlying data sources is difficult, the data set used in the regression analysis, the same as that used by Asdrubali, Sorensen, and Yosha, has not been updated past 1990.[16]

State consumption is approximated as the sum of retail sales and state government consumption. Retail sales data provide a proxy for household spending. State government consumption is defined as government expenditures minus transfer payments.

The four broad regions used in the regression analysis are aggregates of official regions defined by the BEA. Figure 1 shows the precise definitions of the regions, simply referred to as east, west, south, and central.

Figure 1
REGION DEFINITIONS



Note: The map defines the aggregate regions used in the regression analysis.

Risk sharing within regions

The estimates of risk sharing among all 50 U.S states are shown in the first column of Table 1.[17] A central empirical finding is that, over the 1963-90 period, 39 percent of GSP fluctuations were smoothed through capital markets. The disposable income smoothing provided by federal taxes and transfers absorbed only 14 percent of GSP fluctuations, on average. Consumption smoothing absorbed 25 percent.[18] Finally, 23 percent of fluctuations were not smoothed at all, implying that full risk sharing was not achieved.[19]

There are some important regional differences in risk sharing patterns (Table 1). Although risk sharing within the east group was very similar to the nationwide pattern, risk sharing within the central group was clearly different. While income smoothing absorbed 39 percent of state-specific GSP fluctuations in the nationwide estimates, only 28 percent were absorbed through this mechanism in the central group. Surprisingly, consumption smoothing was so large in the central group that consumption by states in this region was totally buffered from GSP fluctuations. In other words, the central group achieved full risk sharing as measured by consumption.

A systematic search for an explanation of these patterns is beyond the scope of this article, but they might be largely explained by industrial structure. Agricultural states like those in the central group typically achieve less income smoothing, but show a high degree of consumption smoothing, which is fully consistent with

Table 1

ESTIMATES OF THE SOURCES OF RISK SHARING WITHIN REGIONS

Percent of state-specific GSP fluctuations smoothed

	Region				
	U.S.	East	Central	South	West
Income smoothing	39	36	28	47	46
	(1)	(3)	(3)	(3)	(2)
Disposable income smoothing	14	14	10	15	14
	(1)	(3)	(1)	(1)	(1)
Consumption smoothing	25	17	61	28	21
	(4)	(3)	(7)	(7)	(6)
Unsmoothed	23	33	2	11	19
	(3)	(12)	(5)	(7)	(5)

Note: Each column of figures reports estimates of the sources of risk sharing among states within the identified group. The entries of each column may not sum to 100 because of rounding. Each entry in parentheses is the standard error of the estimated percentage reported above the standard error. The estimates are based on the period 1963-90.

these findings (Asdrubali, Sorensen, and Yosha). Three underlying factors may help explain this phenomenon. First, during the 1963-90 period, many farms did not have the opportunity to issue stocks on organized markets. Second, farmers tended to have their assets tied up in their own farm. These factors precluded substantial amounts of income smoothing through capital markets. Third, fluctuations of agricultural output are often less persistent than those of, say, manufacturing output. A bad harvest due to weather conditions will typically not repeat itself for years on end, so it makes sense for farmers to maintain the same level of consumption in a bad year by saving less or borrowing more.

The patterns of income and consumption smoothing in the south and west groups also differed from nationwide patterns, as well as from those in the central group. In the south and west groups, capital markets provided relatively extensive income smoothing. Again, this may be due to industrial structure. States in the south and west are rich in natural resources. Because these resources are often owned by large corporations, states with a large amount of resource extraction displayed considerable income smoothing (Asdrubali, Sorensen, and Yosha). For example, the value of Alaskan oil production and, in turn, Alaskan GSP varies widely from year to year because oil prices are highly variable. However, most of the income from Alaskan oil extraction goes to large oil companies owned by stockholders located far from Alaska, while the wages of Alaskans working in the oil industry vary relatively little with the price of oil, leading to substantial income smoothing.

Table 2

ESTIMATES OF THE SOURCES OF RISK SHARING ACROSS LARGE REGIONS

Percent of region-specific GSP fluctuations smoothed

Income smoothing	40
	(4)
Disposable income smoothing	14
	(2)
Consumption smoothing	-10
	(8)
Unsmoothed	56
	(7)

Note: The table entries are estimates of the sources of risk sharing across the east, west, south, and central regions. Each entry in parentheses is the standard error of the estimated percentage reported above the standard error. The estimates are based on the period 1963-90.

Risk sharing across regions

Just as the patterns of risk sharing within regions vary, the patterns of risk sharing across large U.S. regions differ somewhat from patterns across states. Over the 1963-90 period, essentially no consumption smoothing occurred across the east, west, south, and central regions (Table 2). The point estimate indicates that consumption smoothing between regions was negative, although not statistically different from zero, and is interpreted as zero.

The absence of consumption smoothing across large regions means that regional consumption closely tracks region-specific fluctuations in disposable income. There are two potential explanations for this finding. One explanation may be that, because credit markets tend to be regional in nature, regions do not borrow from each other. In particular, over the 1963-90 period, interstate banking was severely limited in the United States, making borrowing across regions more difficult. A second explanation is that individuals may base their own spending on the observed spending habits of other people (Duesenberry). Such behavior could make a state's consumption more similar to the consumption levels of nearby states than to those of distant states.

In contrast, income smoothing was virtually the same across large regions as across states. These results strongly indicate that U.S. capital markets transcend geography. For example, most pension and mutual funds are highly diversified geographically across the United States.[20] Similarly, the amount of income smoothing due to federal taxes and transfers was virtually the same across large regions as between the states within the regions. This is not surprising since the federal tax code and transfer programs do not include special features for particular regions in the United States.

With geography having no effect on income and disposable income smoothing but preventing consumption smoothing across large regions, in total there appears to be less risk sharing across broad regions than across states within regions. This finding means risk sharing is more effective at mitigating output fluctuations that are specific to states than output fluctuations that affect an entire region of the United States. Therefore, policymakers should be more concerned by regionwide variation in output than by variation in an individual state's output.

III. CONCLUSION

This article has identified three mechanisms through which risk is shared across regions of the United States: income smoothing through

capital markets, disposable income smoothing through federal taxes and transfers, and consumption smoothing through saving adjustments. Building on previous research, the article estimated empirically how much each of these mechanisms contributes to risk sharing. For the period 1963-90, income smoothing was by far the most important source of risk sharing.

The article further examined whether risk sharing within four major regions of the United States exhibits similar patterns, finding clear regional differences in income and consumption smoothing but small differences in disposable income smoothing. States within the central United States rely relatively less on income smoothing than on consumption smoothing, while the opposite is true for states in the west and south. These patterns likely reflect industrial structure, in particular regional differences in the dependence on agriculture versus natural resource extraction.

Finally, the article evaluated whether income and consumption smoothing are local in nature. The income smoothing provided by capital markets was found to be truly nationwide, transcending geographic barriers. Similarly, geographic distance has no effect on disposable income smoothing. Consumption smoothing, on the other hand, is significantly stronger among neighboring states. In fact, there is no consumption smoothing across large geographic regions, reflecting either the regional nature of credit markets or geographic patterns in consumption behavior. Overall, there is less risk sharing across broad regions than across states within regions.

APPENDIX

THE DATA

As detailed in Asdrubali, Sorensen, and Yosha, the data are drawn from a variety of sources. Data for GSP, the "value added" of all industries located in a state, are available from the Bureau of Economic Analysis (BEA).[21] Data on state population and personal income net of social security receipts (the sum of earnings and distributed profits, including interest and rent) are also available from the BEA. Income of state governments has been pieced together from many sources, most importantly *Governmental Finances* from the U.S. Bureau of the Census.

State income is defined as the sum of personal income net of transfers, federal nonpersonal taxes and contributions, interest on state and local government trust funds, and state and local government nonpersonal taxes. The logic is to add up all sources of income that would be available for a state, *ceteris paribus*, if there were no federal government. There is no official series that corresponds to this concept. To construct the income series, earnings and profits are calculated from the official BEA data for personal income, which are *pre-* personal income tax but *post-* all other federal taxes as well as *post-* social security contributions and transfers. Therefore, personal and employer social security contributions are added to the BEA personal income figures, and social security transfers are subtracted. Federal nonpersonal taxes, which include corporate taxes and indirect business taxes imputed to individual states, are added, as are state nonpersonal taxes. State governments are considered passive agents for the residents of a state. Therefore, in this accounting, taxes collected by the government of a state are available for consumption by the individuals in the state, possibly in the form of state public goods.[22] Finally, the (considerable) interest revenue from the state's trust funds is added to the measure of state income.

Disposable state income is defined as state income plus federal direct transfers to individuals in a state (for example, social security), plus federal grants to the government of the state, minus total federal taxes raised in the state (including social security contributions). Federal grants to states are published in the *Statistical Abstract of the United States*, whereas federal personal taxes are available by state from the BEA.

State consumption consists of consumption by the residents of the state and consumption by the state government. Annual retail sales by state is used as a proxy for private state consumption. Actual private consumption at the state level is not available, so retail sales are re-scaled by the ratio of total private consumption to total U.S. retail sales. Retail sales are a somewhat noisy proxy for state private consumption but they are the best available. State government consumption is defined as state expenditures minus state transfers.

The nominal values of GSP, income, disposable income, and consumption are converted to real terms using the consumer price index (CPI). Because the ultimate

benefit of risk sharing comes from reducing the volatility of consumption spending, this article focuses on the value of output and income in terms of the consumption they can allow. Accordingly, the CPI is used to deflate nominal output, income, disposable income, and consumption. Although the BEA publishes a GSP deflator for each state, the deflator is an index of the production value, rather than the consumption value, of output.

States are classified into four major regions, which are combinations of the eight official regions of the BEA (Beemiller and Dunbar). The regions used are New England and the Mideast (east), Great Lakes and Plains (central), Southeast (south), and Southwest, Rocky Mountain, and Far West (west). This article uses four regions rather than the official eight because more precise estimates are obtained when the number of states within each region is larger.

ENDNOTES

[1] Asdrubali, Sorensen, and Yosha were the first to consider the full set of risk sharing mechanisms in a unified framework. Prior studies (Mace; Cochrane; Townsend; Attanasio and Davis; Backus, Kehoe, and Kydland; and others) only considered overall smoothing of consumption.

[2] It should be stressed that risk sharing does not mean that income is redistributed across states. Ultimately, *every* state is better off when risk is shared.

[3] Using a specific economic model, Kalemli-Ozcan, Sorensen, and Yosha estimate, for individual U.S. states, the potential gains from U.S.-wide interstate risk sharing, and find them to be substantial and similar in magnitude to the gains from risk sharing among OECD countries.

[4] Grants to state governments, in particular Medicaid, also smooth state-level disposable income. But because direct federal transfers are much larger than grants to states, the term transfers will be used as shorthand for transfers and grants.

[5] Typically, systems of taxes and transfers are not primarily intended to provide risk sharing. The systems' main goals are to finance public goods and to redistribute income, but these activities will often result in smoothing of disposable income.

[6] Theoretical studies have shown that full risk sharing within a group of states implies the per capita consumption of every state is a fixed fraction of the pooled per capita consumption of the group. The main assumptions necessary to derive the result are that utility functions exhibit constant relative risk aversion and that all states discount future utility at the same rate. However, these theoretical studies do not distinguish income from consumption. As a result, in this article, the standard definition of full risk sharing is expanded to apply to income smoothing and disposable income smoothing.

[7] In terms of the information displayed in Chart 1, this means that risk sharing can smooth state-specific fluctuations in GSP growth, but not fluctuations in GDP growth for the entire United States.

[8] These characteristics of full risk sharing do not depend in any manner on the statistical properties of output fluctuations. Hence, no assumptions regarding the statistical properties of these fluctuations need to be made. In particular, this article makes no attempt to distinguish predictable and unpredictable fluctuations in output. Asdrubali, Sorensen, and Yosha found no difference in the smoothing of predictable and unpredictable fluctuations.

[9] This type of data set is known as a panel data set.

[10] In the actual estimation, the constant α_I is allowed to differ across states. That is, the regression actually includes state-specific "fixed effects." The same is true of the other regressions presented later in the article. The empirical results with and without fixed effects are very similar.

[11] If the combination of income smoothing and disposable income smoothing provides full risk sharing, then

state-specific disposable income growth, $\Delta dsi_{it} - \Delta dsi_t$, is zero (because the growth rates of state disposable income and aggregate disposable income are equal). In that event, β_I and β_{DI} sum to one. To see that this is indeed the case, rearrange equation (1) to get

$$\Delta si_{it} - \Delta si_t = constant + (1-\beta_I)(\Delta gsp_{it} - \Delta gsp_t) + \varepsilon_{it}.$$

If $\Delta dsi_{it} - \Delta dsi_t$ is zero, regression (2) is the same as this regression, with $\beta_{DI} = 1 - \beta_I$.

[12] Many risk sharing studies, including nearly all of those listed in note 1, have used regression equation (4) to test for full risk sharing.

[13] Asdrubali, Sorensen, and Yosha use a decomposition of the cross-sectional variance of state-level GSP growth to estimate the β coefficients. Their notation is slightly different, since they use the notation β_K for (capital market) income smoothing and β_F for (federal) disposable income smoothing.

[14] For a given state, the difference between state income and GSP is the income originating from—or going to—other states due to income smoothing. However, this measure overestimates the amount of smoothing achieved through capital markets because part of the measured smoothing should be attributed to corporate earnings retention patterns (it is well known that corporations tend to smooth dividend payments), but there are no data that would allow an allocation of corporate savings by state. The measure of income smoothing is also affected by capital depreciation, for which state-level data are also unavailable. Sorensen and Yosha compare interstate risk sharing in the United States to international risk sharing among OECD countries (for which both corporate earnings retention and capital depreciation data are available), and argue that most of the estimated income smoothing for U.S. states is indeed due to interstate ownership of assets.

[15] As indicated in note 4, the term transfers is used to include grants to state governments. Accordingly, measured state income includes the value of both direct transfers and grants.

[16] Ending the sample in 1990 also facilitates comparison to the results in previous studies.

[17] Asdrubali, Sorensen, and Yosha report nearly identical results, even though that study used a slightly different methodology. Instead of controlling directly for aggregate variables by using state-specific growth rates, Asdrubali, Sorensen, and Yosha removed groupwide fluctuations using time-specific dummy variables.

[18] Asdrubali, Sorensen, and Yosha performed similar regressions using 3-year intervals, rather than annual data. They found that income smoothing and disposable income smoothing vary little with the time interval. In contrast, there is nearly no consumption smoothing over 3-year intervals, underscoring the fact that consumption smoothing is only effective at mitigating short-term fluctuations.

[19] Nonetheless, in the United States as a whole, 77 percent of state-specific GSP fluctuations were smoothed on average. Sorensen and Yosha show that much less smoothing is achieved among OECD and European countries. Although many participants in the debate on European Monetary Unification (Sala-i-Martin and Sachs; Krugman) have discussed the need for a system of federal taxes and transfers to smooth country-specific shocks, capital markets are the most important source of smoothing in the United States.

[20] Coval and Moskowitz provide evidence that some fund managers invest more heavily in geographically close firms.

[21] Because the GSP data currently published by the BEA begin in only 1977, the recent GSP data have been spliced with previously published GSP data for the period 1963-76.

[22] State government taxes levied on personal income should, however, not be added since they are already counted as personal income.

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