Why Does Capital Flow to Rich States? [*]

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Abstract

We study the determinants of capital income flows within the United States: are their magnitudes consistent with the predictions of a simple neoclassical model in which total factor productivity varies across states and over time and capital flows freely across state borders? We find that the answer to this question is affirmative. According to the model, capital will flow to states with relatively high output growth and, because relative growth patterns are persistent, such states also have high output. This implies that high output will be associated with inflows of capital and net outflows of capital income. Our empirical findings correspond well to the predictions of the model and indicate persistent net capital income flows and net cross-state investment positions between states which are an order of magnitude larger than observed capital income flows between countries. Thus, our results imply that frictions associated with national borders are likely to be the main explanation for "low" international capital flows.

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1 Introduction

Capital flows between countries are much smaller than predicted by standard neoclassical models. The manifestations of low capital flows are high correlations of saving and investment, low international risk sharing, and home bias in asset holdings.[1] Low capital flows (relative to theoretical benchmarks) may be due to inherent failures of the frictionless model or to frictions associated with national borders. Therefore, it is important to study the patterns of capital flows between U.S. states, which have a common language, similar institutions, a common currency, and no legal barriers to capital flows—features that typically do not hold across international borders. With fully integrated capital markets, individuals can borrow and lend freely across state borders and, further, insure themselves against state-specific risk by holding a geographically diversified portfolio of assets.[2]

We study the empirical predictions of a frictionless open-economy neoclassical model with a Cobb-Douglas production function and a constant saving rate, in which capital income—but not labor income—is fully diversified between states and where total factor productivity (TFP) varies across states and over time. The model predicts that capital flows into states that experience an increase in TFP resulting in large net capital *income* flows between states. The model also predicts the speed at which net capital income flows decline in the absence of further relative TFP movements. The model is fairly stylized but its broad implications are likely to hold in more complicated settings. Our empirical results using U.S. states match the predictions of the model well.[3] Consequently, frictions associated with national borders are likely to be the main explanation for "low" international capital flows.[4]

Net capital income flows between states are not directly observed; however, in the country-level national accounts net capital income flows are approximately equal to the difference between Gross

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[1]See Feldstein and Horioka (1980), Obstfeld and Rogoff (2000); Backus, Kehoe, and Kydland (1992), Kalemli-Ozcan, Sørensen, and Yosha (2001); French and Poterba (1991), Tesar and Werner (1995), Sørensen, Wu, Yosha, and Zhu (2005).

[2]Consistent with the results of our paper, the Feldstein-Horioka puzzle does not seem to be present for regions within countries. See, for example, van Wincoop (2000) and Sinn (1992).

[3]Our results complement studies such as Asdrubali, Sørensen, and Yosha (1996): they find that state-level income is about 40 percent insured against output shocks. This is broadly consistent with our model where capital income is fully diversified across states while labor income is not diversified.

[4]Examples of frictions associated with borders are explicit barriers to investment or factors affecting investors ex post returns such as bad institutions (corruption, rule of law,..), and sovereign risk; see, for example Alfaro, Kalemli-Ozcan, and Volosovych (2003) and Reinhart and Rogoff (2004).

National Income ("income") and Gross Domestic Product ("output").[5] Output is observed for U.S. states but the state-level equivalent of GNI is not. We use approximations to state-level GNI based on observed state-level personal income and the ratio of output to income ("output/income") is then an indicator of net capital income. In the literature, the ratio of output to income has been used to infer past net capital flows between U.S. states by Atkeson and Bayoumi (1993). They inferred that there are large inter-regional net capital flows within the U.S. leading to large and persistent net capital ownership positions and regional "current account" deficits and surpluses. At the country level, capital flows are usually directly observed, but Bertocchi and Canova (2002) similarly use the output/income ratio to infer past net inflows of capital to former African colonies where the historical capital flows data of interest are not observed.

We estimate two sets of regressions. The first set of regressions examines whether the *level* of the output/income ratio is relatively high for states with high *levels* of output. The second set of regressions examines the relationship between the *change* in the output/income ratio and past output *growth*. The *levels regressions* examine the clear predictions of our model that the level of the output/income ratio is low for a state with large net asset holdings and that a high level of output predicts a high level of the output/income ratio. Intuitively, a positive productivity shock leads to high output and a high output/income ratio—an effect that gets amplified as capital flows into the state. The implication is that capital flows from "poor" to "rich" states, leading to capital income flows in the opposite direction, similar to what is observed at the country level where capital often flows from poor to rich countries.[6] In our empirical section, we run a multiple regression of the output/income ratio on the level of output and on indicators of ownership shares and find coefficients with the signs predicted by the model.

The model makes clear predictions regarding the *change regressions* in terms of observable variables and the empirical results correspond well with these predictions: states with relatively high growth in the 1980s experienced an increase in the output/income ratio in the 1990s of an order of magnitude consistent with the model's predictions. Also, the output/income ratio converges to

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[5]In the country-level national accounts the difference between Gross Domestic Product and Gross National Income is net factor income which includes the net earnings of domestic *residents* abroad (not based on citizenship). However, foreign earnings of domestic residents are usually fairly small compared to capital income.

[6]The finding of a positive coefficient in a regression of capital flows on GDP per capita at the country level is regarded as a "paradox" because it contradicts the open-economy Solow model with integrated capital markets and constant TFP as shown by Lucas (1990).

unity over time when relative growth differentials are controlled for.

In the next section, we derive the theoretical predictions. Section 3 discusses our data and, in section 4, we perform the empirical analysis. Section 5 presents robustness analysis and section 6 concludes the paper.

2 Capital Flows in a Neoclassical Model

Consider N states—which we will refer to as U.S. states—indexed by i, each endowed with a labor force L_i and a Cobb-Douglas production function; time is discrete and we suppress the time-index. Factors of production are paid their marginal products and capital flows freely between states implying that the allocation of capital across states (for given labor force) is determined solely by TFP levels. In order to stress that the allocation of capital is a function of relative levels of TFP, we write the level of capital in state i, $K(A)$, as a function of the level of productivity in state i, A_i, and then the level of output is given by

$$GDP_i = A_i K(A_i)^\alpha L_i^{1-\alpha}. \tag{1}$$

We assume that the labor force is identical to population and, for simplicity of exposition, that each state initially has the same amount of labor $L_i = \frac{1}{N}L$, where L is aggregate labor. The aggregate U.S. capital stock installed is K and, because we consider the United States to be a closed economy, we can also think of K as being a nationwide mutual fund; i.e., as capital *owned*.

State i owns a positive share ϕ_i in the mutual fund implying that the amount of capital *owned* by state i is $\phi_i K$ where $\Sigma\phi_i = 1$. The amount of capital owned by state i may be installed in any state. K_i is capital *installed* in state i and $K = \Sigma K_i$. With no frictions, capital will flow to state i until

$$R = \alpha A_i K_i^{\alpha-1} L_i^{1-\alpha}, \quad \forall i, \tag{2}$$

where R is the equilibrium gross rate of interest. We ignore risk premia—which are likely to be small when capital ownership is diversified—so the ex ante rate of return to investment is same across all states. The gross income of the U.S. mutual fund is RK and the wage rate in state i is $w_i = (1-\alpha)A_i K_i^\alpha L_i^{-\alpha}$. GNI in state i is, therefore,

$$GNI_i = \phi_i \, RK + w_i L_i = \phi_i \, RK + (1-\alpha)A_i K_i^\alpha L_i^{1-\alpha}, \tag{3}$$

and the GDP/GNI ratio is

$$\frac{GDP_i}{GNI_i} = \frac{A_i K_i^\alpha L_i^{1-\alpha}}{\phi_i \, RK + (1-\alpha)A_i K_i^\alpha L_i^{1-\alpha}}. \tag{4}$$

Empirical issues. In the empirical part of the paper, we consider averages over decades in order to avoid issues related to adjustment of capital. We do not imagine machines being dismantled and carted to other states; rather, we imagine that net investment is higher in states with high TFP and that this can be modelled as malleable capital when long time intervals are considered. The predictions of our model hold as long as systematic net migration across states in *response* to productivity shocks is significantly lower than the mobility of physical capital.[7] We interpret TFP very broadly to include taxes, insurance, cost of heating/cooling, transportation, endowments of oil or minerals, agglomeration benefits etc. It is reasonable to think of capital as all factors of production that rely on investment and TFP as capturing all other non-labor inputs in the production function—investment in human capital that requires investment outlays should be considered "investment" while endowments of abilities should be considered contributions to TFP. Country-level evidence that capital formation is a function of productivity is available in Blomstrom et al. (1996) who perform Granger causality tests and show that growth induces subsequent capital formation more than capital formation induces subsequent growth.[8] The assumption that the United States is a closed economy is not likely to affect our empirical results since our regressions control for aggregate U.S.-wide effects.[9]

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[7]The literature provides evidence that labor mobility is not so fast as to instantly equalize wages across states. Bernard et al. (2005) show that there are significant skilled-wage differences across states which implies low levels of net migration. Bound and Holzer (2000) find that imperfect mobility of unskilled workers in the U.S. contributed toward increased income inequality in the 1980s.

[8]We checked empirically that for OECD countries the *level* of TFP (identified as the Solow-residual) is positively correlated with the *level* of capital (both averaged over 1970–2000) and that the *change* in TFP and the *change* in capital from 1970–1975 to 1976–2000 also are positively correlated. The correlations are 0.21 and 0.37, respectively.

[9]If investment in, say, California is financed by Japanese savings, the output/income ratio of California is above unity and our regression analysis will give the correct results because we control for aggregate effects such that our results are determined only by relative output/income ratios. (The results may be slightly weaker in the case of foreign investments because the income from investment in a state then will not decrease the output/income ratio in other states as it otherwise would.)

2.1 Predicted Ratio of GDP to GNI

We start by examining the case of state-varying ownership shares and assume A_i is constant ($=1$ for simplicity) across states. In this case, the amount of installed capital K_i is the same in each state and equal to $K_i = K/N$, i.e., *installed* capital is spread out evenly across states. In this situation, aggregate $GDP = NGDP_i$ and $RK = RNK_i = N\alpha GDP_i$. Therefore, the *predicted GDP/GNI ratio as a function of ownership for identical productivity levels* is

$$\frac{GDP_i}{GNI_i} = \frac{K_i^\alpha L_i^{1-\alpha}}{\phi_i \, N\alpha \, GDP_i + (1-\alpha)K_i^\alpha L_i^{1-\alpha}} = \frac{1}{N\phi_i\alpha + (1-\alpha)} = \frac{1}{1 + (N\phi_i - 1)\alpha}. \tag{5}$$

This number is smaller than one for states with above average ownership ($\phi_i > 1/N$) and vice versa for states with below average ownership shares.

It is simple to demonstrate that in the absence of productivity shocks the ratio of GDP to GNI reverts to 1 assuming that the saving rate is constant across states. The logic is that wage income is the same in all states when productivity levels are similar and because a fraction $1 - \alpha$ of saving is derived from labor income the overall ownership fraction of each state will slowly revert to the average value of $1/N$. In order to get a quantitative impression of the speed with which mean reversion takes place, we performed a simulation of two states which initially have different ownership shares. We focus on one of the states for which GDP/GNI takes an arbitrary value above 1 in the initial period. With $\alpha = 0.33$, a saving rate of 15 percent, and a depreciation rate of 5 percent per year, the model implies a *predicted half-life of about 15 years for the deviation of the GDP to GNI ratio from 1.*

This calculation ignores forward looking savings behavior. According to permanent income theory, individuals save a smaller fraction of their income the higher the expected present value of current income shocks but, because reliable estimates of differences in savings behavior across states are hard to come by, we prefer to not condition our predictions on models of saving.[10]

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[10]Income is composed of capital income and labor income. If an increase in TFP signals future increases in TFP, residents of a state with strong current TFP growth might expect higher future labor income growth and therefore save less. (Only the relative, "state specific," patterns will matter in our regressions.) This will in turn cause a higher future output/income ratio. We cannot, a priori, rule out the possibility that part of the positive relationship we find between past growth and the output/income ratio is due to this effect. However, this effect is not likely to be large because the evidence shows that current state-specific income growth only *weakly* predicts future state-specific income growth, see Ostergaard, Sørensen, and Yosha (2002). (Of course, consumers may use a larger information set in order to predict future income but it is not clear how we could obtain useful empirical data on this issue.) In any

Consider now the case where all ownership shares initially are identical and equal to $1/N = L_i/L$ where L is aggregate population. For $\phi_i = 1/N$ we have $\phi_i RK = \frac{L_i}{L} RK = \frac{L_i}{L} \alpha GDP$, and the *predicted GDP/GNI ratio for identical ownership shares and varying productivity levels* is

$$GDP_i/GNI_i = \frac{GDP_i}{\alpha \frac{L_i}{L} GDP + (1-\alpha) GDP_i} = \frac{1}{\alpha \frac{GDP/L}{GDP_i/L_i} + (1-\alpha)}. \tag{6}$$

Equation (6) predicts that, after controlling for ownership shares, states with relatively high output per capita will have high values of the output/income ratio. If we interpret equations (5) and (6) as showing the partial effects of changing ownership and output we have the prediction that in a multiple regression the level of output/income ratio will depend positively on the level of output and negatively on (indicators of) ownership shares.

2.1.1 The ratio of GDP to GNI as a function of productivity and ownership

We compare the predicted effects of full capital mobility with that of no capital mobility. From equation (2) we have $R = \alpha A_i K_i^{\alpha-1} L_i^{1-\alpha}$, which implies $K_i = L_i (\frac{\alpha A_i}{R})^{\frac{1}{1-\alpha}}$. When $L_i = L/N$ this implies that the relative stock of capital installed is a simple function of the relative levels of TFP: $\frac{K_i}{K_j} = (\frac{A_i}{A_j})^{\frac{1}{1-\alpha}}$.[11] If all states $j \neq i$ have $A_j = A$ and state j is negligible in the total, then $K_j = K/N$, which implies $K_i = K/N * (\frac{A_i}{A})^{\frac{1}{1-\alpha}}$.

If there is no *net* capital mobility, $K_i = K/N$ and $\phi_i = 1/N$, and equation (3) becomes,

$$\frac{GDP_i}{GNI_i} = \frac{1}{\alpha A/A_i + (1-\alpha)}, \tag{7}$$

which for $A_i > A$ implies that $\frac{GDP_i}{GNI_i} > 1$. However, under full mobility of capital, $K_i = K/N * (\frac{A_i}{A})^{\frac{1}{1-\alpha}}$, and we have

$$\frac{GDP_i}{GNI_i} = \frac{A_i (\frac{A_i}{A}^{\frac{1}{1-\alpha}} K)^\alpha}{\phi_i N \, \alpha A K^\alpha + (1-\alpha) A_i (\frac{A_i}{A}^{\frac{1}{1-\alpha}} K)^\alpha} = \frac{1}{\phi_i N \, \alpha (A/A_i)^{\frac{1}{1-\alpha}} + (1-\alpha)}. \tag{8}$$

A comparison of equations (7) and (8) reveals that the effect on the output/income ratio of an

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event, if capital income is fully diversified there will be no state-specific shocks to capital income so any effect would come only from labor income. Therefore, the direction of capital flows would still be in the direction suggested by the model with a fixed saving rate.

[11]Clark and Feenstra (2003) derive similar expressions.

increase in productivity will be amplified by the inflow of capital in response to the higher level of productivity for given ownership. However, equation (8) also reveals that the stronger positive effect of a positive productivity shock on output/income now can be strengthened or attenuated by the relative ownership share; in particular, a state with large holdings of assets may have an output/income ratio below one even in a period with high growth and productivity.

2.2 Predicted Change in the Ratio of GDP to GNI as a Function of Growth and Population

In this section we focus on the predicted change in the ratio as a function of observable variables. If initial $GNI_i = GDP_i$ and GDP of state i grows while aggregate output is unchanged and L_i is fixed, we find from differentiation of (6) with respect to GDP_i:

$$d(\frac{GDP_i}{GNI_i}) = \alpha \frac{dGDP_i}{GDP_i}, \tag{9}$$

which states that the change in the output/income ratio should be proportional to the percentage change in GDP.[12]

The relative population of U.S. states changes over time due to, in particular, migration. In fact, state-level population growth during the 1980s and state-level net migration relative to population are almost perfectly correlated (with a correlation coefficient of 0.96). The relative differences in population growth are thus almost entirely due to migration. Most migrants are young and bring few assets and we, therefore, consider two cases. Case a) where migrants bring zero assets and case b) where each migrant holds the average portfolio.[13]

In case a) capital income received in state i will be constant at $\frac{1}{N}RK$ and relation (9) will still hold. However, the growth rate of GDP is no longer equal to the growth rate of per capita GDP (which is our growth measure in the empirical section). Since the growth rate of GDP equals the growth rate of per capita GDP plus the growth rate of population we obtain the *predicted growth*

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[12]As a function of TFP the change in GDP can be found to be $dGDP_i = (K_i^\alpha L_i^{1-\alpha} + A_i \alpha K_i^{\alpha-1} L_i^{1-\alpha} dK_i/dA_i)dA_i$. We focus on the relation between output/income and the GDP growth rate because the latter is directly observable.

[13]In reality, each migrant probably does not hold the average portfolio. Migration to states such as Arizona and Florida is dominated by wealthy elderly migrants. We control for the number of retirees in each state in our empirical implementation.

in the GDP/GNI ratio as a function of output and population when migrants have zero assets:

$$d(\frac{GDP_i}{GNI_i}) = \alpha \, \frac{d(GDP_i/L_i)}{GDP_i/L_i} \; + \; \alpha \, \frac{dL_i}{L_i} \; . \tag{10}$$

In case b) the capital income received in state i is $\frac{L_i}{L}RK$ where L_i is no longer a constant. We derive the change in the output/income ratio as a function of GDP growth and population growth as

$$d(\frac{GDP_i}{GNI_i}) = \frac{\partial(\frac{GDP_i}{GNI_i})}{\partial GDP_i} dGDP_i \; + \; \frac{\partial(\frac{GDP_i}{GNI_i})}{\partial L_i} dL_i \; .$$

We find the *predicted growth in the GDP/GNI ratio as a function of output and population when migrants have average asset holdings* is

$$d(\frac{GDP_i}{GNI_i}) \;=\; \frac{\alpha}{GDP_i} \, dGDP_i \;-\; \frac{\alpha}{L_i} \, dL_i \;=\; \alpha \frac{d(GDP_i/L_i)}{GDP_i/L_i} \; . \tag{11}$$

In this case, the change in the output/income ratio is proportional to the growth rate of output per capita. A regression that allows for growth in output per capita as well as for population growth will, therefore, be consistent whether case a) or case b) holds; however, the coefficient to population growth will be zero in case b).

In summary, our model makes the empirical predictions that 1) in a multiple regression the output/income ratio will depend positively on the level of output and negatively on (indicators of) ownership shares; 2) the output/income ratio reverts to its mean of 1 with a half-life of about 15 years; and 3) a change in output is followed by a change in the output/income ratio of about α times the growth in per capita GDP—with an additional term, α times population growth if the increase in population is dominated by migrants arriving without savings.

3 Data

We use data from the Bureau of Economic Analysis (BEA) unless otherwise stated. All nominal variables are converted into 2000 prices using the consumer price index. We provide a more detailed description of the variables in the data appendix.

State-level GDP, denoted gross state product (GSP), is published by the BEA as part of the U.S. state-level national accounts. GSP is derived as the sum of value added originating in all

industries in the state, thus, it is exactly the state-level equivalent of GDP. GSP numbers are based on income generated in establishments and the main sources are industrial censuses such as the census of manufactures. GSP is available for the years 1977–2000. Previously published, but no longer updated by the BEA, GSP is available since 1963, but that data is not fully compatible with the data post 1977 and hence we use this data only in our figures.

Our main measure for income is state-level personal income (SPI), which is available from the BEA. While it might seem preferable to use approximate GNI numbers for easier comparison to country-level data, we prefer to focus on the results based on simple SPI since a large number of imputations are needed for our approximation of GNI. SPI is based mainly on surveys of individual income. We show the relation between GNI and GDP in the aggregate U.S. National Income and Product Accounts in appendix A and we discuss the calculation of GSP and SPI in detail in the data appendix.

A simple modification of SPI that may make the data correspond better to GNI is to use SPI *minus* federal transfers, rather than simply SPI. The transfers included in SPI involve redistribution (typically) from richer to poorer individuals and, in particular, redistribution from younger to older individuals. A second modification, which is the closest approximation to "state-level GNI," is to calculate "state income," which is the income 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 following Asdrubali, Sørensen, and Yosha (1996). "State income" plus retained corporate earnings is an approximation to GNI; see the data appendix for details. Retained corporate earnings are not available by state and we impute the state-level numbers from aggregate data.[14] One last modification, that will make the difference between SPI and GSP correspond more closely to the capital income component of factor income flows (while making it less similar to GNI) is to subtract from the SPI of state i the (net) income that commuters living in state i earn in other states, since

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[14]We allocate aggregate retained earnings to states by allocating each state a share which corresponds to the share of that state in total personal dividend income. By imputing aggregate corporate retained earnings to states using fixed weights (the share in personal dividend income) we might be biasing our results towards finding a positive relation between past growth and current output/income ratio. This could happen if corporate earnings in high growth states belong to residents of such states due to preferences for investing locally ("home bias"). (We owe this observation to Julio Rotemberg.) However, Coval and Moskovitz (1999) find that local home bias within the U.S. is not that big: the tendency to invest locally is there, but they find that only 20 percent of investors' portfolio is biased towards local securities. We also checked the ratio of imputed corporate retained earnings to state personal income both for levels (10 year average) and changes (from decade to decade). This is a small number; around 0.03–0.04 for most of the states.

commuter's income is equivalent to the foreign earnings of country's residents. We are able to do so using the "adjustment for residence" data from the BEA. This adjustment is equal to the wage income earned by residents of state i that work in other states (not i) minus the wage income earned by residents of other states (not i) that work in state i. Thus, it is the wage component of a state's "foreign" (from other states) net factor income.

A different approach is to use direct estimates of net external assets for U.S. states 1971–2001 imputed by Duczynski (2000). His net asset estimates are based on personal property (dividend, interest, and rental) income. Personal dividend income constitutes only about 5 percent of total personal income—a fraction much lower than the share α (typically 0.33) of output accruing to capital. Duczynski scales the data such that the aggregate net asset position of all states agrees with the net asset position of the United States. However, the resulting estimates of net capital income flows may well underestimate the extent of net capital income flows for some states because capital income flows between firms in different states may never enter personal property income. For example, capital income may be paid from a company in one state to a bank in another state and then paid as salaries to bank employees without ever becoming personal dividend income. Budd and Slaughter (2000) provide direct evidence that corporations smooth wages across production units in separate countries, which is consistent with net capital income moving across state borders and entering personal income in other states as wage income. For other states, with high rental income, Duczynski's measure may overstate out-of-state ownership because rental income typically is derived from properties in-state. In spite of these differences, we find it important to also use Duczynski's data because they are direct measures of net ownership and therefore provide independent substantiation of our hypothesis that capital on net does flow between states in response to output shocks.

4   Empirical Analysis

4.1   The Output/Income Ratio

The output/income ratio is our measure of the relative magnitude of net inter-state capital income flows to a state. If such flows are zero, the ratio is unity; if they are negative, the ratio exceeds unity; and if they are positive, the ratio is less than unity. We calculate this ratio for each U.S.

state year-by-year, which allows us to study the patterns of inter-state capital income flows over time.

The variables SPI and GSP contain aggregate (U.S.-wide) components—in particular, the burgeoning U.S. balance-of-payments deficits—that may vary over time affecting the output/income ratio for individual states. These aggregate effects are not of interest to us in the context of inter-state capital mobility. To correct for this, we use the normalized output/income ratio:

$$\text{Output/Income}_{it} \; = \; \frac{\text{GSP}_{it} \, / \, \text{SPI}_{it}}{\text{GSP}_t \, / \, \text{SPI}_t} \, ,$$

where,

$$\text{SPI}_t \; = \; \Sigma_i \, \text{SPI}_{it}, \quad \text{GSP}_t \; = \; \Sigma_i \, \text{GSP}_{it} \, .$$

The ratio $\text{Output/Income}_{it}$ captures state i's output/income ratio in year t relative to the aggregate output/income ratio of the U.S. states.

4.2 State "Current Accounts:" Estimates from Romans (1965)

In table 1, we show state-level "current accounts" for U.S. states for 1953 and 1957 (the only years available)—more precisely, we display saving minus investment for these years as estimated by Romans (1965). Those numbers clearly show that saving minus investment was very large and negative for southern states as well as for oil states, which we consider in detail shortly. It is clear that during this period capital was flowing from the north and west to oil-rich states such as Texas and Louisiana, as well as to states in the old south, such as Mississippi and Alabama, which were in the process of catching up. The states with large negative values of saving minus investment in the 1950s tend to be the states with high output/income ratios in the 1980s and 1990s.

We examine directly if the output/income ratio captures past "current accounts" by regressing the output/income ratio averaged over 1963–70 on the average of "current accounts" normalized by population from Romans for the years 1953 and 1957 (averaging may reduce measurement error). The results of this regression are displayed in the first column of table 2. We find a highly significant value of the coefficient to the past "current account" with an R^2 of 0.51. Clearly, there is a strong relationship between the output/income ratio and the "current account" ten years earlier. In columns 2–4, we display the results for similar regressions for the decades of the 1970s, 1980s,

and 1990s. We observe a decline in the explanatory power as we consider more recent decades but the "current account" from the mid 1950s is still a significant determinant of the output/income ratio in the 1990s with an R^2 of 0.19. Of course, the declining R^2 for more recent decades is fully consistent with our model, which predicts that the output/income ratio tends to revert to unity. The coefficient of 0.1 implies that a thousand dollar increase in per capita current account deficit (in 2000 prices) in the mid 1950s led to a 0.1 increase in the log output/income ratio in the 1960s and 1970s. Overall, the results using Romans' data provide evidence supporting the notion that the output/income ratio traces past net capital flows.

Table 3 provides direct evidence for countries that the ratio of GDP to GNI (averaged over the 1990s) is a significant indicator of past current account balances (averaged over the 1980s). Column (1) of table 3 shows the regression of the GDP/GNI ratio on the current account normalized by population. We consider this specification for comparison with the state-level data and we find a coefficient that is strongly significant statistically, although somewhat smaller than the comparable coefficients in table 2. This may reflect exchange rate fluctuations, policy intervention, etc., but a further study of this will take us too far afield. The second column of table 3 shows the regression of the GDP/GNI ratio on the current account normalized by GDP—this specification is more natural to interpret and it shows that the effect is large in economic terms as a country with a current account deficit in the order of 10 percent of GDP is predicted to have a GDP/GNI ratio that is 7 percent higher in the following decade.

4.3   Graphical Evidence: 1963–2000

Figure 1 shows the output/income ratio and the growth rates for eight U.S. Census regions relative to the average across states where the average is normalized to unity. We aggregate to regions in order to get a manageable amount of graphs. The "big picture" that emerges is one where the Southwest had relatively high growth in the 1960s while the Great Lakes and New England had relatively low growth. For New England, this situation rapidly reversed in the 1980s while the Great Lakes regions only slowly recovered to reach the middle of the field by year 2000. The figure also reveals that New England, the Mid East, and the Great Lakes regions consistently have lower output than income, while other regions exhibit higher output than income. The general pattern corresponds well with the historical pattern of high output and income in the central and

northeastern states around the turn of the century—see North (1961). Part of this income is likely to have been invested in other regions, resulting in capital income flows from those regions in the later part of the 20th century.

A significant change in the output/income ratio relative to other regions is found for the Great Lakes. This region saw a steady decrease in the ratio throughout the 1960s and 1970s moving from above to below average.[15] Another significant change is the decline in the output/income ratio for the Southwest at the same time as the output/income ratio increased in New England. These patterns are exactly what our model would predict conditional on the growth patterns: the Great Lakes region throughout our sample was a laggard in terms of relative growth. This region should, according to our model, have been a net supplier of capital to other regions and, consequently, have experienced a slowly declining output/income ratio—exactly as we observe. New England, on the other hand, experienced a rapid reversal of fortune in output growth in the 1980s (at the time referred to as the "Massachusetts miracle") and, therefore, the output/income ratio of New England should have been rapidly increasing. And that is exactly what is borne out by the data. The pattern for the Southwest is the inverse of that found for New England and, again, consistent with our model.

One may notice from figure 1 that even during the period of the mid-1980s where the growth rate of New England was about twice the national average, the output/income ratio for New England stayed below unity. This is consistent with our model when net capital flows are large: New England was a net supplier of capital to other states in the 1950s (and, likely, 1960s) and therefore a net creditor at the beginning of the 1980s (corresponding to an above average value of ϕ_i in the model) and, therefore, the output/income ratio stays below unity as predicted by equation (8)—but not by equation (7) which shows the predicted output/income ratio with full diversification but no net capital flows.

The large changes in oil prices that occurred during the period 1973–74 and 1979–87 are clearly visible in figure 1. The output/income ratio of the southwest region, which contains most of the major oil-producing states, increases due to the oil price hikes in the 1970s and then declines steeply in the years following the Iranian revolution in 1979. Figure 2 explores directly if oil price spikes

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[15]We don't display further details, but a closer study reveals this pattern to mainly be driven by Michigan, likely due to the car industry in Detroit attracting significantly less capital after 1970 than it did earlier.

were reflected in changes in the output/income ratio for states with high output of oil ("oil-states"). We plot the average world price of crude oil and the output/income ratio for the oil-states Alaska, Louisiana, and Wyoming for the years 1963–2000. There is a clear observable pattern with the output/income ratio of these states increasing following (with about a year's lag) steep increases in the price of oil and *vice versa*. This pattern is fully consistent with oil exploration having been financed by other states which in periods of high oil prices receive relatively higher factor income from the oil states.

The very steep changes in the output/income ratio for the oil-states in the 1980s are likely to partially reflect very high returns to capital due to high prices of oil (captured as "productivity shocks" in our model). Therefore, it may be tenuous to directly identify the output/income ratio with net ownership positions, especially in periods of rapidly changing relative prices during which differential returns to capital may be the driving force.

4.4   Specification of Regressions

Our first set of estimations regress the *level* of the output/income ratio on the *level* of output and indicators of ownership and other regressors. Our model predicts that the output/income ratio depends positively on output but we avoid using as a regressor GSP data for exactly the same sample as we use for the output/income ratio for the simple reason that GSP is used in the numerator of this ratio. If GSP is measured with error, such measurement error would lead to a spurious positive correlation of GSP with the output/income ratio and we, therefore, use the logarithm of per capita GSP averaged over the four years (1977–1980) prior to the years used for measuring the output/income ratio (1981–2000). For this empirical strategy to be valid it is important that TFP shocks are persistent such that high output pre-sample is highly correlated with high output in the sample. Glick and Rogoff (1995) provide direct evidence of high persistence of TFP shocks at the country-level. Indirect evidence for U.S. states can be found in Barro and Sala-i-Martin (1991 and 1992). In their growth regressions for U.S. states over decades of the 20th century they find much higher R^2 values when they allow for sectoral shocks—sectoral shocks that vary by decade are consistent with the state-level aggregate A_i changing at the 10-year frequency because states have different sectoral compositions. Indirect evidence of persistence can be found by using the unofficial GSP data going back to 1963 to verify that a high value of GSP in $1977-1980$

typically is capturing growth in the preceding years—and therefore likely to be related to currently high TFP. Regressing output from 1977–1980 on output in 1963–1966 (averaged to minimize noise) and growth from 1966 to 1977 we find that the growth rate is highly significant. For brevity, we do not include tables with these results.

According to our model ownership ratios predict the output/income ratio with a negative co-efficient. Reliable measures of net ownership are not available and we examine if indicators of historical wealth predicts current output/income ratios. As our measure of historical wealth, we use the logarithm of per capita average (over 1939–1949) value of dividend and interest income by state.[16] We have access to this data since 1929 and we prefer values that are distant from the income data used to calculate the current output/income ratio and not too close to the 1977–1980 period to avoid high collinearity with the output data. For that reason, and in order to avoid the financial upheavals of the great depression, we chose the 1939–49 sample. The results are not very sensitive to exactly which sample is chosen, except that the coefficient to this variable is smaller if we use the data from the 1930s.[17]

Oil deposits are highly concentrated in relatively few states that likely obtain a large fraction of the required capital from outside sources—this is most clearly observed in Alaska where the large multinational oil companies have made large investments. As such investments are amortized the output/income ratio of oil states would be expected to be larger than unity. Also, oil-price shocks are equivalent to observable TFP-shocks for oil states and we expect to find a positive relation between the output/income ratio and the value of oil. We do not have direct measures of the value of natural endowments of oil and minerals, so we approximate it for each state by the share of the gross product of the oil and mineral extraction sector in total GSP. We take the average over 1977–80.

Our model does not allow for differences in age of population, but if life cycle saving affects the patterns of net capital flows, then states with a relatively high number of retirees would have higher income relative to output because retirees typically contribute little to output but nevertheless have

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[16]The historical dividend and interest income data is made available to us by the BEA. The BEA publishes the sum of dividend, interest, and rent income, together with other income data, going back to 1929. We prefer to use data that does not include rental income, because this type of income is typically due to locally used and owned property.

[17]We obtain similar results if we leave out the World War II period. One reason might be that dividends were still paid out during the war years.

income from retirement savings. We use the share of residents aged 65 and above in the population of each state in 1980 as a regressor in order to examine potential impacts of life-cycle saving. This will also control for the migration of elderly retirees to sun-belt states.

Our second set of estimations regress the *change* in the output/income ratio on *growth*. The model makes the clear prediction that the change in the output/income ratio is a function of output growth. We show the bulk of our results for the change in the output/income ratio from the 1980s to the 1990s. We choose to regress this change on growth during the 1980s in order to minimize the impact of measurement error, although the coefficient to growth is likely to be biased downwards.[18]

More precisely, we average the output/income ratio over the 1990s and over the 1980s and calculate the change. We then regress the change in the output/income ratio from the 1980s to the 1990s on the growth rates of GSP per capita in the 1980s (The regressor is the total growth over the decade 1981–1990). The model predicts a positive coefficient. Further, we include population growth during the previous decade which according to the model will have a coefficient between zero and the value of the coefficient to lagged output growth. The averaging across decades removes most short-term business cycle effects which are outside the scope of our model.

If we average the output/income ratio over a shorter span of years we can perform panel data regressions and we do so to examine the issue of mean reversion in the output/income ratio. We discuss the exact implementation of the panel data regressions with the empirical results.

4.5   Descriptive Statistics

In table 4, we tabulate dividend and interest income by state averaged over 1939–49 (no data available for Hawaii and Alaska), GSP growth over 1981–1990, GSP averaged over 1977–1980 and the output/income ratio averaged over 1981–2000. The table reveals very large geographical differences in dividend and interest income with the northeastern states displaying much higher levels than southern states, although Illinois and California also rank quite high on this measure. Delaware is an extreme outlier, especially regarding dividend income. GSP 1977–1980 also shows

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[18]This bias may be due to classical measurement error because we use lagged rather than contemporary growth but also from the fact that we regress (suppressing the aggregate variables) $\frac{\sum_{t}^{t+9} \frac{\text{GSP}}{\text{SPI}}}{10} - \frac{\sum_{t-10}^{t-1} \frac{\text{GSP}}{\text{SPI}}}{10}$ on $\log(\text{GSP}_{t-1}) - \log(\text{GSP}_{t-10})$ where a time-period t is a year. If there is measurement error in GSP_{t-1} it will affect the regressor positively and the regressand negatively leading to downward bias. If we instead regress on contemporary growth $\log(\text{GSP}_{t+9}) - \log(\text{GSP}_{t})$ measurement error in both current and lagged output will affect the regressand and the regressor with similar signs leading to upward bias.

high variation with Alaska having an extremely high value of about 63,000 dollars per capita. Next highest is Wyoming—another oil state (included in our estimation sample)—at 43,000 with Mississippi bringing up the rear at only 18,600. The oil states with the highest output levels also have the highest output/income ratios, with Alaska having the highest ratio of 1.63, followed by Wyoming at 1.37. The lowest ratio is found for Florida, likely reflecting capital income received by retirees no longer in the work force. In the following empirical analysis, Delaware is left out (as well as Hawaii and Alaska). Including Delaware has the effect of rendering the dividend and interest income variable less significant statistically but our main qualitative results are robust to the inclusion of this state.

Table 5 reports the mean, maximum, minimum, and standard errors (across the 50 states) of the output/income ratio and the regressors (including some that will be discussed in more detail in the examination of robustness below). The output/income ratio has a mean of about 1 by construction (not exactly 1 due to normalization by the aggregate rather than the average U.S-wide variables) and has a standard deviation of 0.12—this is a large amount of variation because a value of, e.g., 1.12 means that 12 percent of value produced shows up as income in other states on net. GSP 1977–1980 also shows large variation with the value of the output of the most productive state being more than 3 times than that of the least productive state. In general, the regressors display large variation. The standard deviation of the change in the output/income ratio from the 1980s to the 1990s is 0.11 which means that—over a decade—a change of 10 percentage points or more in the fraction of output in a state that is paid out on net to other states is not uncommon. There is somewhat less variation in the percent of retirees in the population or the percent of individuals with a tertiary degree (college or more).

GSP growth from 1981 to 1990 has a standard deviation of 15 percent, which means that several states grew more than 1.5 percentage point per year faster than the average state during that decade. This large variation in growth rates makes it possible for us to examine the main implication of our model with good precision. Population growth also displays large variation across states with Nevada increasing population via in-migration by as much as 36 percent in the 1980s while West Virginia lost 9 percent of its population over that period.

4.6 Correlation between Regressors

In table 6, we display the matrix of correlations between the regressors (and the regressand) in levels in the top panel and in growth rates in the lower panel. These correlations are calculated for the sample of 47 states that are used in the regression analysis. The highest correlation for this sample (0.68) is between the north indicator dummy for northern regions and dividend and interest income reflecting the movement of capital from the northern regions in the early part of the century. Average dividend and interest income 1939–1949 and average GSP 1977–1980 are positively correlated with a correlation of 0.43. This correlation is, however, not so high that it precludes obtaining estimates of the separate impact of these regressors. Average oil share 1977–1980 is positively correlated with GSP but not with dividend and interest income and this variable is negatively correlated with the manufacturing share. Average agriculture share 1977–1980 is negatively correlated with the dummy for northern regions and with dividend and interest income. Another notably high correlation is that of human capital (number of people with tertiary degrees as a fraction of population in 1989) with dividend and interest income (0.60). Average population growth 1977–1980 is positively correlated with output and negatively correlated with dividend and income while the share of retirees in the population in 1980 is negatively correlated with population growth. The regressand has a high correlation with oil (0.75) and with GSP and a negative correlation with dividend and interest income.

The lower panel reveals that GSP growth from 1980 to 1990 and population growth from 1980 to 1990 are weakly correlated with a correlation of 0.17 while the change in the output/income ratio is highly correlated with GSP growth with a correlation of 0.64—the change in the output/income ratio has a positive correlation with population growth.

4.7 Results from Cross-Sectional OLS Regressions

Level regressions

Our main results for the level regressions are presented in table 7. The regressions are performed for 47 states because we do not have dividend and interest income for Alaska and Hawaii and Delaware is very atypical. Alaska is also very atypical, with an extremely high share of GDP due to oil-extraction—the results in column (1) would be somewhat more statistically significant if Alaska were added (see section 5). Column (5) displays the results for our main specification but, in order

to evaluate the impact of individual regressors as well as robustness, we show in column (1) the regression of the output/income ratio on (a constant and) GSP 1977–1980 and add regressors one-by-one in the remaining columns in the order in which we found the regressors to be of interest a priori.

In column (1), GSP 1977–1980 is statistically significant at conventional levels. This variable explains 34 percent of the variation in the dependent variable according to the R^2 and the coefficient is positive. A positive sign is consistent with capital flowing to productive states with high output. The coefficient is about 0.3, which implies that a state with output 10 percent above average has a ratio of output/income 3 percent above average, everything else equal. Since the output/income ratio is 1 on average this implies that a state that produces 50 percent more than the U.S. average is predicted to have an output/income ratio of about 1.15, which means that approximately 15 percent of the state's output accrues to income in other states. Thus, the estimated coefficient is clearly large in terms of economic significance.

Dividend and interest income, added in column (2), predicts the current output/income ratio negatively, as predicted, with a very high t-statistic even though the historical variable refers to observations more than 50 years ago. The estimated coefficient implies that states with a 10 percent higher than average level of interest and dividend income in the 1940s has an output/income ratio that is almost 1 percent lower today. If states with relatively high income in the past invested their savings in states with high total factor productivity, this is what we would expect to find. It is maybe more surprising that the effect is as long lasting as this result indicates.

The coefficient to oil share, in column (3), is likewise highly statistically significant. The inclusion of this variable lowers the coefficient to GSP 1977–1980 somewhat relative to column (2), but this is exactly what our model would lead us to believe: an oil price shock is an direct measure of productivity of capital in the "oil states" and including oil share should, therefore, lower the impact of GSP 1977–1980. The impact of oil, as measured from the regression, is large—the coefficient of about 0.56 implies that a state, such as Wyoming, with a fraction of oil in GDP of 0.25, has an output/income ratio of 1.14, *ceteris paribus*, implying that 14 percent of output shows up as income in other states due to the effect of this variable alone. Wyoming's output is on the order of 40,000 dollars, and 14 percent of that is about 6,000 dollars, which—if we assumed a rate of return of 10 percent, would imply that capital in the oil-extraction sector in the amount of 60,000 dollars

per capita is owned by out of state residents. While this number is based on several imputations and not likely to be exact, it highlights that on average the amount of out-of-state capital invested in oil-extraction (capital that is installed in Wyoming but owned by other states) is very large.

Adding the percent of retired persons in the population, in column (4), we find a negative significant coefficient in line with our expectations. This supports the notion that retirees receive income from savings but contribute little to output. This coefficient is also large in economic terms. A state like Florida has almost 50 percent more retirees than average and our results predict that Florida has an output/income ratio 5 percent below average because of the large number of retirees in the state.

Our model predicts that relative population growth may affect the change in the output/income ratio and, therefore, also the level. However, it is perfectly possible that the level of the output/income ratio is not correlated with (recent) population growth and, as shown in the last column, this is clearly the case.

Change Regressions

Table 8 explores whether the change in the output/income ratio is explained by per capita output growth and population growth as predicted and whether population growth affects the change in the output/income ratio consistent with the model. We include a constant in the regression so the estimated effect of, say, output growth can be interpreted in line with the model prediction for a change in output keeping the aggregate constant.

The effect of GSP growth from 1980 to 1990 is statistically significant and this variable alone explains 40 percent of the variation in the output/income ratio. In autarky, the output/income ratio would be constant and equal to 1.0 and no regressors would be significant. The significant positive coefficient to GSP growth from 1980 to 1990 supports our interpretation that an increase in TFP brings about growth and capital inflows. The estimated coefficient of about 0.3 implies that a state which from 1980 to 1990 grew 10 percent faster than the average state (1 percent faster during the 1980s at the annual rate) would have an output/income ratio that would be 0.03 higher in the 1990s than in the 1980s.[19] In section 2, equation (9), we found the prediction that the output/income ratio will increase by about α times the percent change in GDP. The typical estimate

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[19]For example, North Carolina's per capita GDP grew 13 percent faster than average GDP over the 1980s.

of the capital share α is around 0.3, and our estimated value hits the "bulls eye" for this coefficient. For international data, Glick and Rogoff (1995) regress changes in gross investment and current accounts on to the changes in TFP and find that gross investment reacts stronger than the current account which is add odds with theory under the assumption of perfect capital mobility.[20] While we are not able to run exactly the same regression as Glick and Rogoff (due to the fact that we cannot calculate the Solow residual) our results, nonetheless, indicate that interstate capital movements are much better described by the frictionless model than the international capital movements.

We can get a rough order of magnitude of the net capital income flows involved as follows: the average per capita output of a state over our sample is about 30,000 dollars. An increase in the output/income ratio of 0.03 corresponds to 900 dollars worth of capital income being paid to other states annually. If this increase is mainly caused by a change in net ownership rather than a surge in productivity, we can expand on the quantification. If the return to capital is (say) 10 percent, this would imply that capital in the order of 9,000 dollars per capita were financed on net by other states.

We pointed out earlier that our estimate will suffer from downward bias due to the use of lagged output growth, especially if it is measured with error. To explore this possibility we run a contemporaneous regression by regressing the change in the output/income ratio from 1980s to 1990s as before on the growth rate of GSP per capita in 1990s (the regressand is growth over 1991–2000). We obtained a (not tabulated) value of 0.62. This value is likely to be more severely affected by (upward) bias if there is measurement error. Therefore, there is some uncertainty regarding the value of the estimate but the data clearly indicates a large impact of growth on the capital income flows in the direction and of the order of magnitude suggested by the model.

In the second column, we add the rate of population growth. The difference in population growth rates between states is mainly due to migration (the correlation between the two in the 1990s is 0.96). Equations (10) and (11) imply that the coefficient to population growth should be equal to capital's share in output if migrants typically bring zero assets; and if migrants bring average amounts of assets the coefficient will be 0—values between 0 and capital's share of output have meaningful interpretations within our model. The estimated value is 0.08. We cannot strictly reject

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[20]Gruber (2000) even finds *no* responsiveness of the current account to real growth rates for a panel of OECD countries during 1975–2000.

(at the usual 5 percent level) that migrants bring average assets, nor can we reject that migrants bring 0 assets. However, both of these extremes are near the end of the 95 percent confidence interval so the results are consistent with migrants being a mix of probably young migrants with zero assets and older migrants with average (or, in the case of retirees, above average) assets.[21]

No other regressors were found to be significant, but many of our regressors change only slowly over time and may display little variation even from decade to decade, in which case the *change regressions* will not be able to pick up the potential effects.

5 Robustness Analysis

5.1 Other Measures of Income

The validity of the way we interpret the results is highly dependent on the difference between output and our income variable being a reasonable approximation to net capital income from other states, so we find it important to demonstrate that our main results are robust to reasonable alternative ways of calculating our income variable.

Table 9 explores whether the *level regressions* are sensitive to the precise definition of "income" in the denominator of the output/income ratio. Overall, the estimates are quite robustly estimated, with the signs and relative magnitudes showing little variation across the first four columns—the regressand has a different interpretation in column (5). Column (1) replicates fourth column of table 7 for easy reference while in column (2) personal income is adjusted for federal transfers; the only meaningful effect of this adjustment is on the estimated impact of retirees in the population, which becomes statistically insignificant. This indicates that a large part of the income of retirees consists of federal transfers (notably social security and medicare) which, of course, is fully consistent with casual observation. In column (3), we adjust personal income for cross-state commuters' wage income. This adjustment lowers the coefficients to dividend and interest income and GSP 1977–1980, although these regressors are still statistically significant. The coefficient to oil share is similar to the one found column (2). In column (4), approximate GNI is used rather than personal

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[21]We attempted to also include as a regressor the rate of net inter-state migration as a percent of state population $1975 - 1980$ in order to directly examine the issue of migration. The migration variable is, however, so closely correlated with population growth that we obtained non-sensible results due to multi-collinearity. Substituting the population growth rate with net inter-state migration gives very similar results but we opt for population growth rates since we have this variable available at an annual frequency over a longer time period.

income but the estimated coefficients are quite similar to those of column (1) except that percent of population that are retired is not statistically significant since federal transfers are not part of this approximate GNI. Nonetheless, the overall impression is that our main results are robust to the way the income variable is measured. In column (5), we use Duczynski's (2000) estimates of net external liabilities. Since now the regressand is the stock of liabilities per capita, the order of magnitude of the estimated coefficients is different. For example, the coefficient to GSP 1977–1980 implies that a 10 percent higher output is associated with an approximate 2,000 dollars higher net per capita liabilities. If rates of return are roughly similar across states, say 10 percent, this can be translated into net factor income flows: an increase in output from 20,000 dollars to 22,000 dollars and a change in liabilities from (say) 0 to 2,000 dollars would lead to a change in outgoing capital income flows of 200 dollars per year and a change in the output/income ratio from 1 to 22,000/21,800=1.01. This 1 percent increase in the output/income ratio is smaller than the 3 percent increase suggested by the results of table 7. However, Duczynski's data captures only net flows and is not intended to capture the differences in the output/income ratio due to productivity changes for identical ownership shares as illustrated by equation (7). The overall message of the results is, however, similar to that obtained using the output/income ratio and the t-statistics are statistically significant as well when we use Duczynski's net asset variables. Another implication of these results is that our results are not solely driven by movements in the labor income part of SPI because Duczynski's data is based only on property income. The remaining results for net external liabilities are perfectly sensible: states with high income in the past still have lower levels of net liabilities, oil states have high levels of liabilities, and states with many retirees have lower levels of net liabilities. Overall, the results using net liabilities all support our previous interpretations.

In table 10, we examine whether the *change regressions* are sensitive to the definition of "income." Column (1) repeats our preferred regression, while column (2) shows the results of the same specification when personal income is adjusted for federal transfers. In column (3), we adjust personal income for cross-state commuters' wage income. By doing so we isolate the component of wage income generated within the state borders but the results are robust to this modification. The estimation results are virtually identical across the first three columns and, therefore, robust the which measure of income we use. In column (4), we use a more elaborate approximation to GNI based on the "state income" variable as discussed in the data appendix. In column (5), we

consider Duczynski's data again. We find that states with high growth in the 1980s increased their net external liabilities and, therefore, held relatively fewer net assets in the 1990s, consistent with capital flowing into the high-growth states on net. The results imply that a state which grew 10 percent faster than average from 1981 to 1990 (1 percent annually) increased its net liabilities by about 4219 dollars per capita (42,190 times 0.1). If GSP 1977–1980 was 25,000 dollars on average, this implies that in order to increase output by 2,500 dollars, capital in the amount of 4219 dollars was attracted from out of state. This number is not comparable with that of the previous columns but it confirms that capital on net flows to states with positive TFP shocks.

5.2   Additional Control Variables

We show that the results are robust to the inclusion of some other variables that are likely to be correlated with ownership and productivity. We consider *Geography*. Historically, the northern states were the seat of U.S. industrialization and much wealthier than the south. Anecdotal evidence suggests that capital has moved to the U.S. South as labor productivity was catching up with the North due to improved education as described by, e.g., Connolly (2003) and Caselli and Coleman (2001). We define a dummy variable, which takes the value 1 for New England, Mid-East, and Great Lakes and 0 for other regions.[22]   We also consider some *Sectoral Shares* other than oil. Historically, agricultural areas have often been laggards in terms of TFP growth, but this may not be true in recent periods for the U.S. It is also the case that farms typically have relied little on foreign capital, although this seems to be changing: large farms in parts of the country are highly capital intensive and it is possible that part of this capital has been financed from other states, although only recently has the farming sector seen major trends towards a corporate structure (see Drabenstott 1999). We include the share of agriculture in GSP in the same way (and for the same sample) as for the oil and mineral extraction share in GSP. We further include the share of manufacturing in GSP. In order to dampen the impact of outliers, we use the transformation $\log(1+x)$ for all the endowment variables. Last, we consider measures of *Human Capital*. Residents in states with a relatively high number of educated individuals may have higher output relative to

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[22]We constructed this dummy variable after experimenting with dummy variables for all regions in multivariate regressions including our other regressors. The estimated effects were consistent with these three regions being different from the remaining regions. This result, of course, corresponds to the fact that these are the three regions with low output/income ratios in figure 1.

their income if individuals with college degrees (partially) financed their student loans from savings in other states. Alternatively, high human capital may be correlated with a high level of TFP and again we would expect that human capital would be correlated with a high output/income ratio. We control for human capital, which is measured as the number of college graduates in a state relative to population in 1989 (the first available year for this variable).

The first column of Table 11 demonstrates that the effect of GSP 1977–1980 is still significant for the *level regression* when all 50 states are included while the other columns explore the role of adding the additional regressors to the specification in table 7. Due to the somewhat limited number of degrees-of-freedom, we add each of these regressors one-by-one. (We experimented with regressions that simultaneously allowed for more, or even all, potential regressors. The results from such regressions show the same patterns as table 11.) The results of table 11 point to none of the additional regressors being significant. The coefficient to the dummy variable north is not significant. In (not tabulated) regressions where dividend and interest income is left out, the regressor north is highly significant. This agrees with the historical record of capital flowing from the northeast to the rest of the U.S. as people moved (broadly speaking) West and South and investment opportunities opened up in these regions. This effect is, however, better captured by the dividend and interest income variable in the sense that the multiple regression clearly assigns the significant coefficient to this economic variable rather than the geographic variable. We find an insignificant positive coefficient to human capital, manufacturing share and an insignificant negative coefficient to agricultural share.

We did the same exercise for the *change regressions* (not tabulated) and nothing entered significantly. Most likely, these regressors change too slowly even from decade to decade.

5.3   Panel Regressions

Our regressions so far used data averaged over a time-interval of a decade. In choosing the interval length we face a trade-off. For long enough intervals adjustment costs in investments can be taken to be negligible and business cycle effects will average out. However, even if there is ample evidence that (relative) productivity shocks are persistent, these shocks do not last forever and we may obtain higher variation in growth rates if we consider shorter intervals. It is, therefore, important to verify that our results are robust to other reasonable choices of interval length.

In table 12 we show regressions for 10-year intervals, 7-year intervals, and 5-year intervals. The panel data setting is also ideal for examining the final prediction of our model, that the output/income ratio is mean reverting with a half-life of about 15 years. We examine this by adding the lagged output/income ratio as a regressor.

The estimated coefficient to lagged growth is lower than in table 8 which is due to the high correlation with the lagged output/income regressor. It is significant in columns (2) and (3) at the 5 percent level and in column (1) at the 10 percent level.[23] The coefficient to the lagged ratio measures how much the output/income ratio would revert towards unity, ceteris paribus, during one time period—when the length of the time period becomes shorter this coefficient should become smaller and this is what we find. The estimates imply similar half-lives for the reversion of the output/income ratio to unity. For example, the estimated coefficient to the lagged ratio of –0.32 in column (3) implies that about a third of a deviation of the output/income ratio from unity will disappear over 5 years. The coefficient to population growth declines with the interval length which may be due to limited variation in population growth at shorter intervals. However, the estimated values all are consistent with our model and indicate that some migrants bring no assets and others—maybe the majority—bring the average amount of assets with them.

All in all, the results of the panel regression are robust to the choice of period length (when it is 5 years or longer) and consistent with our model especially regarding migration and mean reversion, while the point estimate for lagged output growth has the right sign and a reasonable order of magnitude considering that the estimate is likely to be subject to downward bias.

6   Conclusion

We study capital income flows between U.S. states. In a simple neoclassical model with capital ownership being perfectly diversified across states, with total factor productivity that varies across states and over time, and no barriers to movement of capital between states, capital should flow to states that experience a relative increase in TFP and, therefore, growth. We use the state-level ratio of output to personal income as a measure of net outflows of capital income and, hence, as an indicator of past net capital inflows. We then examine if capital income on net flows from states

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[23]The lagged output/income ratio is correlated with the lagged growth rate for the same reason that the current output/income ratio is correlated with the current growth rate as discussed in footnote 18.

which experience relatively high growth as predicted by the model. We find this prediction clearly confirmed by the data. Simple "back of the envelope" calculations reveal that the capital flows involved are very large. Frictionless capital markets may, therefore, be important for economic growth and welfare by allowing investment to be directed to states where it can be most efficiently employed.

Standard neoclassical models, such as ours, imply that a typical state should hold foreign capital in an amount of about 3 times GDP. At the country level, foreign asset and liability positions in the OECD has increased at a remarkable rate in the 1990s—see Lane and Milesi-Ferretti (2001). Nonetheless, almost all countries hold amounts of foreign assets below the level of GDP (with Ireland being a notable exception), which may be due to inherent failures of the frictionless model or to frictions associated with national borders. Our evidence shows that net capital income flows between U.S. states are consistent with the predictions of a simple frictionless neoclassical model. Consequently, frictions associated with national borders are likely to be the main explanation for "low" international capital flows.

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Appendix A: Relation between GDP and GNI of the United States.

	U.S. GDP (Gross value of production physically *in* the United States)
+	Income from U.S. owned direct investment in other countries
–	Income of foreign owned direct investment in the United States
+	Income from U.S. owned portfolio investment in other countries
–	Income of foreign owned portfolio investment in the United States
+	Income from U.S. government investment in other countries
–	Income of foreign investment in United States government assets
+	Wage and salary earned in other countries by residents of the United States
–	Wage and salary earned in the United States by residents of other countries
+	Taxes on production and imports (collected by the United States from foreign companies)
–	Taxes on production and imports (collected by foreign governments from U.S. companies)
=	U.S. GNI (Gross value of production *owned* by U.S. residents)
+	Subsidies – Indirect business taxes (domestic)
–	Corporate saving
–	Net interest
+	Personal interest income
–	Contributions for social insurance
+	Government transfers to persons
=	Personal Income

Notes:

(i) *Residents* of the United States contribute to U.S. GNI whether they are *citizens* of the Unites States or not and, while the number of foreign citizens in the United States is large, the total wage and salary of foreign residents in the United States is fairly small (less than 4 percent of total U.S. income payments to foreign countries in 2002).

(ii) Government investments abroad are mainly official currency reserves, while government liabilities are mainly treasury securities.

For further details, see OECD (1993),"System of National Accounts Glossary 1993" and BEA (2003), "Preview of the 2003 Comprehensive Revision of the National Income and Product Account," Survey of Current Business, June 2003.

Data Appendix

GSP: State-level GDP, denoted Gross State Product (GSP), is published by the Bureau of Economic Analysis (BEA). GSP is derived as the sum of value added originating in all industries in the state, thus it is exactly the state-level equivalent of GDP.[24]

GSP is calculated from the income side of the accounts and contains three components: compensation of employees; taxes on production and imports (TOPI); and gross operating surplus (including noncorporate income). "Compensation of employees" consists mostly of employee wages and salaries *disbursements*; to keep consistency with the rest of the GSP components the BEA adjusts these disbursements to reflect production, i.e. when labor services were employed, rather than when they were actually paid. For most industries and GSP components, the estimates are based on *establishment* data (rather than company data) by state. For selected industries (railroad transportation, transportation by air, and electric utilities) the estimates of some capital charges are based on company data; these are allocated to the states in which the company has operating establishments based on indicators of capital stock or its use, e.g., electric generating capacity. Thus, GSP is calculated on a *"when accrued, where accrued"* basis.

GSP estimates are available for 1977–2000. GSP data exists for 1963–1976 as well, but is based on a different methodology which is inconsistent with the 1977–2000 estimates.

SPI: State-level Personal Income (SPI) is also published by the BEA. SPI is defined as the income *received* by, or on behalf of, all the residents of the state and is designed to be conceptually and statistically consistent with the U.S. national estimates of personal income.

The SPI estimates are primarily based on administrative-records data and on data from censuses and surveys. The data from administrative records (like Federally-administered transfer programs) may originate either from the recipients of the income or from the source of the income; for example, federal transfers may be reported by the federal government or by the recipient states or individuals. The data from censuses is mainly collected from the recipient of the income. Some data is reported and recorded by the recipient's place of work rather than by the recipient's place of residence. Therefore, adjustments are made to the data in order to reflect the recipient's place of residence. Most adjustments are directly applied to the series that the BEA publishes, but the

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[24]See Beemiller and Downey (2001).

largest adjustment, "Adjustment for residence" of earnings is reported separately.

SPI is derived as follows:

Earnings by place of work

– Contributions for government social insurance (by employee and employer)

+ Adjustment for residence

+ Dividends, interest, and rent

+ Personal current transfer receipts

= SPI

Persons (from "personal income") consist of individuals, nonprofit institutions that serve individuals, private non-insured welfare funds, and private trust funds. The wage component of SPI takes into account cross-state commuters, so that the wages of persons residing in a particular state but working elsewhere (another state, Canada or Mexico), even temporarily, are included in that state's personal income; see "net commuters' income" description below. Other components of SPI, like estimates of non-farm proprietors' income and of contributions for government social insurance by the self-employed are derived from source data that is reported by the tax-filing address of the recipient. This address is usually that of the proprietor's residence; therefore, the data is, in principle, recorded by place of residence. Thus, SPI is defined on a *"when earned, where earned"* basis. SPI is available for our entire sample.

The difference between SPI and GSP: Conceptually, the main difference between GSP and SPI is that while GSP is defined on a *"when accrued, where accrued"* basis, SPI is defined on a *"when earned, where earned"* basis. The methodology of estimating these series reflect the difference. This means that they are estimated using different data sources: GSP estimates are based on payrolls from establishment data, while SPI estimates are based on income from administrative-records and censuses. So although both are measured form the income side they are based on different data.

A few examples may clarify this difference. Suppose a machine produces widgets in Wisconsin. The output of that machine minus the cost of its inputs will be recorded as part of Wisconsin's GSP. But if the firm that operates the machine is partially owned by someone that lives in Ohio, where she reports her dividend income for tax purposes, then this dividend income will show up in Ohio's SPI. Now suppose that the machine needs a worker to operate it. The workers wage is accrued to Wisconsin's GSP, but if she lives in Iowa, her salary will show up in Iowa's SPI.

The relation of personal income to GDP in the aggregate U.S. National Income and Product Accounts is shown in appendix A.

Federal Transfers: This series is the sum of 11 different series, each of which we identify as measuring transfers from the U.S. federal government to individuals or state-specific institutions (typically governments). These series—published by the BEA and available for our entire sample—are: "Old age, survivors and disability insurance payments," "Railroad retirement and disability payments," "Workers' compensation payments (Federal and State)," "Medical payments," "Supplemental security income (SSI) payments," "Food stamps," "Other income maintenance," "Unemployment insurance benefit payments," "Veterans' benefits payments," "Federal education and training assistance payments (excl. veterans)," "Federal government payments to nonprofit institutions." The series for workers compensation includes some transfers which are not from the federal government but we did not attempt to correct for this.

Net Commuters' Income: This series is denoted "Adjustment for residence" by the BEA and is available for our entire sample. It is a component of SPI. The adjustment is equal to the wage income earned by residents of state i that work in other states (not i) minus the wage income earned by residents of other states (not i) that work in state i. Thus, it is the wage component of a state's "foreign" (from other states) net factor income. The BEA estimates this series by using "Journey to Work" surveys, which are performed by the Census Bureau.

State Income: State income is calculated starting from the BEA data for SPI, which is pre- personal income tax but post- all other federal taxes as well as post- social security contributions and transfers. Therefore, we add to SPI personal and employer social security contributions and subtract social security transfers. We further add state non-personal taxes, in order to combine non-cancelling income of 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 public goods. Finally, we add the interest revenue on the state's trust funds. The detailed construction of State Income involves a large number of data sources and a number of imputations; see Asdrubali, Sørensen, and Yosha (1996) for details.

Corporate Retained Earnings: Corporate retained earnings of firms are reported by the BEA only at the aggregate U.S. level, and are available for our entire sample. We impute state corporate retained earnings by allocating the aggregate number to each state according to its share in

aggregate personal dividend income.

Historical Dividend and Interest Income: Separate series of personal dividend income and personal interest income have been made available to us by Kathy Albetsky from the BEA for 1929–2000. The BEA publishes the sum of personal dividends, interest, and rent income by state in 1929–2000.

Population: This series is published by the BEA and is available for our entire sample.

College Graduates: The proportion of college graduates in the population by state is published by the Census Bureau for the years 1989–2000.

Oil Prices: This series was obtained from the Energy Information Administration in the U.S. Department of Energy for 1968–2000.

State "Current Accounts" The investment and saving data for 1953 and 1957 are from Romans (1965). Romans picked the two cycle-peak years of 1953 and 1957. His total investment estimates for each state are calculated by aggregating investment in manufacturing, mining, railroads, other transportation, public utilities, communications, agriculture, and construction. He uses annual surveys for some industries and balance sheets of companies (railways, utilities, etc.) for others. For industries where neither is available, he imputes from aggregate investment figures utilizing state-level wages and salaries for that particular industry. His saving estimates are based on state-level data, when available, on currency and bank deposits, saving and loan shares, private insurance and pension reserves, consumer debt, securities loans, mortgages, and bank debt, and involves a large number of imputations.

Net External Liabilities: By utilizing the difference between property income received and property income produced, Duczynski (2000) estimates net external assets for U.S. states for various years as a percent of GSP. Updated estimates for 1977–2001 have been made available to us by Petr Duczynski. By multiplying Duczynski's estimates by GSP and reversing the sign, we obtain net external liabilities (rather than assets).

Oil Share: The BEA publishes estimates of the value added in the "Oil and gas extraction" industry sector by state. "Oil Share" is the percent of this sector in GSP.

Manufacturing Share: The BEA publishes estimates of the value added in the "Manufacturing" industry sector by state. "Manufacturing Share" is the percent of this sector in GSP.

Agriculture Share: The BEA publishes estimates of the value added in the "Agriculture, forestry,

fishing, and hunting" industry sector by state. "Agriculture Share" is the percent of this sector in GSP.

Retirement: The Census Bureau publishes age profiles of the population by state for 1970–2000 (unfortunately, we could not obtain the data for 1972). We use the number of people age 65 and above as our measure of retired persons.

North: An indicator variable that takes the value 1 if a state is in one of northern regions and 0 otherwise. These states are: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont (New England); Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania (Mid-East); Illinois, Indiana, Michigan, Ohio, Wisconsin (Great Lakes).

SPI–transfers: SPI minus Federal Transfers.

SPI–commuters' income: SPI minus Commuters' Net Wage Income (Adjustment for Residence).

GNI (approximation): State Income from Asdrubali, Sørensen, and Yosha (1996) plus Corporate Retained Earnings.

Table 1: **State "Current Accounts" in 1953 and 1957**

	S–I in 1953 per capita	S–I in 1957 per capita	S–I in 1953 millions	S–I in 1957 millions
Alabama	–114	–629	–54	–319
Alaska	.	.	.	.
Arizona	–1226	–654	–170	–120
Arkansas	–576	–559	–159	–158
California	648	876	1231	2039
Colorado	216	–195	48	–53
Connecticut	1229	946	413	364
Delaware	2058	3970	112	276
Florida	542	956	278	682
Georgia	–29	–259	–16	–159
Hawaii	.	.	.	.
Idaho	–963	–754	–89	–79
Illinois	623	–19	876	–30
Indiana	–473	–1398	–307	–1033
Iowa	819	–68	334	–30
Kansas	–116	–688	–36	–239
Kentucky	–404	–280	–182	–134
Louisiana	–1316	–1472	–585	–748
Maine	247	247	35	38
Maryland	543	154	216	72
Massachusetts	982	1401	732	1127
Michigan	88	–342	93	–422
Minnesota	503	318	238	170
Mississippi	–110	–807	–36	–275
Missouri	847	502	528	343
Montana	–754	–533	–72	–58
Nebraska	778	–519	159	–118

State "Current Accounts" in 1953 and 1957—continued

	S–I in 1953 per capita	S–I in 1957 per capita	S–I in 1953 millions	S–I in 1957 millions
Nevada	–595	–118	–18	–5
New Hampshire	1309	557	111	52
New Jersey	486	521	394	488
New Mexico	–1655	–1064	–194	–147
New York	1461	1790	3517	4783
North Carolina	–133	–205	–85	–146
North Dakota	–1292	–781	–122	–78
Ohio	–869	–531	–1157	–815
Oklahoma	30	–508	10	–189
Oregon	–48	–408	–12	–114
Pennsylvania	79	620	131	1109
Rhode Island	681	1195	86	166
South Carolina	–192	–447	–65	–166
South Dakota	149	–230	15	–25
Tennessee	–328	–275	–169	–154
Texas	–580	–1246	–750	–1844
Utah	–175	–1039	–20	–140
Vermont	408	130	24	8
Virginia	–63	–99	–35	–62
Washington	–173	–664	–66	–295
West Virginia	–909	–1470	–272	–442
Wisconsin	324	–42	176	–26
Wyoming	–1357	–1756	–61	–90

Notes: These data is from Romans (1965). "S−I" is the difference between state-level saving and state-level investment for the given years. All series are in 2000 prices. Romans' total investment estimates for each state are calculated by aggregating investment in manufacturing, mining, railroads, other transportation, public utilities, communications, agriculture, and construction. He uses annual surveys for some industries and balance sheets of companies (railways, utilities,etc.) for others. For industries where neither is available, he imputes from aggregate investment figures utilizing state-level wages and salaries for that particular industry. His saving estimates are based on state-level data, when available, on currency and bank deposits, saving and loan shares, private insurance and pension reserves, consumer debt, securities loans, mortgages, and bank debt, and involves a large number of imputations.

Table 2: **State "Current Accounts" and Net Capital Income**

Dependent Variable: Log of Average Output/Income

	(1)	(2)	(3)	(4)
Sample	1963−1970	1971−1980	1981−1990	1991−2000
States	47	47	47	47
Average Saving minus Investment per capita 1953−1957	−0.09 (5.04)	−0.10 (4.30)	−0.08 (2.54)	−0.04 (2.32)
R^2	0.51	0.50	0.29	0.19

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Average Output/Income is output divided by income (and normalized by U.S. output/income), where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over the relevant sample, given in "Sample". Average Saving minus Investment per capita 1953−1957 is the difference between state-level saving and state-level investment per capita, averaged for the two years for which this data is available, 1953 and 1957. State-level investment and state-level saving are from Romans (1965) and used in thousands of dollars in 2000 prices in the above regressions. See table 1 for the detailed explanations of state-level investment and saving estimates. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 3: **Country Current Accounts and Net Capital Income**

Dependent Variable: Log of Average GDP/GNI 1991−2000

	(1)	(2)
Sample	1991−2000	1991−2000
Countries	24	24
Average Current Account Per Capita 1981−1990	−0.033 (4.24)	− −
Average Current Account/GDP 1981−1990	− −	−0.70 (3.10)
R^2	0.24	0.30

Notes: 24 country observations: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. Average GDP/GNI 1991−2000 is the ratio of GDP to GNI normalized by the ratio of the sum of country-level GDPs to the sum of country-level GNIs in the sample, averaged over 1991−2000. Average Current Account Per Capita 1981−1990 is denominated in thousands of US dollars in 2000 prices and is averaged over 1981−1990. Average Current Account/GDP 1981−1990 is the ratio of the current account to GDP averaged over 1981−1990. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 4: **Descriptive Statistics by State**

	Avg. Dividend Inc. 1939−1949	Avg. Interest Inc. 1939−1949	GSP Growth 1980−1990	Avg. GSP 1977−1980	Avg. Out/Inc 1981−2000
Alabama	91.54	163.34	19.22	20,201	0.98
Alaska	.	.	−46.04	63,426	1.63
Arizona	182.46	300.29	3.76	23,502	0.97
Arkansas	64.18	137.50	17.72	19,450	0.97
California	451.10	561.99	15.97	29,642	1.02
Colorado	301.04	437.14	7.11	27,640	1.00
Connecticut	881.53	778.44	34.43	27,657	0.96
Delaware	1846.49	860.02	40.49	28,380	1.21
Florida	404.19	405.22	16.96	21,852	0.88
Georgia	173.98	189.98	26.46	22,624	1.07
Hawaii	.	.	26.50	29,492	1.06
Idaho	85.37	269.30	4.65	22,958	0.97
Illinois	421.06	498.47	15.41	28,595	0.99
Indiana	214.20	305.85	14.57	24,489	0.98
Iowa	164.52	347.55	6.66	25,988	0.98
Kansas	115.39	299.11	9.14	25,432	0.97
Kentucky	163.19	191.12	13.99	22,493	1.03
Louisiana	155.54	221.39	−10.47	29,678	1.23
Maine	394.94	516.45	24.53	19,435	0.93
Maryland	472.86	568.16	26.80	24,143	0.88
Massachusetts	629.07	675.06	31.38	25,099	0.99
Michigan	307.69	410.73	11.75	26,361	0.95
Minnesota	248.94	380.58	15.16	26,416	0.99
Mississippi	58.18	121.50	12.04	18,594	1.00
Missouri	321.69	379.03	16.96	24,479	0.99
Montana	197.74	342.49	−8.18	24,322	0.94
Nebraska	171.21	337.71	16.69	25,194	1.01

Descriptive Statistics by State—continued

	Avg. Dividend Inc. 1939−1949	Avg. Interest Inc. 1939−1949	GSP Growth 1980−1990	Avg. GSP 1977−1980	Avg. Out/Inc 1981−2000
Nevada	534.41	549.99	5.48	32,226	1.07
New Hampshire	437.30	533.42	28.75	21,558	0.93
New Jersey	466.87	600.63	34.77	26,183	0.95
New Mexico	179.61	225.41	−2.99	25,088	1.13
New York	726.88	908.47	23.34	28,652	1.02
North Carolina	153.86	152.73	26.11	22,269	1.05
North Dakota	72.11	252.14	−5.13	25,003	1.01
Ohio	374.76	398.71	12.95	25,670	0.98
Oklahoma	150.98	223.83	−8.52	24,848	0.99
Oregon	214.83	432.19	7.31	26,098	0.97
Pennsylvania	423.30	477.04	17.89	24,161	0.92
Rhode Island	583.55	598.69	23.96	21,802	0.92
South Carolina	90.14	155.05	26.03	19,560	1.00
South Dakota	105.65	239.10	21.06	21,935	1.01
Tennessee	137.32	189.95	23.17	21,786	1.02
Texas	171.05	265.15	−3.12	29,488	1.12
Utah	175.30	287.17	8.38	22,802	1.04
Vermont	328.35	473.06	26.39	20,370	0.96
Virginia	230.20	235.47	27.16	24,191	0.99
Washington	232.67	431.22	16.38	27,577	0.99
West Virginia	173.37	186.22	0.95	21,599	0.94
Wisconsin	269.22	438.38	12.12	25,166	0.97
Wyoming	226.85	400.49	−24.22	43,191	1.37

Notes: Avg. Dividend Inc. 1939−1949 and Avg. Interest Inc. 1939−1949 are, respectively, dividend and interest income per capita in 2000 prices, averaged over 1939−1949. GSP growth 1980−1990 is the growth rate of GSP per capita, from 1980 to 1990. Avg. GSP 1977−1980 is GSP per capita in 2000 prices, averaged over 1977−1980. Average Out/Inc 1981−2000 is output divided by income (and normalized by U.S. output/income), where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over 1981−2000.

Table 5: **Descriptive Statistics**

	Mean	S.D.	Max.	Min.
Avg. Output/Income 1981−2000	1.02	0.12	1.63	0.88
Avg. GSP 1977−1980 ($1,000 per capita)	25.8	6.80	63.4	18.6
Avg. Div&Int Inc. 1939−1949 ($1,000 per capita)	0.69	0.46	2.70	0.18
Avg. Oil Share 1977−1980 (percent)	3.00	6.00	22.00	0.00
Avg. Manufacturing Share 1977−1980 (percent)	21.00	9.00	36.00	5.00
Avg. Agriculture Share 1977−1980 (percent)	4.00	4.00	18.00	1.00
Retirees/Population 1980 (percent)	11.00	2.00	18.00	3.00
Avg. Population Growth 1977−1980 (percent)	1.34	1.37	5.93	−0.54
Tertiary/Population 1989 (percent)	20.00	4.00	28.00	11.00
Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990	−0.01	0.11	0.16	−0.61
GSP Growth from 1980 to 1990 (percent)	13.68	17.56	37.27	−49.94
Population Growth from 1980 to 1990 (percent)	7.43	9.09	36.47	−8.63
Avg. Output/Income 1981−1990	1.03	0.17	1.93	0.87

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Average Output/Income 1981−2000 is output divided by income (and normalized by U.S. output/income), where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over 1981−2000. Average GSP 1977−1980 is GSP per capita in 2000 prices, averaged over 1977−1980. Average Div&Int Inc. 1939−1949 is the sum of dividend and interest income per capita in 2000 prices, averaged over 1939−1949. Average Oil Share 1977−1980 is the share of the oil and mineral extraction sectors in GSP by state, averaged over 1977−1980. Average Manufacturing Share 1977−1980 is the share of the manufacturing sector in GSP by state, averaged over 1977−1980. Average Agriculture Share 1977−1980 is the share of the agriculture sector in GSP by state, averaged over 1977−1980. Retirees/Population 1980 is the share of retirees in state population in 1980. Avg. Population Growth 1977−1980 is the average (annual) population growth in 1977−1980. Tertiary/Population 1989 is the share of population that has a bachelors degree or more in 1989. Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990 is the average of the ratio over 1991−2000 minus the average of the ratio over 1981−1990. GSP Growth is the rate of GSP per capita growth from 1980 to 1990. Population Growth is the rate of growth of state population from 1980 to 1990. Average Output/Income 1981−1990 is output divided by income (and normalized by U.S. output/income), where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over 1981−1990.

Table 6: **Correlation Matrix**

	North	GSP	D&I	Oil	Ret	Pop	Ter	Man	Agr
Avg. GSP 1977−1980	−0.02								
Avg. Div&Int Inc. 1939−1949	0.68	0.43							
Avg. Oil Share 1977−1980	−0.31	0.48	−0.24						
Retirees/Population 1980	0.16	−0.39	0.09	−0.36					
Avg. Pop. Growth 1977−1980	−0.50	0.33	−0.10	0.33	−0.48				
Tertiary/Population 1989	0.25	0.36	0.60	−0.02	−0.16	0.06			
Avg. Manu. Share 1977−1980	0.53	−0.36	0.09	−0.51	0.22	−0.52	−0.23		
Avg. Agri. Share 1977−1980	−0.39	−0.13	−0.42	0.00	0.31	−0.17	−0.13	−0.33	
Avg. Out/Inc 1981−2000	−0.41	0.59	−0.25	0.75	−0.57	0.44	−0.04	−0.39	0.00

	GSP Growth	Pop Growth
Population Growth from 1980 to 1990	0.17	
Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990	0.64	0.24

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Average Output/Income 1981−2000 is output divided by income (and normalized by U.S. output/income), averaged over 1981−2000, where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over 1981−2000. Average GSP 1977−1980 is GSP per capita in 2000 prices, averaged over 1977−1980. Average Div&Int Inc. 1939−1949 is the sum of dividend and interest income per capita in 2000 prices, averaged over 1939−1949. Average Oil Share 1977−1980 is the share of the oil and mineral extraction sectors in GSP by state, averaged over 1977−1980. Retirees/Population 1980 is the share of retirees in state population in 1980. Average Pop. Growth 1977−1980 is the average (annual) population growth in 1977−1980. North is an indicator variable that takes the value of one for states that are in the Northern regions of the U.S., namely New England, Mideast and Great Lakes. Tertiary/Population 1989 is the share of population that has a bachelors degree or more in 1989. Average Manu. Share 1977−1980 is the share of the manufacturing sector in GSP by state, averaged over 1977−1980. Average Agri. Share 1977−1980 is the share of the agriculture sector in GSP by state, averaged over 1977−1980. Average Out/Inc 1991−2000 minus Average Out/Inc 1981−1990 is the average of the ratio over 1991−2000 minus the average of the ratio over 1981−1990. GSP Growth is the rate of GSP per capita growth from 1980 to 1990. Population Growth from 1980 to 1990 is the rate of growth of state population from 1980 to 1990. All variables in top panel are in logs except Average Pop. Growth 1977−1980 and the dummy North. Average Oil Share 1977−1980, Average Manufacturing Share 1977−1980 and Average Agriculture Share 1977−1980 are transformed to log(1+share) in order to dampen outliers and avoid zero observations.

Table 7: **Net Capital Income Flows**

Dependent Variable: Log of Average Output/Income 1981−2000

	(1)	(2)	(3)	(4)	(5)
States	47	47	47	47	47
Log Average GSP 1977−1980	0.29 (3.12)	0.43 (5.93)	0.29 (4.95)	0.24 (4.41)	0.24 (4.44)
Log Average Div&Int Income 1939−1949	− −	−0.09 (5.71)	−0.06 (3.97)	−0.05 (3.35)	−0.05 (3.44)
Log Average Oil Share 1977−1980	− −	− −	0.56 (3.14)	0.54 (3.47)	0.55 (3.52)
Log Retirees/Population 1980	− −	− −	− −	−0.11 (2.72)	−0.10 (2.25)
Average Population Growth 1977−1980	− −	− −	− −	− −	0.15 (0.41)
R^2	0.34	0.65	0.73	0.76	0.76

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Average Output/Income 1981−2000 is output divided by income (and normalized by U.S. output/income), where output is Gross State Product (GSP) and income is State Personal Income (SPI), averaged over 1981−2000. Average GSP 1977−1980 is GSP per capita in 2000 prices, averaged over 1977−1980. Average Div&Int Income 1939−1949 is the sum of dividend and interest income per capita in 2000 prices, averaged over 1939−1949. Average Oil Share 1977−1980 is the share of the oil and mineral extraction sectors in GSP by state, averaged over 1977−1980; this regressor is transformed to log(1+share) in order to dampen outliers and avoid zero observations. Retirees/Population 1980 is the share of retirees in state population in 1980. Average Pop. Growth 1977−1980 is the average (annual) population growth in 1977−1980. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 8: **Change in Net Capital Income Flows**

Dep. Var: Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990

	(1)	(2)
States	47	47
GSP Growth from 1980 to 1990	0.30 (3.12)	0.28 (3.26)
Population Growth from 1980 to 1990	– –	0.08 (1.34)
R^2	0.41	0.43

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990 is the average of the ratio over 1991−2000 minus the average of the ratio in 1981−1990. GSP Growth is the rate of growth of GSP per capita from 1980 to 1990. Population Growth is the rate of growth of state population from 1980 to 1990. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 9: **Net Capital Income Flows: Other Measures of Income**

Dependent Variable: Log of Average Output/Income 1981−2000

	(1)	(2)	(3)	(4)	(5)
Dependent Var.	$\frac{Out}{Inc.I}$	$\frac{Out}{Inc.II}$	$\frac{Out}{Inc.III}$	$\frac{Out}{Inc.IV}$	$NEL.$
Income measure	SPI	SPI–Fed.Tr.	SPI–Commut.	Approx.GNI	Net Ext.Lib.
States	47	47	47	47	47
Log Average GSP 1977−1980	0.24 (4.41)	0.20 (3.20)	0.13 (2.76)	0.15 (3.20)	18.74 (221)
Log Average Div&Int Income 1939−1949	−0.05 (3.35)	−0.06 (3.97)	−0.02 (2.13)	−0.06 (4.23)	−10.25 (4.72)
Log Average Oil Share 1977−1980	0.54 (3.47)	0.65 (3.53)	0.62 (4.43)	0.52 (2.97)	88.21 (3.63)
Log Retirees/Population 1980	−0.11 (2.72)	−0.04 (0.79)	−0.17 (5.44)	−0.06 (1.47)	−25.02 (3.59)
R^2	0.76	0.72	0.78	0.69	0.76

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Average Output/Income 1981−2000 is output divided by income (and normalized by U.S. output/income), averaged over 1981−2000, where output is Gross State Product (GSP) and our income measure varies as follows. Column (1) uses SPI for income. Column (2) uses SPI–Federal Transfers for Income. Column (3) uses SPI–Adjustment for Residence for Income. The adjustment for residence is equal to the wage income earned by residents of state i that work in other states (not i) minus the wage income earned by residents of other states (not i) that work in state i. The mean of this variable as a percent of SPI for the sample here (47 states) is 0.7 percent; the standard deviation is 3 percent; the maximum (Maryland) is 11.4 percent; the minimum (New York) is –3.8 percent. Column (4) uses an approximation to state-level GNI based on Asdrubali et al. (1996) (see data appendix for details). This variable is available till 1999 so all the variables in this column are re-defined accordingly. Column (5) uses Net External Liabilities Per Capita from Duczynski (2000) in thousands of dollars and 2000 prices, averaged over 1981−2000. The mean of this variable is –0.54; the standard deviation is 2.12; the maximum is 2.80; the minimum is –12.27. Average GSP 1977−1980 is GSP per capita in 2000 prices, averaged over 1977−1980. Average Div&Int Income 1939−1949 is the sum of dividend and interest income per capita in 2000 prices, averaged over 1939−1949. Average Oil Share 1977−1980 is the share of the oil and mineral extraction sectors in GSP by state, averaged over 1977−1980; this regressor is transformed to log(1+share) in order to dampen outliers and avoid zero observations. Retirees/Population 1980 is the share of retirees in state population in 1980. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 10: **Change in Net Capital Income Flows: Other Measures of Income**

Dependent Variable: Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990

	(1)	(2)	(3)	(4)	(5)
Dependent Var.	$\Delta\frac{Out}{Inc.I}$	$\Delta\frac{Out}{Inc.II}$	$\Delta\frac{Out}{Inc.III}$	$\Delta\frac{Out}{Inc.IV}$	ΔNEL
Income measure	SPI	SPI–Fed.Tr.	SPI–Commut.	Approx. GNI	Net Ext.Lib.
States	47	47	47	47	47
GSP Growth from 1980 to 1990	0.28 (3.26)	0.26 (3.17)	0.27 (3.24)	0.26 (3.42)	42.19 (3.52)
Population Growth from 1980 to 1990	0.08 (1.34)	0.09 (1.36)	0.09 (1.41)	0.10 (1.61)	11.05 (1.08)
R^2	0.43	0.44	0.47	0.47	0.48

Notes: 47 observations (missing data for Alaska and Hawaii; the outlier Delaware is left out). Avg. Out/Inc 1991−2000 minus Avg. Out/Inc 1981−1990 is the average of the ratio over 1991−2000 minus the average of the ratio in 1981−1990 where output is Gross State Product (GSP). GSP Growth is the rate of growth of GSP per capita from 1980 to 1990. Population Growth is the rate of growth of state population from 1980 to 1990. Our income measure varies as follows: column (1) uses SPI for income, column (2) uses SPI–Federal Transfers for Income, and column (3) uses SPI–Adjustment for Residence for Income. The adjustment for residence is equal to the wage income earned by residents of state i that work in other states (not i) minus the wage income earned by residents of other states (not i) that work in state i. The mean of this variable as a percent of SPI for the sample here (47 states) is 0.7 percent; the standard deviation is 3 percent; the maximum (Maryland) is 11.4 percent; the minimum (New York) is –3.8 percent. Column (4) uses an approximation to state-level GNI based on Asdrubali et al. (1996) (see data appendix for details). This variable is available till 1999 so all the variables in this column are re-defined accordingly. Column (5) uses Net External Liabilities Per Capita from Duczynski (2000) in thousands of dollars and 2000 prices, averaged over 1981−2000. The mean of this variable is –0.54; the standard deviation is 2.12; the maximum is 2.80; the minimum is –12.27. GSP Growth from 1980 to 1990 is the rate of growth of GSP per capita from 1980 to 1990. Population Growth from 1980 to 1990 is the rate of growth of state population from 1980 to 1990. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 11: **Net Capital Income Flows: Additional Controls**

Dependent Variable: Log of Average Output/Income 1981−2000

	(1)	(2)	(3)	(4)	(5)
States	50	47	47	47	47
Log Average GSP 1977−1980	0.40 (6.45)	0.23 (3.69)	0.23 (4.57)	0.24 (4.48)	0.24 (3.88)
Log Average Div&Int Income 1939−1939	− −	−0.04 (2.11)	−0.04 (3.10)	−0.05 (3.53)	−0.05 (2.78)
Log Average Oil Share 1977−1980	− −	0.55 (3.45)	0.54 (3.50)	0.59 (3.49)	0.53 (3.29)
Log Retirees/Population 1980	− −	−0.11 (2.21)	−0.11 (2.39)	−0.10 (2.02)	−0.10 (1.89)
Average Population Growth 1977−1980	− −	0.07 (0.14)	0.16 (0.42)	0.38 (0.68)	0.13 (0.35)
North	− −	−0.01 (0.28)	− −	− −	− −
Log Tertiary/Population 1989	− −	− −	−0.01 (0.47)	− −	− −
Log Avg. Manufacturing Share 1977−1980	− −	− −	− −	0.10 (0.79)	− −
Log Avg. Agriculture Share 1977−1980	− −	− −	− −	− −	−0.05 (0.24)
R^2	0.64	0.77	0.77	0.77	0.77

Notes: See table 5 for detailed explanations of all variables. Average Oil Share 1977−1980, Average Manu. Share 1977−1980 and Average Agri. Share 1977−1980 are transformed to log(1+share) in order to dampen outliers and avoid zero observations. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.

Table 12: **Change in Net Capital Income Flows: Panel Regressions**

Dep. Var: Change in Output/Income

	(1)	(2)	(3)
Sample	$1981-2000$	$1980-2000$	$1981-2000$
GSP Growth	0.08	0.15	0.10
Lagged	(1.75)	(3.97)	(2.06)
Output/Income	-0.42	-0.35	-0.32
Lagged	(7.59)	(11.40)	(9.34)
Population Growth	0.08	0.06	0.02
Lagged	(1.83)	(1.39)	(0.49)
Interval length	10	7	5
Time Periods	1	2	3
Observations	47	94	141
R^2	0.78	0.73	0.60

Notes: 47 states used in all regressions (missing data for Alaska and Hawaii and the outlier Delaware is left out). In each column the definition of a period of the panel changes; it is an average over a time interval, denoted "Interval length." For example, in column (2) the time-interval in each period of the panel is 7 years; hence we have 2 periods covering $1987-2000$ and a lagged period 1980–1986. The number of observations is 2*47=94. Change in Output/Income is the difference between the output/income ratio in the current period and the previous one. GSP Growth Lagged is the total growth of GSP per capita within the previous period; thus, in column (2) it is the total growth over 7 years. Output/Income Lagged is the value the output/income ratio in the previous period. Population Growth Lagged is the total growth of population in the previous period. A constant is included in all specifications. Heteroskedasticity robust t-statistics in parentheses.
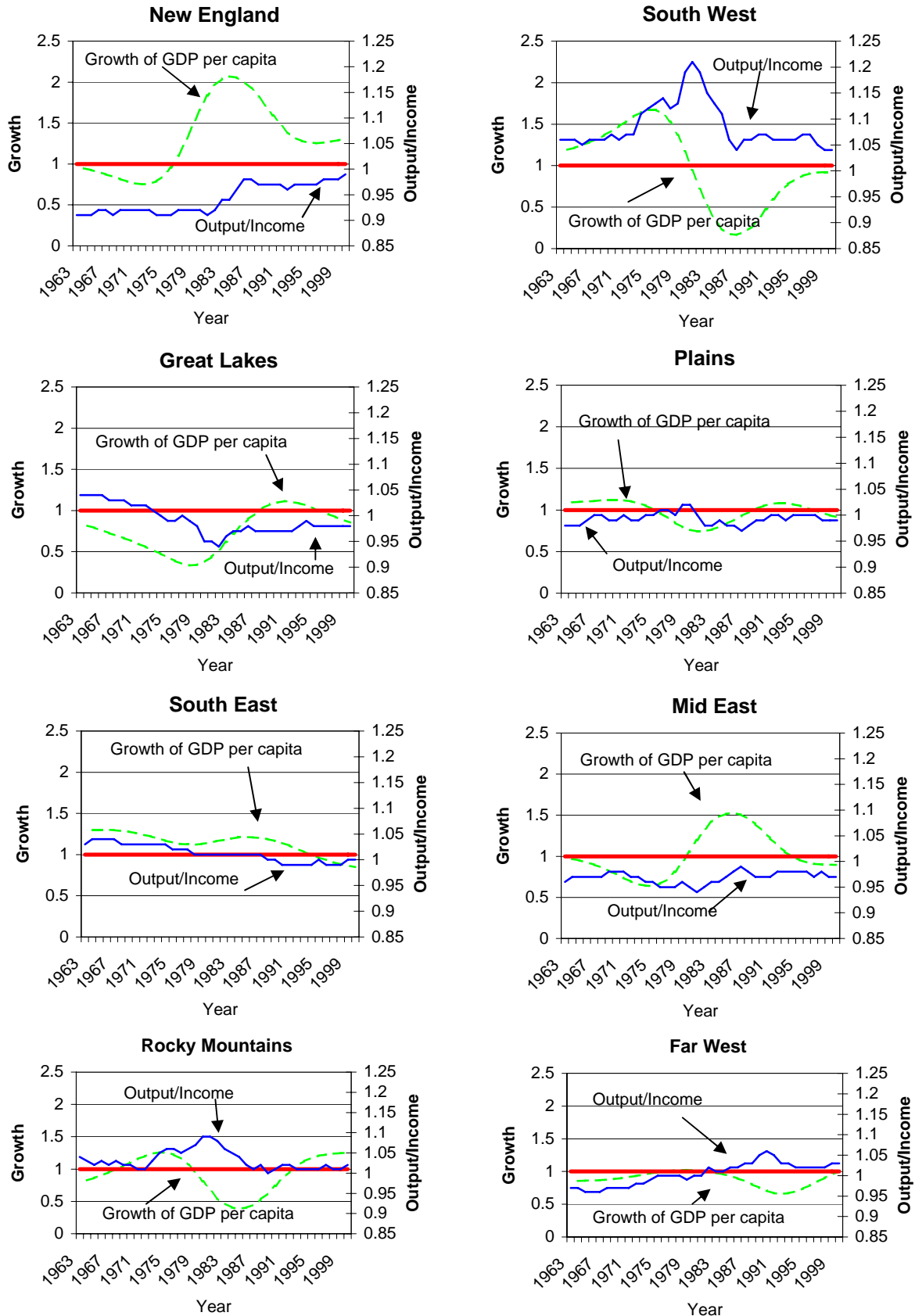
Figure 1

Figure 2: Average Output/Income for Alaska, Louisiana and Wyoming, versus World Real Price of Crude Oil