Channels of Interstate Risk Sharing: United States 1963-1990

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CHANNELS OF INTERSTATE RISK SHARING: UNITED STATES 1963-1990*

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We develop a framework for quantifying the amount of risk sharing among states in the United States, and construct data that allow us to decompose the cross-sectional variance in gross state product into several components which we refer to as *levels of smoothing*. We find that 39 percent of shocks to gross state product are smoothed by *capital markets,* 13 percent are smoothed by the *federal government,* and 23 percent are smoothed by *credit markets.* The remaining 25 percent are not smoothed. We also decompose the federal government smoothing into subcategories: taxes, transfers, and grants to states.

I. INTRODUCTION

Many countries are considering entering economic and monetary unions. What can we learn about the degree of income and consumption smoothing they can hope to achieve, by looking at the states of the United States? How important is a central government relative to market institutions for income and consumption smoothing? To shed light on these issues, we study the patterns of risk sharing among U. S. states during the period 1963–1990. There are several channels through which risk sharing can occur in a federal regime. First, the members of the federation can share risk via cross-ownership of productive assets, facilitated by a developed capital market. Second, the tax-transfer system of the federation's central government is a vehicle for further income smoothing. Third, the members of the federation may smooth their consumption by adjusting their asset portfolio, for example through lending and borrowing on national credit markets. For brevity we call these levels of smoothing capital market, federal government, and credit market smoothing.

The scope for interstate risk sharing in the United States can be illustrated by the fact that state production per capita is more variable than nationwide production per capita. The ratios of the standard deviations of real per capita gross state product of the 50 states (for 1963–1990) to the standard deviation of gross domestic product range from 0.8 to 6, with an average of 2.

We develop a framework for quantifying the amount of interstate risk sharing achieved at each of these levels of smoothing in the United States. Our methodology, centered on a decomposition of the cross-sectional variance in gross state product, yields a relation of the following type: $1 = \beta_K + \beta_F + \beta_C + \beta_U$, where β_K, β_F, and β_C are the fractions of shocks to gross state product smoothed via capital markets, by the federal fiscal system, and via credit markets, and β_U is the fraction not smoothed. Our main objective is to estimate the components of this relation. For the period 1963–1990 we find that 39 percent of shocks to gross state product are smoothed by capital markets, 13 percent are smoothed by the federal government, and 23 percent are smoothed by credit markets. The remaining 25 percent are not smoothed. We compare our estimate of federal smoothing through the tax-transfer system with those of Sala-i-Martin and Sachs [1992] and von Hagen [1992].

We also decompose the federal government smoothing into subcategories: taxes, transfers, and federal grants to states. The most interesting findings are that federal grants to states smooth approximately 2.5 percent of shocks to gross state product, which is small compared with the smoothing through the federal tax-transfer system, and that unemployment insurance smoothes 1.7 percent. We repeat the analysis for three subperiods, 1963–1970, 1971–1980, and 1981–1990, finding a monotone increase in capital market income smoothing. Smoothing by the federal government increased from the sixties to the seventies, and has remained relatively stable since, in both amount and composition. The amount of credit market smoothing appears to be less stable through time, increasing sharply during the seventies but decreasing equally sharply in the eighties.

Next, we study how income and consumption smoothing vary with the frequency of the data used in the regressions. We find that the amount of credit market smoothing decreases considerably when the time elapsed between consecutive observations increases. We suggest a possible explanation, based on the idea that credit constraints may be more severe over a longer horizon. We

further estimate the persistence of shocks to gross state product in each state, finding that credit market consumption smoothing is considerably lower in states where shocks to gross state product are more persistent.

We classify states according to mineral extraction (mainly oil) and agricultural production, finding that "oil states" rely primarily on capital market smoothing, whereas "corn states" rely more on credit market smoothing. Finally, we find that changes in consumption are responsive to changes in the gross state product of neighboring states, suggesting that geographic proximity facilitates risk sharing.

The finding of less than full risk sharing is consistent with related empirical work on consumption smoothing in the United States (e.g., Cochrane [1991] and Crucini [1995]; however, see Mace [1991]), with work on international portfolio diversification and risk sharing (e.g., French and Poterba [1991], Canova and Ravn [1996], Obstfeld [1994], van Wincoop [1994], and Lewis [1996]), and with evidence of less than full risk sharing in village India [Townsend 1994]. The insurance role of the tax-transfer system has been studied by Sala-i-Martin and Sachs [1992], von Hagen [1992], Atkeson and Bayoumi [1993], Goodhart and Smith [1993], and Bayoumi and Masson [1995].

In the next section we present the variance decomposition, and discuss measurement and econometric issues. In Section III we present the results, and Section IV concludes.

II. Decomposing the Cross-Sectional Variance in Gross State Product

We do not distinguish between the citizens of a state and the government of the state, and regard the per capita gross product of each state as exogenous. We treat gross state product as a homogeneous nondurable good, so our analysis ignores capital as well as capital gains and losses. With full risk sharing, consumption in each state is a fixed proportion of aggregate output, regardless of the nature of the stochastic process governing shocks to gross state product.[1]

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1. For detailed derivations of similar results, see, e.g., Huang and Litzenberger [1988 Chapter 5], Cochrane [1991], Attanasio and Davis [1994], and Townsend [1994].

Let *gsp, si, dsi,* and *c* denote per capita gross state product, state income, disposable state income, and state consumption. State income *si* includes dividend, interest, and rental income payments across state borders; disposable state income *dsi* includes federal taxes and transfers.[2] If there is full risk sharing after capital market smoothing, *si* should not comove with *gsp*. If full risk sharing is not achieved, there is scope for further income smoothing by the federal tax-transfer system.[3] If full risk sharing is achieved at this level, *dsi* should not comove with *gsp*. Otherwise, there is scope for further consumption smoothing on asset markets. If full risk sharing is achieved after all the channels of smoothing, *c* will not vary with *gsp* for a given level of aggregate output. Although testing for full risk sharing is implicit in our methodology, our main objective is to break down the observed risk sharing (whether full or not) into its components.[4]

We turn to the decomposition of the period-by-period, cross-sectional variance in gross state product. For the moment, we suppress the time index. Consider the identity,

$$(1) \qquad gsp^i = \frac{gsp^i}{si^i} \frac{si^i}{dsi^i} \frac{dsi^i}{c^i} c^i,$$

where *i* is an index of states. Smoothing takes place via capital markets, the tax-transfer system, and credit markets if gsp^i/si^i, si^i/dsi^i, and dsi^i/c^i vary positively with gsp^i, namely an increase in gsp^i entails a smaller increase in si^i, which in turn entails an even smaller increase in dsi^i, and so forth.

In order to obtain a simple measure of smoothing from the identity in (1), we take logs and differences, multiply both sides by $\Delta \log gsp^i$ and take expectations, obtaining the following decomposition of the cross-sectional variance in *gsp*:

$$\begin{aligned} \text{var}\{\Delta \log gsp\} = \quad & \text{cov}\{\Delta \log gsp, \Delta \log gsp - \Delta \log si\} \\ & + \text{cov}\{\Delta \log gsp, \Delta \log si - \Delta \log dsi\} \\ & + \text{cov}\{\Delta \log gsp, \Delta \log dsi - \Delta \log c\} \\ & + \text{cov}\{\Delta \log gsp, \Delta \log c\}. \end{aligned}$$

2. Conceptually, these variables are linked through the following identities: *si* = *gsp* + net factor income; *dsi* = *si* + federal transfers − federal taxes; and *dsi* − *c* = savings.
   3. The federal tax-transfer system is not primarily intended to provide risk sharing. However, a redistributive policy may turn out to have smoothing effects.
   4. In most of our analysis we do not take interstate migration into account. If workers were extremely mobile, migrating whenever the slightest shock hit

Divide by the variance of $\Delta \log gsp$ to get

$$(2) \qquad 1 = \beta_K + \beta_F + \beta_C + \beta_U,$$

where β_K is the ordinary least squares (OLS) estimate of the slope in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$, β_F is the slope in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C is the slope in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U is the coefficient in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$. We interpret β_K, β_F, and β_C as the incremental percentage amount of smoothing achieved at each level, and β_U as the amount not smoothed. If $\beta_U = 0$, there is full risk sharing, and the coefficients β_K, β_F, and β_C sum to 1. Otherwise, they sum to less than one. We do not constrain any of the β coefficients, at any level, to be positive or less than one. Therefore, if there is dis-smoothing at some level, it will be reflected in a negative value of β.

At the practical level, we run the panel regressions,

$$(3) \qquad \Delta \log gsp_t^i - \Delta \log si_t^i = \nu_{K,t} + \beta_K \, \Delta \log gsp_t^i + u_{K,t}^i,$$
$$\Delta \log si_t^i - \Delta \log dsi_t^i = \nu_{F,t} + \beta_F \, \Delta \log gsp_t^i + u_{F,t}^i,$$
$$\Delta \log dsi_t^i - \Delta \log c_t^i = \nu_{C,t} + \beta_C \, \Delta \log gsp_t^i + u_{C,t}^i,$$
$$\Delta \log c_t^i = \nu_{U,t} + \beta_U \, \Delta \log gsp_t^i + u_{U,t}^i,$$

where $\nu_{.,t}$ are time fixed effects. The β coefficients will then be weighted averages of the year-by-year cross-sectional regressions.[5] The time fixed effects capture year-specific impacts on

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their region of residence, differences in per capita gross state product would not last long. Most of the smoothing would be achieved prior to any activity in the channels of risk sharing we study. However, although there is considerable labor mobility in the United States, it involves long lags [Barro and Sala-i-Martin 1991; Blanchard and Katz 1992], so there is ample scope for interstate income and consumption smoothing. This issue is briefly addressed in the next section. We also ignore the potential utility smoothing effect of federal public goods. If the federal government indeed provides more public goods to depressed states, then we underestimate the smoothing role of the federal government. Finally, we regard the United States as a closed economy. That is, we ignore all forms of international risk sharing. If the federal government borrows abroad and spends the money on transfers or grants to states, the resulting smoothing will be picked up as part of our measure of federal government smoothing. If individual states (or citizens) borrow and lend internationally, our methodology will attribute the resulting smoothing to consumption smoothing. The finding of French and Poterba [1991], that there is very little international risk sharing, suggests that this is not a serious omission.

5. A typical coefficient of the time fixed effect regression is $\hat{\beta}_y = \Sigma_t \Sigma_i (gsp_t^i - \overline{gsp}_t) y_t^i / \Sigma_t \Sigma_i (gsp_t^i - \overline{gsp}_t)^2$, where y is a left-hand-side variable, and $\overline{gsp}_t$ is average gsp across states in period t. In a cross-sectional regression for period t, $\hat{\beta}_{y,t} = \Sigma_i (gsp_t^i - \overline{gsp}_t) y_t^i / \Sigma_i (gsp_t^i - \overline{gsp}_t)^2$. Thus, $\hat{\beta}_y$ is a weighted average of the $\hat{\beta}_{y,t}$ coefficients with weights $\Sigma_i (gsp_t^i - \overline{gsp}_t)^2 / \Sigma_t \Sigma_i (gsp_t^i - \overline{gsp}_t)^2$. The least squares estimator gives higher weight to years with larger cross-sectional variation in the regressor since they are more informative about risk sharing.

growth rates, most notably the impact of the growth in U. S. Gross Domestic Product. Using these equations, we measure the degree to which changes in *gsp* affect, e.g., same year state consumption. We do not claim that changes in *gsp* are fully unpredictable and that lagged *gsp* does not affect current consumption. Rather, we start by exploring smoothing at the annual frequency and take a closer look at dynamic issues later.

The sum of capital market and credit market smoothing constitutes the fraction of shocks smoothed through transactions on markets. An important distinction between these forms of smoothing is that capital market smoothing is a result of ex ante arrangements, prior to the occurrence of shocks, whereas credit market smoothing takes place ex post, after shocks occur. Capital markets can provide insurance against persistent as well as transitory shocks. By holding claims to output in other states citizens smooth temporary shocks to their home gross state product, for example, an exceptionally bad crop, as well as more permanent shocks such as the decline of a particular industry. By contrast, credit markets typically smooth only transitory shocks, since lenders in other states are reluctant to grant credit to states that are hit by shocks that are expected to persist. Furthermore, smoothing negative shocks through the sale of assets is more difficult when shocks are permanent since it requires selling large amounts (e.g., one's house) which is costly and time consuming.

Data

We describe the main sources of data and the methodology for constructing the various measures of smoothing. Further details are provided in the Appendix.

Gross State Product. We use the Bureau of Economic Analysis (BEA) data for gross state product, which is defined as the "value added" of the industries of the state.[6] Dividing by population, we get per capita gross state product *gsp*. As all our measures are in per capita terms, we often omit the term "per capita" for the sake of brevity.

State Income. Defined as the sum of earnings (wages and proprietors' income) and distributed profits (including interest and rent) of residents of the state, plus state and federal nonpersonal taxes (including corporate taxes and indirect business

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6. Namely, sales or receipts plus inventory change minus consumption of goods and services purchased from other industries or imported from other states.

taxes). State income equals gross state product minus retained earnings (including capital consumption) plus net factor income plus federal nonpersonal taxes allocated by incidence, and is constructed as follows. 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, we add to the BEA personal income figures personal and employer Social Security contributions, and subtract Social Security transfers. We also add state nonpersonal taxes, since we do not distinguish between the state government and the residents of a state—the taxes collected by the government of the state are available for consumption by its residents, possibly in the form of state public goods. Finally, we add the interest revenue on the state's trust funds. The resulting number is (ceteris paribus) what would have been available for consumption by the residents of the state had there been no fiscal intervention on the part of the federal government.

Interstate smoothing of earnings can occur through commuting across state borders. The BEA takes commuters' income into account in the construction of the personal income data. Therefore, state income incorporates this kind of smoothing. The same is true for income smoothing through distributed profits, interest, and rent, which occurs when residents of one state hold securities of corporations and property in other states. These forms of income are included in the BEA personal income estimates, and hence are picked up by state income.

Only distributed profits are recorded as part of income. Therefore, smoothing via retained profits occurs if corporations retain a smaller fraction of the production value in states that are subject to negative production shocks. Although our estimates are, no doubt, sensitive to this, we cannot isolate smoothing via retained earnings from other channels of smoothing.

There is no consensus concerning the incidence of federal nonpersonal taxes (e.g., federal corporate income taxes and federal unemployment taxes). We follow the allocation rules of the Tax Foundation in constructing weights for the allocation of most federal taxes across individual states.[7] We realize that there may be alternative, equally reasonable, imputation methods. However, it is outside the scope of this paper to resolve the question of the geographical incidence of the corporate income tax. Sala-i-

7. For details see Tax Foundation [1974] and the Appendix.

Martin and Sachs [1992], for example, take the view that since indirect taxes constitute a small fraction of total federal taxes (17 percent), they can be ignored without seriously affecting the results.

Since state unemployment trust funds are managed by the Treasury, and since there is federal legislation regarding minimum contributions and defining benefits, we regard the unemployment contributions of the state-federal unemployment system as a federal tax, and the unemployment payouts as a negative federal tax. Other authors [Sala-i-Martin and Sachs 1992; von Hagen 1992] argue that the system should not be regarded as federal (indeed, many states contribute beyond the minimum requirement). We do not take a stand on this issue. Rather, we isolate the smoothing effect of unemployment contributions and benefits (as well as of other components of federal government smoothing). The results are reported in Section III.

Disposable State Income. Defined as state income plus federal direct transfers to individuals in the state (e.g., Social Security), plus federal grants to the government of the state, minus total federal taxes raised in the state (including Social Security contributions). It should be noted that the sum of net federal transfers is negative for all years in the sample since the federal government absorbs resources to finance federal public goods, which are ignored in our analysis. Federal grants to states are published in the *United States Statistical Abstract,* whereas federal personal taxes are available by state from the BEA. The BEA also publishes data for transfers broken down into categories which can be assigned to either the federal or state governments. The major exception is "medical payments" which consists of Medicare, CHAMPUS,[8] and Medicaid. Since the latter is state administered, we use total medical payments minus Medicaid payments by state in order to obtain a measure of federal medical payments to individuals by state.[9]

State Consumption. Consists of consumption by the residents of the state and consumption by the state government. The latter is defined as state expenditures minus state transfers. As a proxy for per capita private state consumption, we use per capita annual retail sales, by state. Actual private consumption at the

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8. Civilian Health and Medical Plan for the Uniformed Services.
9. The federal share of Medicaid payments is included in the federal grants to state governments.

state level is not available, so we rescale retail sales by the ratio of total private consumption to total U. S. retail sales. Our measure of consumption for a state is the sum of state government consumption and rescaled retail sales.

Econometric Issues

Since state level data may be measured with less precision than aggregate U. S. data, one may worry about measurement errors. The errors arise because some of the data used for constructing *gsp* estimates are imprecise, and because the BEA often interpolates survey data which are not collected annually.[10]

It is well-known that measurement errors in the regressor bias the estimates toward zero, while measurement errors in the regressand only lead to increased standard errors. The regressor *gsp* is particularly likely to be measured with error for small states. We partly alleviate the problem by weighting our regressions with the state-specific variance. To the extent that our coefficients are still biased, we would overstate the amount of capital market smoothing (since β_K is one minus the regression of $\Delta \log si$ on $\Delta \log gsp$) and understate the amount not smoothed.[11] Potential bias in our estimates of federal and credit market smoothing may be positive or negative since, for example, β_F is the difference of the regression coefficients of $\Delta \log si$ and $\Delta \log dsi$ on $\Delta \log gsp$. Over longer horizons measurement errors are likely to be less serious.[12]

If state taxes are correlated with output and affect state price levels, then our measures of income smoothing might be affected. This is part of a more general problem—the evolution of prices across states. Ideally, we should account for this problem by di-

10. Interpolation, like white noise measurement errors, increases the cross-sectional variance of measured *gsp*. By contrast, interpolation may decrease the variance of time series data. Therefore, the higher variance of the *gsp* time series, as compared with the variance of *GDP*, is not necessarily inflated by measurement errors.

11. This assertion rests on independence of measurement errors in the left- and right-hand-side variables, but since retail sales data are used by the BEA in the construction of *gsp* estimates, it is possible that the left-hand-side variable *c* and the right-hand-side variable *gsp* are positively correlated. This would contribute to overstating the amount not smoothed. Also, *gsp* may be correlated with other left-hand-side variables resulting in similar effects on the estimated coefficients.

12. Measurement errors due to misallocation of production to calendar year will be smaller, random i.i.d. measurement errors will tend to cancel out, and errors due to interpolation will become less severe.

viding current prices by state price indices. Unfortunately, such state price indices are not available.

We are aware that retail sales is a somewhat noisy proxy for state private consumption (e.g., travel expenses are not included in retail sales), but to our knowledge, it is the best available. The correlation between annual increments of aggregate U. S. retail sales and aggregate U. S. private consumption, both measured in real (cpi deflated) terms, is 0.84. Furthermore, regressing aggregate real Δ log (retail sales) on real Δ log (Gross Domestic Product) yields a coefficient of 0.8795, whereas regressing aggregate real Δ log (private consumption) on real Δ log (Gross Domestic Product) yields a coefficient of 0.8803. Therefore, it seems that for our purpose state retail sales are a reasonable proxy for state private consumption.

It should be kept in mind that measurement errors in retail sales, as in any left-hand-side variable, do not result in biased estimates, only in higher standard deviations. Indeed, our estimates of the fraction of shocks to gross state product not smoothed, β_U, exhibit much higher standard deviations than the estimates of the other β coefficients.

It is well-known since the work of Nelson and Plosser [1982] that most U. S. macroeconomic time series exhibit unit root or near unit root behavior, and that time series regressions involving unit root processes may give results that are spurious in the sense of Granger and Newbold [1974] and Phillips [1986]. The time series in our data set are clearly best characterized as unit root processes.[13] The time differenced specification is therefore appropriate. Further autocorrelation (as well as autocorrelation that would be induced by differencing a stationary series) will entail loss of efficiency, but not bias. Given the large cross-sectional dimension of the data set, this potential loss of efficiency is not serious.

The variance (over time) of the data series fluctuates considerably across states. For example, a small oil-producing state like Alaska displays a large variance in state product. From preliminary estimations we found that taking this heteroskedasticity into account had a large impact on the results. We therefore performed the estimations in two steps. In the first step we esti-

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13. We performed Augmented Dickey-Fuller tests for a unit root for each of our series state by state. We were never able to reject a unit root in *gsp* or *dsi*, while we rejected a unit root in *si* for one state, and rejected a unit root in *c* for seven states.

mated the equations in (3) for the entire panel by OLS, which corresponds to seemingly unrelated regression estimates since all the equations have the same regressors. We used the residuals to estimate the variance for each state, which we used to correct for heteroskedasticity in the second step. Since we corrected the equations in (3) one by one, the regressor is no longer identical in the three equations, and we therefore also estimated the cross-equation correlation matrix Ω from the initial residuals and estimated the whole system using generalized least squares (GLS). Although this estimation ignores the correlations between states, we did not find it advisable to use the estimated 50 by 50 correlation matrix in the GLS estimation, as this matrix would have to be estimated from very short samples. Likewise, we ignored potential error autocorrelation in the second-step estimation. Our second-step estimator is therefore consistent but not asymptotically efficient, since it seems likely that the added noise from using an imprecise estimate of the covariance in the GLS estimation would outweigh the asymptotic benefits for our short time series. However, we did take this covariance into account in constructing the estimates of the standard errors. In constructing the standard errors, we allowed for first-order autocorrelation in the residuals (constrained to follow the same AR(1) process for all three equations), and we allowed for a full 50 by 50 covariance matrix Γ between the states (again restricted to be the same for the three equations). Denoting the matrix of time series correlations for each state by R, we, in fact, assumed an error structure of the form $\Sigma = \Omega \otimes \Gamma \otimes R$ for the heteroskedasticity-corrected equations. To the extent that the assumptions on Σ are correct, this then gives consistent estimates of the standard errors.[14] We do not report the estimate of the 50 by 50 cross-state correlation matrix, but the residual autocorrelation was fairly low, with a point estimate of negative 0.10.

In order to further guard against outliers, we also estimated the relations (one by one) using a least absolute deviations estimator that is considerably more robust to outliers than OLS. We do not report those estimates, since they were very similar to the GLS estimates.

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14. The Σ matrix is used in the computation of the standard errors but not in the computation of the coefficient (since inverting it, as would have been the case if we had used this matrix in a full GLS estimation, may result in large imprecision).

TABLE I

GLS ESTIMATES OF INCOME AND CONSUMPTION SMOOTHING (PERCENT)

	1964–1990
Capital markets (β_K)	39
	(3)
Federal government (β_F)	13
	(1)
Credit markets (β_C)	23
	(6)
Not smoothed (β_U)	25
	(6)

Percentages of shocks to gross state product absorbed at each level of smoothing. Standard errors are in parentheses. β_K is the GLS estimate of the slope in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$, β_F is the slope in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C is the slope in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U is the coefficient in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$. We interpret β_K, β_F, and β_C as the incremental amount of smoothing achieved at each level, and β_U as the amount not smoothed.

III. RESULTS

In Table I we display the empirical results. We find that 25 percent of shocks to gross state product are not insured. As indicated by the estimated standard error, this number is clearly statistically significant, so we reject the hypothesis of full interstate risk sharing. This finding is consistent with most existing literature. We now turn to our main focus, namely the decomposition of interstate smoothing into its various levels.

Our breakdown shows that a considerable part of shocks to gross state product (39 percent) is absorbed by capital market smoothing. We interpret this as a consequence of cross-ownership of capital, although we remind the reader that commuters' income and patterns of earnings retention may also make up a fraction of this number. The amount of smoothing accomplished by the federal tax-transfer system is 13 percent and is clearly statistically significant like the other components. The amount of smoothing at the last level, which we refer to as credit market smoothing, is 23 percent. The total amount of smoothing through capital and credit markets is therefore 62 percent which clearly dominates the 13 percent smoothed by the federal government.

We further decompose the amount of income smoothing by the federal government. The results in Table II are calculated as follows. Consider, for example, federal direct taxes. We measure the sensitivity of $\Delta \log$ (state income) to $\Delta \log gsp$ using the methodology described in the previous section. Then we measure the

TABLE II

GLS ESTIMATES OF COMPONENTS OF INCOME SMOOTHING BY THE FEDERAL
GOVERNMENT (PERCENT)

1964–1990	
Federal direct taxes	4.3
	(0.5)
Unemployment benefits	1.9
	(0.1)
Other federal direct transfers	6.3
	(0.3)
Federal grants to states	2.5
	(0.3)
Unemployment contributions	−0.2
	(0.1)
Corporate income taxes	−0.6
	(0.0)
Social Security contributions	−1.0
	(0.1)
Other excise taxes	−0.2
	(0.0)
Total federal smoothing	13.0

Percentages of shocks to gross state product absorbed at each level of income smoothing by the federal government. Standard errors are in parentheses. The estimates are obtained from a regression of $\Delta \log si - \Delta \log (si + x)$ on $\Delta \log gsp$, where x is a generic variable representing each of the above components. The estimates are interpreted as the incremental amount of smoothing achieved by each component.

sensitivity of Δ log (state income + federal direct taxes) to Δ log *gsp*. We find that the former regression coefficient is larger. The difference (4.3 percent) is the amount of smoothing achieved by federal direct taxes.[15]

The results indicate that the major part of income smoothing by the federal government occurs through federal direct transfers to individuals (not including unemployment benefits), which smooth 6.3 percent of shocks to gross state product. In total, the direct tax-transfer system smoothes 10.6 percent of shocks. Federal grants to state governments smooth an additional 2.5 percent. The component "other excise taxes" consists mainly of alcohol and tobacco taxes, as well as other indirect business taxes. Unemployment insurance taxes have a dis-smoothing ef-

15. The estimation does not impose on the partial smoothing effects to add up to 13 percent, which is total federal smoothing (they add up to slightly less). This is a minor discrepancy that cannot be avoided without making arbitrary assumptions. For the sake of consistency with the results in Table I, the numbers in Table II have been rescaled to add up to 13 percent (total federal smoothing).

fect (−0.2 percent), indicating that during recessions states con-
tribute a larger fraction of gross state product to unemployment
funds. This dis-smoothing effect is small compared with the
smoothing effect of unemployment benefits (1.9 percent) result-
ing in an overall smoothing effect (1.7 percent) of the unemploy-
ment insurance system. As pointed out earlier, the smoothing of
unemployment insurance can be attributed to the federal govern-
ment (as we do here) or to state governments, as some other au-
thors do.

Social security contributions, corporate income taxes, and
"other excise taxes" all have a small dis-smoothing effect. These
components have been imputed to states, so their dis-smoothing
effect is subject to more imprecision than the other components.

Subperiods

An interesting question is whether the smoothing done by
the federal government would have been undertaken by private
markets had there been less federal smoothing. One way of get-
ting an indication of this is to see whether the amount of federal
smoothing has varied over subperiods and whether the amount of
market smoothing has varied correspondingly. As the time series
dimension of our data set is rather short (27 years for the differ-
enced data), we chose to split it into three subperiods.

The results are reported in Table III. Capital market income
smoothing increases considerably from decade to decade re-
flecting, most probably, financial innovation and better access to

TABLE III
GLS ESTIMATES OF INCOME AND CONSUMPTION SMOOTHING (PERCENT): SUBPERIODS

	1964–1970	1971–1980	1981–1990
Capital markets (β_K)	27	34	48
	(4)	(4)	(4)
Federal government (β_F)	5	16	14
	(2)	(1)	(1)
Credit markets (β_C)	37	45	19
	(7)	(8)	(9)
Not smoothed (β_U)	30	6	19
	(6)	(7)	(8)

Percentages of shocks to gross state product absorbed at each level of smoothing for three subperiods.
Standard errors are in parentheses. β_K is the GLS estimate of the slope in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$, β_F is the GLS estimate of the slope in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C is the slope in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U is the coefficient in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$. We interpret β_K, β_F, and β_C as the incremental amount of smoothing achieved at each level, and β_U as the amount not smoothed.

securities markets. During the 1980s almost half of a shock to gross state product was smoothed on capital markets. Federal income smoothing has increased remarkably from 5 percent of a shock smoothed during the sixties, to 16 percent during the seventies, reflecting the impact of social programs introduced (in the sixties) by President Johnson as part of the Great Society. Capital market and federal smoothing seem to have moved together during the past decades, with no indication that one is a substitute for the other. The amount of credit market smoothing appears to be less stable through time, increasing sharply during the seventies but decreasing equally sharply during the eighties. The results suggest that the decrease in credit market smoothing and the slight decrease in federal smoothing during the eighties were only partly compensated by the increase in capital market smoothing, resulting in a higher fraction of shocks to gross state product not smoothed (as compared with what happened in the seventies). We feel that a deeper examination of the changes across periods is an interesting topic for further research, but nevertheless we dare speculate that the changes in nonfederal smoothing are a consequence of better access to capital markets on the one hand and possibly of the high interest rates in most of the 1980s on the other. This may explain the strong shift away from credit market smoothing during the eighties (borrowing is expensive, and many individuals and firms are credit constrained) and into capital markets. Of course, the nature of the shocks may have influenced the patterns of smoothing. For example, shocks to gross state product in the seventies may have been less persistent than in the sixties or the eighties, which could explain the observed pattern of credit market smoothing (we address the issue of persistence of shocks later). In Figure I we plot a kernel estimate of the different levels of smoothing. The area under the uppermost curve is the amount left unsmoothed after capital market smoothing, the area under the curve below is the amount left unsmoothed after capital market + federal smoothing, and the area under the bottom curve is the amount eventually left unsmoothed. The trends described above are clearly visible.[16]

16. Each curve is constructed by first estimating year-by-year β coefficients and then applying a kernel smoother. We used a normal density with standard deviation 2 as the kernel. The standard deviation was chosen from visual inspection as the lowest value that gives a smooth curve. To correct for heteroskedasticity, the year-by-year cross-sectional regressions are weighted by the square root of state population, and the numbers shown in the tables will not be exact averages of the plotted coefficients.
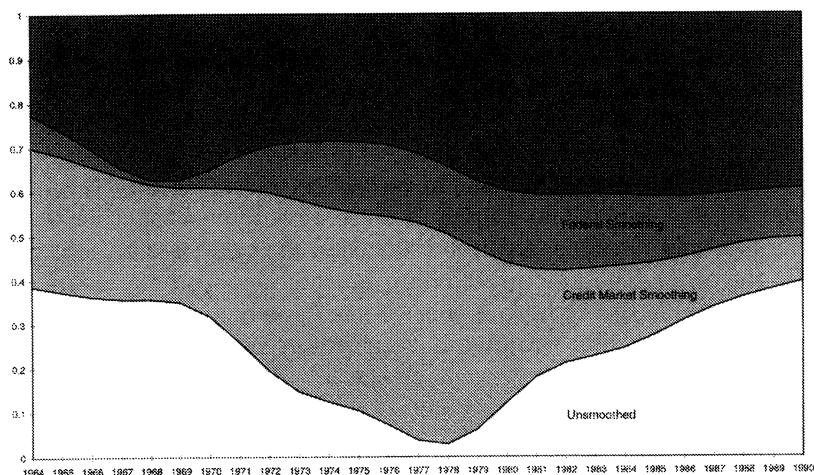
FIGURE I
Year-by-Year Income and Consumption Smoothing

Varying the Length of the Differencing Interval

We now ask how income and consumption smoothing are affected by the frequency of the data used in the regressions. It is likely that the dynamics are richer than in (3). The last equation, for example, may be of the form,

$$\Delta \log c_t^i = \nu_{U,t} + \beta_U \, \Delta \log gsp_t^i + f\big(\Delta \log gsp_{t-1}^i, \ldots\big) + u_{U,t}^i.$$

This more general specification does not allow a simple variance decomposition. Therefore, rather than attempt to model the function $f(\cdot)$ explicitly, we take the simpler approach of varying the length of the differencing interval, which allows us to perform the variance decomposition in a manner analogous to that used for one-period differencing. For example, lagged *gsp* may enter the above regression with a positive coefficient. The estimation of (3) using longer differencing intervals would pick up this effect in the form of a larger β_U coefficient.

In Table IV we present results for regressions using *k*-differenced data (adjacent observations are *k* years apart). The amount of capital market smoothing is not affected considerably by the differencing frequency. By contrast, credit market smoothing declines sharply with the differing frequency, from 23 percent of shocks smoothed for $k = 1$ to 5 percent for $k = 5$ (the latter not

TABLE IV
GLS ESTIMATES OF INCOME AND CONSUMPTION SMOOTHING FOR DIFFERENT
FREQUENCIES OF THE DATA (PERCENT)

	$k = 1$	$k = 2$	$k = 3$	$k = 5$	$k = 10$
Capital markets (β_K)	39	34	44	36	47
	(3)	(4)	(2)	(3)	(1)
Federal government (β_F)	13	15	16	17	18
	(1)	(1)	(1)	(1)	(1)
Credit markets (β_C)	23	16	7	5	−17
	(6)	(8)	(6)	(8)	(3)
Not smoothed (β_U)	25	30	34	42	53
	(6)	(8)	(7)	(8)	(3)

Percentages of shocks to gross state product absorbed at each level of smoothing for $k = 1, 2, 3, 5, 10$ where the data are differenced using intervals of k years. Standard errors are in parentheses. β_K is the GLS estimate of the slope in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$, β_F is the slope in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C is the slope in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U is the coefficient in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$. We interpret β_K, β_F and β_C as the incremental amount of smoothing achieved at each level, and β_U as the amount not smoothed.

significantly different from zero), while the amount not smoothed increases sharply. For $k = 10$ there is dis-smoothing on credit markets. This may reflect effects due to durability which we ignore in our analysis, or simply that lenders actually pull out loans from states that have been unlucky for several years in a row. Finally, there is a small but solid (monotonic and significant) increase in the amount smoothed by the federal government as the differencing frequency rises, partly compensating for the reduced credit market smoothing.

Since not all shocks are insured on capital markets, states are bound to use credit markets after the realization of a bad shock in order to smooth consumption. The cumulative shock to the gross state product of some states after several years may be very large (bad luck each and every year). The citizens of such states would need large amounts of credit, which many may not be able to obtain. This results in less credit market smoothing and a higher fraction of shocks unsmoothed. Of course, the higher the persistence of the shocks, the harder it is to smooth consumption by borrowing on credit markets, an issue we address shortly.

The higher amount of federal government smoothing as the differencing interval is increased suggests that the government responds to shocks with a lag (see the discussion in Goodhart and Smith [1993, p. 427]).

The increase, as k increases, in the fraction of shocks not

smoothed is consistent with findings by Attanasio and Davis [1994], who found that relative wage movements over longer differencing intervals are associated with large relative consumption movements, whereas for one- and two-year differencing there is no consistent effect of relative wage movements on relative consumption.[17]

As discussed above, if the regressor is measured with error, we would overstate the amount of capital market smoothing and understate the amount not smoothed. Over longer horizons measurement errors are likely to be less serious (see footnote 12). If measurement errors were driving our results, we would expect to see a decline in capital market smoothing over longer horizons and a simultaneous increase in the fraction not smoothed. We do measure an increasing amount left unsmoothed as the differencing interval lengthens, but since this is not accompanied by less capital market smoothing, we find it unlikely that our results are driven by measurement errors.

Persistence of Shocks to Gross State Product

We investigate income and consumption smoothing patterns according to the persistence of shocks to gross state product. Highly persistent shocks can be insured through advance purchase of securities on capital markets but are difficult to smooth ex post on credit markets since those who wish to borrow are unlikely to repay.

It would be of interest to examine whether persistence of shocks is different across subperiods, but a long sample is needed in order to estimate persistence. We therefore examine whether states which tend to have persistent shocks have smoothing patterns different from those of other states.

To quantify persistence, we use the Campbell and Mankiw [1987] measure of persistence of fluctuations. In order to keep the number of estimated parameters reasonably low, we estimated an autoregressive model with three lags.[18]

We split our sample in two: states with highly persistent shocks to $\Delta \log gsp$ (top third) and the rest. The average persistence measure for the high persistence group is 1.72, whereas for the low persistence group it is 0.96. We estimate β coefficients for each group separately. A typical panel regression takes the form,

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17. For a comprehensive study of relative wage movements in the United States, see Katz and Murphy [1992].

18. The Campbell and Mankiw measure of persistence for an AR(p) process $\Delta x_t = \mu + \Sigma_{i=1}^{p} \phi_i \Delta x_{t-i} + \varepsilon_t$ is $1/(1 - \Sigma_{i=1}^{p} \phi_i)$.

TABLE V
GLS ESTIMATES OF INCOME AND CONSUMPTION SMOOTHING (PERCENT): PERSISTENCE
OF SHOCKS TO GROSS STATE PRODUCT

	Low	High
Capital markets (β_K, β_K^*)	33	46
	(3)	(4)
Federal government (β_F, β_F^*)	11	16
	(1)	(1)
Credit markets (β_C, β_C^*)	33	14
	(7)	(7)
Not smoothed (β_U, β_U^*)	24	24
	(7)	(7)

Percentages of shocks to gross state product absorbed at each level of smoothing for states with low and high (top third) persistence of shocks. The average Campbell and Mankiw [1987] persistence of fluctuations measure for the high persistence group is 1.72, whereas for the low persistence group it is 0.96. Standard errors are in parentheses. β_K and β_K^* are the GLS estimates of the slopes in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$, for the low and the high persistence states, β_F and β_F^* are the slopes in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C and β_C^* are the slopes in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U and β_U^* are the slopes in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$.

$$(4) \qquad \Delta \log y_t^i = v_{y,t} + \beta_y D \Delta \log gsp_t^i + \beta_y^*(1 - D) \Delta \log gsp_t^i + u_{y,t}^i,$$

where $D = 1$ for states in one group and $D = 0$ for the other states, y is a generic left-hand-side variable of the equations in (3), and β_y and β_y^* are the fractions of shocks smoothed at level y for each group of states.[19]

We find that credit market smoothing is considerably lower for states with highly persistent shocks to gross state product; see Table V. However, for these states capital market smoothing and federal government smoothing are higher, resulting in the same degree of overall smoothing for the two groups. It seems, therefore, that the federal tax-transfer system favors individuals and states suffering from persistent adverse shocks. It is also apparent that individuals who are likely to be hit by persistent shocks insure themselves on capital markets, anticipating the difficulty in obtaining credit after the occurrence of a shock.

Sectoral Composition

States may find that access to capital and credit markets depends on the composition of *gsp*. It is likely that, for example, ownership of mineral resources is easier to sell on capital markets than the rights to manufacturing or agricultural output. We

19. Lewis [1996] uses the same type of equation to test for institutional differences between groups of countries.

TABLE VI
GLS ESTIMATES OF INCOME AND CONSUMPTION SMOOTHING (PERCENT): SECTORAL
COMPOSITION

| | Agriculture | | Manufacturing | | Mineral extraction | |
	Low	High	Low	High	Low	High
Capital markets (β_K, β_K^*)	33	12	38	41	33	53
	(3)	(1)	(3)	(4)	(3)	(4)
Federal government (β_F, β_F^*)	14	18	14	12	12	16
	(1)	(1)	(1)	(1)	(1)	(1)
Credit markets (β_C, β_C^*)	12	51	26	16	27	14
	(6)	(8)	(6)	(8)	(7)	(8)
Not smoothed (β_U, β_U^*)	29	14	23	31	28	17
	(6)	(7)	(6)	(8)	(7)	(7)

Percentages of shocks to gross state product absorbed at each level of smoothing. Standard errors are in parentheses. For agriculture and manufacturing, "high" refers to the top third whereas for mineral extraction (oil) it refers to the six largest, in terms of the sector's weight in gross state product. β_K and β_K^* are the GLS estimates of the slopes in the regression of $\Delta \log gsp^i - \Delta \log si^i$ on $\Delta \log gsp^i$ for the two groups in each case, β_F and β_F^* are the slopes in the regression of $\Delta \log si^i - \Delta \log dsi^i$ on $\Delta \log gsp^i$, β_C and β_C^* are the slopes in the regression of $\Delta \log dsi^i - \Delta \log c^i$ on $\Delta \log gsp^i$, and β_U and β_U^* are the slopes in the regression of $\Delta \log c^i$ on $\Delta \log gsp^i$.

compare the patterns of income and consumption smoothing for states that differ in the sectoral composition of *gsp*, classifying states according to agricultural, manufacturing, and mineral extraction (mainly oil) intensity. The results are presented in Table VI. Farm states rely much less on capital market smoothing and much more on credit market smoothing, most likely reflecting limited access to capital markets in rural areas. The large amount of credit market smoothing achieved suggests that residents of rural areas can obtain credit relatively easily. This may be a result of less severe information asymmetries or of better collateral.

Manufacturing intensity seems to play no particular role in determining the amount and composition of risk sharing. By contrast, we find that oil states rely heavily on capital market smoothing and less on credit market smoothing, reflecting the fact that much of the oil in these states is owned by residents of other states.

The Insurance Role of the Federal Tax-Transfer System: Comparison with Previous Work

Sala-i-Martin and Sachs [1992] regress federal log-taxes and log-transfers on state income using regional U. S. data for the period 1970–1988, finding a very large response of federal taxes

and transfers to shocks in state income: 35 cents reduction in taxes *and* approximately 30 cents increase in transfers in response to a negative shock of one dollar. The substantial difference in the results requires discussion.

In order to make sure that our very different findings are not due to data discrepancies we repeat their regressions with our data, obtaining results that are similar to theirs. There are several methodological differences that may account for the difference in the results. First, Sala-i-Martin and Sachs use levels of log-taxes, log-transfers, and state income in their regressions, whereas we use differenced data. Indeed, von Hagen [1992] performs an exercise similar to that of Sala-i-Martin and Sachs, using state data in differenced logs, for the period 1981–1986. He obtains a much smaller response of taxes to shocks in gross state product—a decline in gross state product of one dollar reduces federal taxes by eight cents and increases federal direct transfers by two cents, totaling ten cents absorbed by the federal tax-transfer system. This estimate is very much in line with our estimated fraction of a shock smoothed through the federal tax-transfer system. We run the von Hagen regressions with our data, obtaining similar results. Regressions in levels have a different interpretation than our regressions. As we have shown above, our results are sensitive to the length of the differencing reflecting complicated dynamics that are difficult to model parametrically on a short time series. The results obtained by Sala-i-Martin and Sachs are best interpreted as measuring the long-run effect of a level change in state income.[20] Our methodology uses differenced data and relies more on cross-sectional variation in state level data (weighted appropriately to account for time variation), capturing the effect of current changes in gross state product on current consumption.[21]

Further Issues

Neighboring States. To get a handle on the importance of geographical proximity for sharing risk, we regress Δ log (con-

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20. Level regressions on data with unit roots or near unit roots pose special problems as they may be either spurious or cointegrating in the sense of Engle and Granger [1987]. Since the theory of cointegration in panel data is not well developed, we leave further exploration to future research.

21. Another source of discrepancy is that Sala-i-Martin and Sachs use regional income (rather than gross state product) as a regressor, and U. S. aggregate variables that may affect different regions in different ways as instruments (e.g., oil prices).

sumption) on Δ log *gsp* and Δ log (regional *gsp*),[22] still allowing for time fixed effects, obtaining a positive coefficient for both regressors, 0.10 and 0.37 with standard errors 0.04 and 0.06, respectively.[23] The fact that changes in state consumption comove strongly with changes in regional output and less strongly with state output, suggests that consumption smoothing is to a large extent regional.[24] The correlation of changes in state consumption with changes in regional output may be driven in part by cross-border shopping—when income is high in Massachusetts, its residents shop more in Rhode Island. This is mainly a problem for small states that are given a lower weight in the heteroskedasticity-corrected regressions.

Migration. We briefly investigate income smoothing via interstate migration. Barro and Sala-i-Martin [1991, p. 132], using data on net migration by state for the periods 1963–1970, 1971–1979, and 1980–1987, find that the elasticity of the one-year net rate of migration with respect to state income is 0.0261. In this paragraph differencing is with respect to these subperiods. To get a sense of the order of magnitude of smoothing through interstate migration, we compute, using the same migration data,[25] Δ log *gsp**, the rate of change in per capita *gsp* if there had been no migration. We compute *gsp** by dividing total gross state product by population adjusted for migration. *gsp* already incorporates this kind of smoothing (changes in state population reflect migration). The amount of smoothing is measured by regressing Δ log *gsp* on Δ log *gsp** (both weighted by the length of the subperiod), with time fixed effects. The coefficient is 0.73 (with standard error 0.02) which is the fraction of shocks not smoothed, namely, 0.27 of shocks are smoothed via interstate migration over a period of roughly ten years. Therefore, migrants dilute the per cap-

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22. We use BEA regions; see Beemiller and Dunbar [1993].

23. With this specification there is no natural variance decomposition.

24. If regional *gsp* is a better proxy for measured state *gsp* due to measurement errors, then the smaller coefficient on state *gsp* may simply reflect bias. To investigate the issue, we regressed Δ log *si* on Δ log *gsp* and Δ log (regional *gsp*), obtaining a coefficient of 0.59 for Δ log *gsp* with standard deviation 0.01, and of 0.06 for Δ log (regional *gsp*) with standard deviation 0.02. We also regressed Δ log *dsi* on Δ log *gsp* and Δ log (regional *gsp*), obtaining coefficients of 0.12 with standard deviation 0.01, and 0.02 with standard deviation 0.01. Since the coefficient on regional *gsp* is smaller in both of these regressions, it is unlikely that the larger regional coefficient in the consumption regression is driven by measurement errors.

25. The data for the period 1963–1970 are from *Historical Statistics of the United States, Colonial Times to 1970,* Bureau of the Census, 1975. The rest of the data are from the *United States Statistical Abstract.*

ita gross state product of states with positive shocks by 2.7 percent per year, which is precisely the number estimated by Barro and Sala-i-Martin. The computation of *gsp** assumes that total gross state product is independent of migration. Therefore, the above estimate should be regarded as an upper bound on smoothing via interstate migration. Since migrants in practice take their human capital with them, shocks to gross state product are probably diluted by much less.

Predictability of Fluctuations in Gross State Product. We decompose $\Delta \log gsp$ into a predictable part and an unpredictable part. As predictors, we use lagged $\Delta \log gsp$ and lagged $\Delta \log$ (regional *gsp*). Since our time series is short, we use two lags, obtaining on average an R^2 of 0.27. We then estimate (3) using the fitted value and the innovations as regressors (each separately, in place of $\Delta \log gsp$), finding that the estimated coefficients are extremely similar for the predictable and the unpredictable components of changes in *gsp*.

Aggregate Data. We run time series regressions corresponding to the regressions in (3) using aggregate U. S. data. This amounts to a decomposition of the time series variance of *GDP.* For the first level of smoothing we regress $\Delta \log GDP_t - \Delta \log SI_t$ on $\Delta \log GDP_t$, where SI_t denotes the period t aggregate state income, obtaining the coefficient 0.11 (0.09), where the standard deviation is in brackets, reflecting no capital market smoothing. Similarly, we regress $\Delta \log SI_t - \Delta \log DSI_t$ on $\Delta \log GDP_t$, obtaining the coefficient 0.15 (0.09), maybe reflecting some federal government smoothing, $\Delta \log DSI_t - \Delta \log C_t$ on $\Delta \log GDP_t$, obtaining the coefficient of 0.07 (0.1), reflecting no credit market smoothing, and $\Delta \log C_t$ on $\Delta \log GDP_t$, obtaining the coefficient 0.66 (0.06), implying that a large fraction of shocks is not smoothed. A possible interpretation is that the regressions measure the amount of income and consumption smoothing of the United States with the rest of the world. The estimated coefficients are consistent with the well-documented virtual absence of international portfolio diversification, and suggest that the U. S. federal government provides some intertemporal smoothing, probably through foreign debt, and that private international lending and borrowing does not have an important role in smoothing U. S. aggregate consumption. Of course, one would have to control for fluctuations in world output. We leave the study of channels of international risk sharing to future research.

IV. CONCLUDING REMARKS

Several interesting findings emerge from the analysis. First, there is a considerable amount of smoothing via capital markets (about 40 percent of shocks to gross state product are smoothed via this channel). Second, the federal government smoothes 13 percent of shocks to gross state product via taxes, transfers, and grants to states. By decomposing federal smoothing, we find that the federal tax system smoothes 4.3 percent of changes to gross state product, the transfer system (not including unemployment insurance) smoothes 6.3 percent, unemployment benefits smooth 1.9 percent, and grants to states smooth 2.5 percent. A third important finding is that in recent years there has been an increase in capital market smoothing, whereas the amount of credit market smoothing has been less stable through time. Finally, we find that states which suffer persistent shocks to gross state product rely more on capital market smoothing and less on credit market smoothing. Federal income smoothing slightly favors such states.

It would be interesting to say something about the channels of capital market smoothing: how much of the smoothing is achieved via interregional cross-ownership on organized stock markets, and what is the role of intermediaries in promoting interstate income and consumption smoothing? In countries where stock markets are "thinner" than in the United States, is there less interregional risk sharing via capital markets? Does the central government play a larger role in terms of smoothing in these countries? Is financial innovation responsible for the shift into capital market smoothing? How are these changes related to the decrease in the saving rate of the past years? Clearly, there is need for more work on these issues.

APPENDIX: DATA CONSTRUCTION

Gross State Product (gsp)

Data for gross state product are available from the Bureau of Economic Analysis (BEA); see Beemiller and Dunbar [1993].[26] The series (as all our data) were transformed to a per capita basis using midyear state population estimates of the Bureau of the Census.

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26. The data revision described in Beemiller and Dunbar [1993] goes back to 1977. The data for the earlier years were scaled so that the series were equal in 1977.

State Income (si)

State income is constructed as follows:

state personal income	18,668.6
+ federal nonpersonal taxes and contributions	2,150.9
+ state and local nonpersonal taxes	1,444.0
+ interest on state and local funds	504.6
− direct transfers (federal and state)[27]	2,692.8
= state income	20,075.3

The numbers are aggregate United States per capita figures for 1990 (in 1990 dollars). They are included in order to provide the reader with the relative order of magnitude of the various entries.

State personal income is available from the BEA. Transfers are composed of direct government transfers to individuals and to nonprofit institutions, which are available from the BEA. The other components of state income are constructed from more detailed data, and we explain this construction for each series in turn.

Federal nonpersonal taxes and contributions:

federal corporate income taxes	374.8
+ tobacco taxes	16.4
+ miscellaneous taxes and other excise taxes	236.3
+ social security contributions	1461.6
+ unemployment insurance taxes	61.8
= federal nonpersonal taxes and contributions	2150.9

Total federal corporate income taxes are available from the United States Budget.[28] The incidence by state is not known and has been imputed using the weights suggested by the Tax Foundation [1974]. The weight used for a state is the (half-half) aver-

27. Transfers from the state government to a citizen of the state do not contribute to state income.
28. Historical Tables, Budget of the United States Government, 1995, Executive Office of the President, Office of Management and Budget, Washington, DC.

age of the share of the state in U. S. personal income and its share in property income (the sum of dividend, interest, and rental income, available by state from the BEA).

Aggregate tobacco taxes are available from the United States Budget and are allocated according to weights constructed as the (half-half) average of the share of the state in U. S. personal income and its share in the population.

Other excise taxes consist of taxes on alcohol, crude oil windfall profits, telephone, highways, airways and airports, as well as taxes raised for the black lung disability fund and the hazardous substance superfund. These taxes are allocated to states according to the share of each state in personal income.

Social Security contributions include employment taxes and contributions (OASDHI,[29] railroad retirement and pension fund, railroad Social Security equivalent account), and other retirement contributions. The data for each aggregate component of Social Security contributions are from the United States Budget. The incidence by state has been imputed using the weights suggested by the Tax Foundation [1974]. The weight used for a state is the (half-half) average of the share of the state in U. S. personal income and its share in personal Social Security contributions, available by state from the BEA.

The state burden of state unemployment insurance taxes deposited with the Treasury is assumed to be equal to the actual taxes in each state. This number is published annually in Government Finances.[30]

State and local nonpersonal taxes:

	state and local tax revenue	2010.8
−	state and local personal taxes	566.8
=	state and local nonpersonal taxes	1444.0

Total state and local tax revenue is available from Government Finances. The data for state and local personal taxes are from the BEA. The BEA publishes calendar year data, whereas Government Finances data are by fiscal year. It does not seem possible to correct for this minor imprecision.

Interest on state and local funds:

29. Old-Age, Survivors, Disability, and Hospital Insurance.
30. Until 1966 the publication was titled Governmental Finances. It is published by the Bureau of the Census, Washington, DC.

	interest on state insurance trust funds	229.1
+	interest on state miscellaneous funds	109.6
+	interest on local insurance trust funds	51.7
+	interest on local miscellaneous funds	125.7
−	interest on state unemployment deposits at the Treasury	11.5
=	interest on state and local funds	504.6

Data by state on interest on state insurance trust funds and interest on state miscellaneous trust funds are published annually in Government Finances. Aggregate data for interest on local insurance trust funds and interest on local miscellaneous trust funds are taken from Government Finances, and are allocated to states according to each state's share in personal income. Interest on the state unemployment funds deposited in the Treasury are published in Government Finances. As we treat state unemployment contributions as a federal tax, the interest on these funds is not considered as income of state governments.

Disposable State Income (dsi)

	state income	20,075.3
+	federal grants to state governments	523.4
+	federal transfers to individuals	2,041.7
−	federal nonpersonal taxes and contributions	2,150.9
−	federal personal taxes	1,935.7
=	disposable state income	18,553.8

Federal grants have been collected from the *United States Statistical Abstract,* and federal personal taxes are available by state from the BEA. Federal transfers to individuals include the following components:

	OASDI payments	978.4
+	railroad retirement and disability payments	28.9
+	federal civilian employee retirement payments	127.4

+	military retirement payments	88.7
+	workers' compensation	5.4
+	supplemental Social Security (SSI)	66.8
+	food stamps	75.1
+	other federal income maintenance	40.2
+	unemployment insurance benefits	77.0
+	veterans benefits	70.9
+	federal education and training payments	29.5
+	federal payments to nonprofit institutions	16.9
+	total medical payments	695.9
−	Medicaid payments	259.4
=	federal transfers to individuals	2041.7

These series, except for Medicaid, are all available by state from the BEA. The series for medical payments include Medicaid which is state administered, and which therefore is subtracted from total medical payments. Medicaid data by state are published in the *Statistical Abstract*. The series for workers' compensation contains some state payments, but we did not attempt to correct for this minor problem.

State Consumption (c)

	retail sales (rescaled)	14,660.6
+	state and local government consumption	2,695.3
=	state consumption	17,355.9

Retail sales by state are published in the Survey of Buying Power in Sales Management (after 1976, Sales & Marketing Management). These data are proprietary, and we thank the publishers of Sales & Marketing Management for permission to use the series. Unfortunately, retail sales are only a part of total personal consumption, so in order to obtain an estimate of total personal consumption, we rescale the retail sales data by the ratio of aggregate U. S. private consumption to aggregate U. S. retail sales for each year.

State and local government consumption is computed as follows:

| state and local government expenditure | 3346.3 |
| − state and local transfers | 651.0 |

| = state and local government consumption | 2695.3 |

State and local government expenditure data are published annually in Government Finances (entry "direct general expenditure"). State and local transfers are computed as follows:

| direct transfers | 2692.8 |
| − federal direct transfers | 2041.8 |

| = state and local transfers | 651.0 |

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