Why Does Capital Flow to Rich States? *

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Abstract

Empirical evidence shows that the magnitude, and even the direction, of net international capital flows does not fit neoclassical models well. In particular, rich countries attract net flows that these models predict should go to poor, capital scarce countries. The 50 U.S. states comprise an integrated capital market with very low barriers to capital flows which make makes them an ideal testing ground for such neoclassical models. We develop a simple frictionless open economy neoclassical model with perfectly diversified ownership of capital and find that capital flows between the U.S. states are consistent with the model. We conclude that the small size and "wrong" direction of net international capital flows is likely due to frictions in international financial markets associated with national borders.

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1 Introduction

International capital flows have surged since the early 1990s, creating renewed interest in their determinants. One salient fact of this recent increase is the small size of net capital flows relative to gross flows.[1] In addition, capital has been shown to flow "uphill" from poorer to richer countries in the last decade, a phenomenon that manifests itself in the recent global imbalances.[2] These empirical patterns are at odds with theoretical benchmarks. The goal of this paper is to demonstrate the viability of the simple neoclassical model in the ideal setting of fully integrated economies such as the 50 U.S. states. We develop a frictionless open economy neoclassical model where capital income is fully diversified and show that it fits the data for U.S. states well, both qualitatively and quantitatively.

The key elements of our model are as follows. Capital income—but not labor income—is fully diversified between states and total factor productivity (TFP) varies across states and over time.[3] We assume that capital markets are fully integrated such that individuals can borrow and lend freely across state borders and insure themselves against state-specific risk by holding a geographically diversified portfolio of assets. Hence, relative investment is determined by relative productivity levels and savings do not have any role in determining relative investment. The model predicts that capital flows to fast growing states from slow growing states and as a result high growth states pay capital income to other states.[4] With persistent productivity shocks high output—"rich"—states end up being net debtors more often than not.

[1] Obstfeld and Taylor (2005) characterize 1990s as the era of limited "development finance" relative to "diversification finance."

[2] As shown by Lucas (1990) capital should flow from rich to poor countries as implied by the Solow model, where capital markets are integrated and the level of total factor productivity is constant across countries and over time.

[3] 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 United States contributed toward increased income inequality in the 1980s.

[4] More precisely, capital pays capital income in the form of dividends, interest, and transfers within multi-state companies. Capital income flows to and from other states provide risk sharing. 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.

Using simulations we find support for the following implications of the model: 1) income increases less than output in high growth states, 2) net dividends converge to zero in the absence of growth shocks, and 3) high output states tend to pay net dividends. We then verify that these results hold using U.S. state-level data. Consequently, we conclude that the main explanation for the small size and "wrong" direction of international capital flows is more likely due to "frictions" associated with national borders—making international financial markets de facto incomplete—rather than to deficiencies in the simple neoclassical model.[5]

Testing the implications of the model in a regression framework requires data on interstate net capital flows. We do not have data on state level current accounts, but income flows ("dividends") between states typically reflect past net investment flows. However, dividend payments between states are not directly observed either. In the country-level national accounts net capital income flows are approximately equal to the difference between Gross National Income ("income") and Gross Domestic Product ("output").[6] 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. Thus, the ratio of output to income ("output/income") is an indicator of net capital income. We derive the predictions of the model for the output/income ratio and test these predictions.

The output/income ratio has been used before to infer past net capital flows between U.S. states by Atkeson and Bayoumi (1993a,b) who found large inter-regional net capital flows within the U.S. However, they did not systematically match their findings to a model nor did they study the determinants of state level capital flows. Of particular relevance is their finding that personal dividend income highly correlated across states which is consistent with our assumption that capital ownership is diversified geographically. At the country

[5]Examples of frictions associated with borders are explicit barriers to investment or factors affecting investors ex post returns such as bad institutions (corruption and rule of law), and sovereign risk; see, for example Alfaro, Kalemli-Ozcan, and Volosovych (2007) and Reinhart and Rogoff (2004).

[6]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.

level capital flows are usually directly observed, but Bertocchi and Canova (2002) 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.

The surge in international asset trade has triggered a recent research effort on the portfolio models of the current account. Starting with the partial equilibrium approach of Kraay and Ventura (2000), this literature highlights the importance of countries' net external positions in the determination of current account balances, and hence the pattern of capita flows. A central result out of this literature is that countries hold a constant ratio of domestic to foreign capital, which has been debated recently.[7] We contribute to this debate as our model shows portfolio shares follow a mean-reverting process, an implication that is supported by the U.S. state-level data.

In the next section, we derive and simulate theoretical predictions. Section 3 performs the empirical analysis. Section 4 presents robustness analysis and Section 5 concludes the paper.

2 Capital Flows in a Neoclassical Growth Model

Consider states $i = 1, ..., N$, with labor force L_{it}. Output at time t is given by $GDP_{it} = A_{it}K_{it}^{\alpha}L_{i}^{1-\alpha}$, where K_{it} is capital in state i and $0 < \alpha < 1$. The aggregate capital stock is K_t, and we consider the United States to be a closed economy.[8] Hence, K_t is also a nationwide mutual fund. State i's ownership share of the fund is given by ϕ_{it} so assets *owned* by state i is $B_{it} = \phi_{it}K_t$ where $\Sigma\phi_{it} = 1$ implying $K_t = \Sigma B_{it} = \Sigma K_{it}$, where the last equality follows from the assumption that the U.S. is a closed economy.

[7] According to Kraay and Ventura (2000) capital flows are caused by portfolio growth through changes in wealth, where countries invest the marginal unit of wealth as the average unit. In other words, portfolio shares are constant. On the other hand, more recent papers, such as Devereux and Sutherland (2006), Evans and Hnatkovska (2005) and Tille and van Wincoop (2008a), focus on general equilibrium effects and show that international capital flows can be broken down into a portfolio growth component that is associated with savings and a portfolio reallocation component associated with changes in expected risk and returns.

[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.

Under market integration the ex ante gross rate of return to investment is R_t for all states. In our simulations, R_t will be the equilibrium market clearing rate of interest. We assume that capital ownership is fully diversified and therefore risk premiums are negligible. The gross income of the U.S. mutual fund is $R_t\, K_t$ and the wage rate in state i is $w_{it} = (1-\alpha) A_{it} K_{it}^{\alpha} L_{it}^{-\alpha}$. Gross (pre-depreciation) income, GNI in state i is, therefore, $GNI_{it} = \phi_{it}\, R_t K_t + w_{it} L_i = \phi_{it}\, R_t K_t + (1-\alpha) A_{it} K_{it}^{\alpha} L_i^{1-\alpha}$ and the GDP/GNI ratio is

$$\frac{GDP_{it}}{GNI_{it}} = \frac{A_{it} K_{it}^{\alpha} L_i^{1-\alpha}}{\phi_{it}\, R_t K_t + (1-\alpha) A_{it} K_{it}^{\alpha} L_i^{1-\alpha}} = \frac{GDP_{it}}{\phi_{it}\, R_t K_t + (1-\alpha) GDP_{it}}\ . \tag{1}$$

Assuming state i is small (growth in state i will not affect $R_t K_t$), we have

$$d(\frac{GDP_{it}}{GNI_{it}}) \approx \alpha\, \frac{dGDPit}{GDP_{it}} \tag{2}$$

with strict equality if $GNI_{it} = GDP_{it}$ to start with (the situation where all ownership shares are identical). This simple relation holds when capital income is diversified, labor income is not, and a share α of GDP accrues to capital.

We allow for changes in the labor force due to migration. We consider two cases: a) migrants carry no assets and b) migrants carry assets in an amount equal to the average of the integrated economy. Other cases can easily be extrapolated from these. In case a) $dGNP/dL = (1-\alpha) dGDP/dL$ as migrants will only receive labor income while in case b) $dGNP/dL = dGDP/dL$. When capital instantly flows to restore the capital labor ratio, $dGDP/dL = (GDP/L) dL$ because the per capita capital stock will be unchanged leaving per capita output unchanged. Combining this with equation (2) we get in case a)

$$d(\frac{GDP_{it}}{GNI_{it}}) \approx \alpha\, \frac{d(GDPit/L_{it})}{GDP_{it}/L_{it}}\,, \tag{3}$$

and in case b)

$$d(\frac{GDP_{it}}{GNI_{it}}) \approx \alpha\, \frac{d(GDPit/L_{it})}{GDP_{it}/L_{it}} - \alpha\, dL_{it}/L_{it}\ . \tag{4}$$

2.1 The level of the output/income ratio as a function of productivity and ownership

Capital will flow to state i until the marginal return to capital equals the U.S.-wide gross interest rate R_t; i.e., $R_t = \alpha A_{it} K_{it}^{\alpha-1} L_i^{1-\alpha}, \ \ \forall i, t$ and $K_{it} = L_{it}(\frac{\alpha A_{it}}{R_t})^{\frac{1}{1-\alpha}}$. The relative stock of capital installed will then satisfy: $\frac{K_{it}}{K_{jt}} = \frac{L_{it}}{L_{jt}}(\frac{A_{it}}{A_{jt}})^{\frac{1}{1-\alpha}}$.[9] Thus, the equilibrium capital-labor ratio is higher in region i, if the productivity, A_i is higher, than in region j.

Our model is a simple DSGE model. We show the deterministic version of the model in order to facilitate the exposition although our simulations allow for random state-specific productivity shocks. We assume that agents do not demand any risk premium on investments since when capital ownership is fully diversified state-specific risk premiums are likely to be negligible. Nevertheless, the prediction of the model that the states that receive positive productivity shocks will tend to have high output and a high GDP/GNP ratio need not hold in all states at any given time. If capital flows to high growth regions we should, everything else equal, see that high output regions run current account deficits and hold negative net asset positions.[10] On the other hand, poorer regions might be in the "catch-up growth" phase, which implies that we should observe low output regions have relatively higher growth and are attracting capital from other regions; an example is the U.S. southern states in the 1950s.[11]

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

[10] Kraay and Ventura (2000) develop a model where investment risk is high and diminishing returns are weak. Their model implies that positive productivity shocks lead to deficits in debtor countries and surpluses in creditor countries. In our model, because of full diversification and no risk premia, relative investment will be determined by relative productivity with no role for savings. Hence, both debtor and creditor countries can attract capital on net if they hit by positive productivity shocks. In addition, we assume that productivity shocks are persistent (as shown by Glick and Rogoff (1995)) as oppose to Kraay and Ventura's assumption that they are transitory.

[11] Note that Gourinchas and Jeanne (2007) and Prasad et al. (2007) find exactly the opposite in a developing country context; i.e., they find capital goes to *less* productive countries and a positive correlation between current account and growth, respectively.

2.2 Simulation of the Model

In order to evaluate the quantitative predictions of the model, we simulate it for N=50 open economies, "states," for T=100 years using a Cobb-Douglas production function with capital's share, $\alpha = 0.33$. We set $L_{it} = 1$ for $\forall i, t$. For the productivity process, we assume

$$\log(A_{it}) = \log(A_0) + \rho \log(A_{it-1}) + \sigma\, \epsilon_{it} \ ,$$

where ϵ is a standard normal innovation, independent across states and periods.

For given K_t (determined at $t-1$) and R_t we use the first order condition and set

$$K_{it} \ = \ (\frac{\alpha A_{it}}{R_t})^{\frac{1}{1-\alpha}} \ , \qquad \forall i, t.$$

We iterate over R_t to find the equilibrium R_t as the interest rate for which $\Sigma_{i=1}^{50} K_{it} = K_t$. Having found K_{it} we find $w_{it} = (1-\alpha) A_{it} K_{it}^{\alpha}$ and calculate $GNP_{it} = w_{it} + \phi_{it} R_t K_t$. Aggregate GNP_t ($= GDP_t$) is then found as $GNP_t = \Sigma_{i=1}^{50} GNP_{it}$.

The law of motion for capital is given by $K_{t+1} = (1-\delta) K_t + S_t$ where gross savings S_t=$sGNP_t$, s is the savings rate, and δ is the depreciation rate. The stock of ownership owned by state i in period $t+1$ is $\phi_{it} K_t * (1-\delta) + s * GNP_{it}$ and the law of motion for the ownership share is

$$\phi_{it+1} = \frac{\phi_{it} K_t * (1-\delta) + s * GNP_{it}}{K_t * (1-\delta) + s * GNP_t} \ .$$

To initialize the process we choose an arbitrary K_0 and simulate the model for a number of years until it converges to a steady-state value. We start the following iterations from the steady state value. We set the initial level of productivity in each state $A_0 = 1$ (a normalization) and the initial ownership share of each state $\phi_{i0} = 1/50$.

For the parameters that govern the productivity process, we choose $\rho = 0.99$ and $\sigma = 0.05$. The standard deviation of productivity is chosen to generate state level output volatility that is similar to what we found in the data. We use $s = 0.20$ and $\delta = 0.05$. The calibration of these parameter values is guided by aggregate and state-specific moments in the data. We simulate the model for 100 years in each iteration.

Note that in the absence of productivity shocks, with equal populations and productivity levels, the portfolio shares revert to the mean of $1/N$ and hence GDP/GNP ratio reverts to 1 over time, assuming that the saving rate is constant across states. The intuition is simple: consider a state with a one-time positive productivity shock. This state will see output increase more than income but because wages will be higher than in other states, savings will also be higher. The higher savings will result in higher asset income in the following period and the result is gradual convergence of the level of income to the new output level.

2.3 Regressions with Simulated Data

We perform cross-sectional regressions using the simulated values for 50 states. We performed 200 regressions (from 200 simulations) and report the average coefficients. Each simulation is for "T=100" years. Table 1, column (1), displays results from regressing the log average output/income ratio in the last 20 years on log average output from the 3 preceding years. (These "years" are chosen to match the empirical regressions in Tables 5 and 6.) We find a statistically significant coefficient of 0.06 implying that high output states have higher output than income and, therefore, are net recipient of out-of-state capital. In other words, capital flows to "rich" states on average. In column (2), we add the lagged ownership share. In the actual data as well as in the simulated data, high output regions tend to have high ownership shares, so to limit collinearity we use ownership shares that are averaged over data five "decades" ago.[12] We get a negative significant coefficient of –8.42, implying that states which had higher than average ownership shares 50 years ago still tend have income that is higher than output. The interpretation of this coefficient is that a state which owned 0.01 percentage points more of the aggregate U.S. capital stock will enjoy almost 8 percent more capital income on average.[13]

[12]More precisely we average over observations 39–49 where the left-hand side is averaged over observations 81–100.

[13]The average share is 1/50=0.02 so 0.01 corresponds to a very large increase in ownership share.

Table 2 shows the results of a regression of the change in the output/income ratio average from the second to last last decade to the last decade regressed on the growth in output over the second to last decade. Based on the analytical result displayed above we expect a coefficient near 0.33 and we find a significant coefficient of 0.08—the passing of time results in a clearly smaller coefficient than the derivative we found corresponding to instant (and instantly observed) adjustment. Column (2) shows that if we add the output/income ratio of the previous decade we find a coefficient of 0.13 to lagged growth and a coefficient to the lagged output income ratio of –0.41. This implies a half-life for output-income deviations (from the average of unity) of about 15 years.

We performed sensitivity analysis by changing parameter values and initial arbitrary values. The results of the regressions are somewhat sensitive to the size of the productivity shocks (the larger shocks, the larger the coefficient to lagged output in Table 1) and the exact parameters values are sensitive to the depreciation rate (typically, smaller coefficients with high depreciation) while the results of the change regressions are very robust. However, the results are qualitatively robust.

3 Empirical Analysis

The raw data series were obtained from the Bureau of Economic Analysis (BEA), unless otherwise stated. All nominal variables are converted into 2000 prices using the consumer price index.[14] We provide a 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

[14]A quantity index for real GDP-growth is available for states but our specification captures the effect of, for example, oil-price variation on capital flows which we would substantially miss if we used quantity indices.

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 a descriptive sense.

Our main measure for income is state-level personal income, SPI, which is based mainly on administrative-records data and on data from censuses and surveys. SPI is derived as adding personal earnings, government transfers and dividend, interest and rental income and subtracting contributions to government social insurance. 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. We show the relationship between GNI and GDP in the aggregate U.S. National Income and Product Accounts, and we discuss the calculation of GSP and SPI in detail in the appendix. After presenting our main results, we introduce modifications to SPI show results for imputed GNI approximations.

3.1 The Empirical Output/Income Ratio

The output/income ratio measures the relative magnitude of net inter-state capital income flows from a state. If such flows are zero, the ratio is unity; if they are negative, the ratio is less than unity; and if they are positive, the ratio exceeds 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 and affect 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:

$$\text{Output/Income}_{it} = \frac{\text{GSP}_{it} \Big/ \text{SPI}_{it}}{\text{GSP}_{t} \Big/ \text{SPI}_{t}},$$

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.

3.2 Graphical Evidence: 1963–2000

Figure 2 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 Southwest region had relatively high growth in the 1960s while the Great Lakes and New England regions 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

[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.

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 opposite of that found for New England and, again, consistent with our model.

The large changes in oil prices that occurred during the period 1973–74 and 1979–87 are clearly visible in Figure 2. 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 3 explores directly if oil price spikes 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 three years 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 bottom line is that the graphical evidence is fully consistent with the historical development of the U.S. states. Kalemli-Ozcan, Turan, and Sørensen (2008) show that convergence of output across the U.S. states was mainly over by the late 1980s, while there was strong "catch-up" growth in 1950s and 1960s. Romans (1965) constructs state-level "current accounts" for U.S. states for 1953 and 1957.[16] Romans (1965) shows that saving minus investment was very large and negative for southern states as well as for oil states

[16]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.

Figure 1: Output/Income Ratio, U.S. Regions

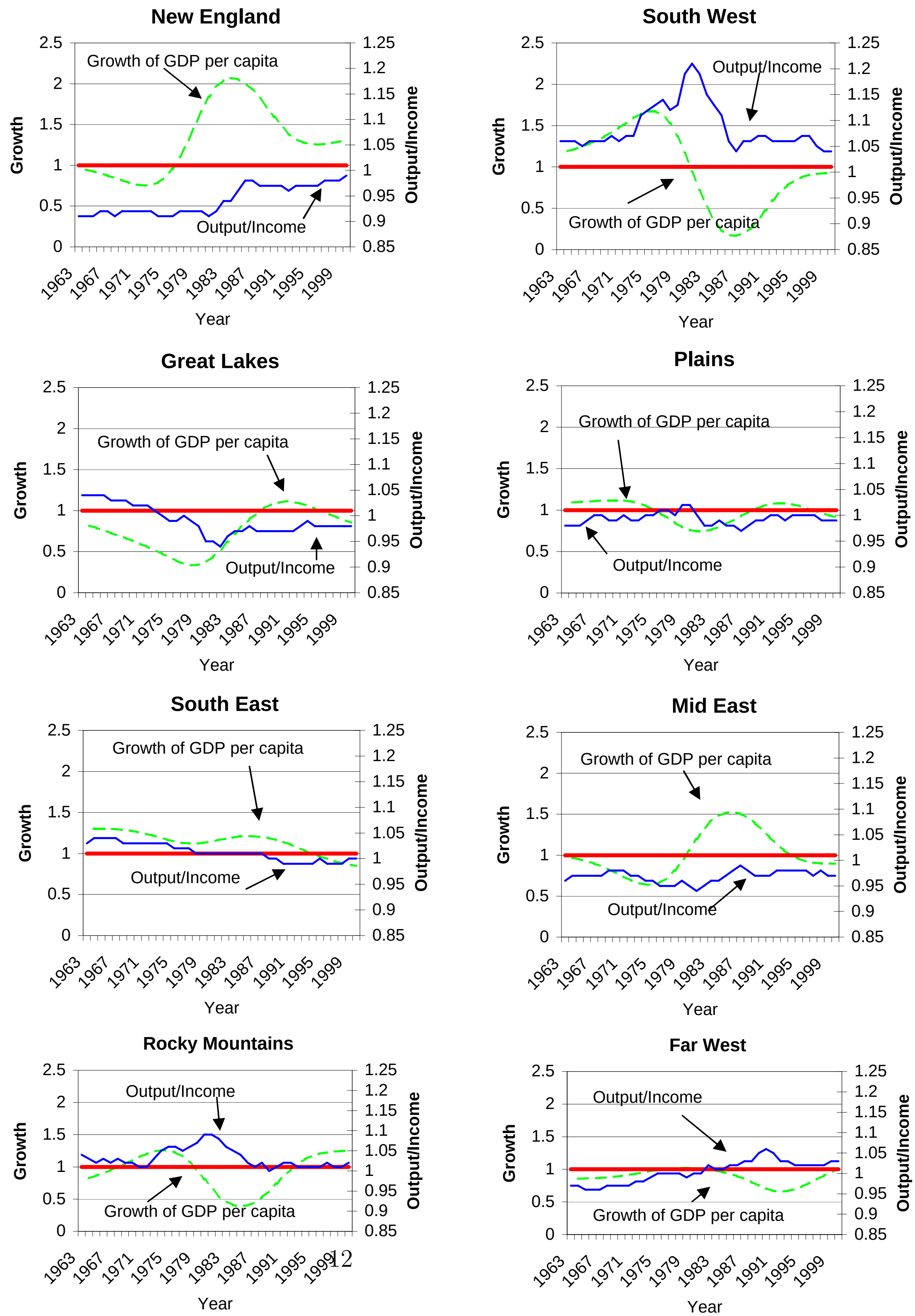
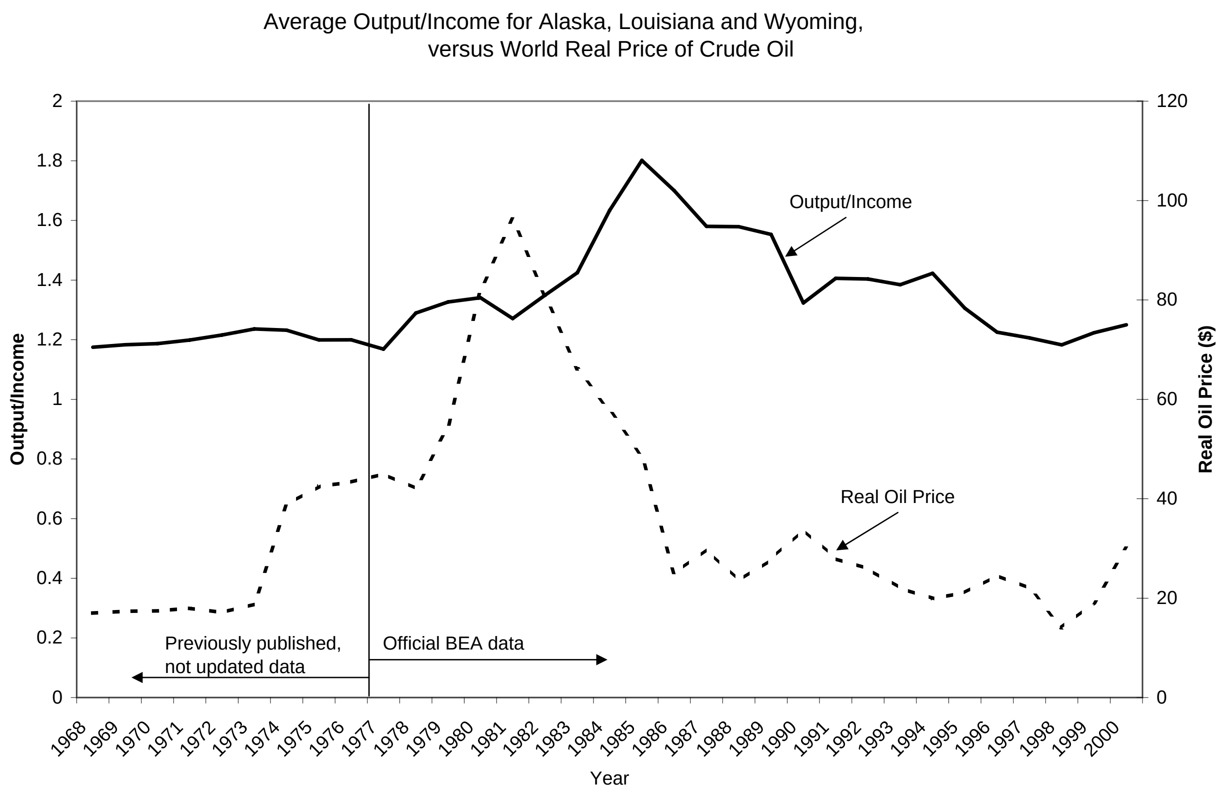


Figure 2: Output/Income Ratio, Oil Regions



in the 1950s. 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, as shown by Kalemli-Ozcan, Turan, and Sørensen (2008). One may notice from figure 3 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 and New England was a net supplier of capital to other states in the 1950s and remained a net creditor at the beginning of the 1980s (corresponding to an above average value of ϕ_i in the model).

3.3 Specification of Regressions

We estimate regressions with real data similar to the ones in Tables 1 and 2 that use simulated data. We fit cross-sectional regressions to data averaged over long time spans in order to minimize the potential effects of business cycles and measurement errors. For completeness, we also show the results of panel regressions where the data has been average over fewer years.

The main regressors are lagged output per capita, lagged growth of output per capita, and the lagged output-income ratio. Reliable measures of net ownership are not available, so we examine whether indicators of historical wealth predict current output/income ratios. As our measure of historical wealth, we use the logarithm of per capita value of dividend and interest income by state, averaged over 1939–1949.[17] 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

[17] The historical dividend and interest income data was 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 mostly imputed rental income of locally used and owned property.

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.[18]

We include other controls that are not present in the model, but are important in reality: 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. 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, averaged over 1977–80. States with a relatively high number of retirees may have higher income relative to output because retirees typically contribute little to output but nevertheless have 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 the potential impact of life-cycle saving. This will also control for the migration of elderly retirees to sun-belt states.

In the growth regressions, 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.

3.4 Descriptive Statistics

In Table 3, we tabulate per capita dividend and interest income by state averaged over 1939–49 (no data available for Hawaii and Alaska), GSP growth per capita averaged over 1981–1990, GSP per capita 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.

[18]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.

Delaware is an extreme outlier. GSP 1977–1980 also shows high variation with Alaska having an extremely high value of about 63,000 dollars per capita. Next highest is Wyoming—another oil state—at 43,000. These oil states also exhibit the highest output/income ratios. The lowest ratio is found for Florida, which reflects capital income received by retirees who are no longer in the work force.

Table 4 reports the mean, maximum, minimum, and standard errors (across the 50 states) of the output/income ratio and all 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 and has a standard deviation of 0.12.[19] This is a large amount of variation because a value of 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. 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.

3.5 Results from Cross-Sectional OLS Regressions

Level regressions

Our main results for the level regressions are presented in Table 5. 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 stronger if Alaska were added. 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

[19]The mean is not exactly equal to 1 due to normalization by the aggregate rather than the average U.S-wide values.

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. 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 economically large and meaningful. Compared to the estimate from simulated data the coefficient to GSP 1977-1980 is significantly larger; however the result matches the qualitative finding of our simulations that capital tends to flow to high output states.

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. One might find it surprising that the effect is as long lasting as this result indicates but in our regression using simulated date we also found ownership shares 50 years in the past to be highly significant. (We can't compare the actual coefficients because the historical dividend and interest income doesn't correspond exactly to ownership shares.)

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, this is not the case empirically. In the next section we show that population growth also does not affect growth in the output/income ratio.

Change Regressions

Table 6 explores whether the change in the output/income ratio is explained by per capita output growth and population growth as predicted and whether the effect of population growth on the change in the output/income ratio is 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.[20] In section 2, we found the prediction that the output/income ratio will increase by about α times the percent change in GDP and the typical capital share α is around 0.3. Our simulated coefficient was somewhat lower so the fit isn't perfect but, as for the levels regression, in the right direction and not too far off. For international data, Glick and Rogoff (1995) regress changes in gross investment and current accounts on 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 and existence of persistent productivity shocks.[21] 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

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

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

capita were financed on net by other states.

In the second column of Table 6 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). The estimated coefficient to population growth is 0.08 with a t statistic of 1.34. Hence, we cannot strictly reject (at the usual 5 percent level) that the coefficient is zero, which is consistent with case (b) of the model, which implies that migrants carry with them average amounts of assets. Moreover, the coefficient to GSP growth hardly changes, which increases our confidence in this interpretation. On the other hand, we can reject that the coefficient to population growth is the negative of GSP growth, which corresponds to case (a).[22]

In the last column, we add the lagged value of output/income. This renders the coefficient to growth smaller at 0.08 while the coefficient to lagged output/income takes a value of −0.42. These estimated values corresponds extremely well to the values from the simulated data. The half-life of 15 years for output/income deviations is spot-on while the coefficient to lagged growth now is slightly smaller than predicted. Overall, we consider this a very good fit.

No other regressors were found to be significant as shown in detail in the robustness section below, 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.

3.6 Some Empirical Issues

We discuss some potentially important empirical issues. We average over decades in order to avoid issues related to adjustment costs of capital and business cycles.[23] At the same time,

[22]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.

[23]We avoid using overlapping samples for the regressor output and for the dependent variable output/income ratio for the simple reason that output is used in the numerator of this ratio and measurement

for our empirical strategy to produce significant empirical results TFP shocks need to be persistent so the averaging done to eliminate the business cycle will not average out relative productivity shocks. As mentioned, Glick and Rogoff (1995) provide direct evidence of high persistence of TFP shocks at the country-level while 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.

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 modeled as malleable capital when long time intervals are considered.[24] Country-level evidence 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.[25]

Last, we ignore 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. However, empirical predictions of the forward looking saving behavior for current account responses vary depending on the nature and persistence of the shock. As argued by Glick and Rogoff (1995), the intertemporal approach to the current account implies that following a permanent country-specific shock, there will be a current account deficit in excess of the corresponding rise in investment. This is because permanent income rises more than current income as a result of the permanent shock leading to a fall in saving.

error would lead to a spurious positive correlation of output with the output/income ratio.

[24]We interpret TFP very broadly to include taxes, insurance, cost of heating/cooling, transportation, endowments of oil or minerals, agglomeration benefits etc. In particular, relative price changes, such as oil price shocks that the increase the return to capital in oil-rich states are an important source of TFP variation in our data.

[25]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.

Hence, given the random walk nature of country-specific shocks for OECD countries, they argue that the finding of larger responses of investments than current accounts constitutes a puzzle. They argue that the response of savings can be justified by productivity shocks that are slowly mean reverting.[26] In case of a transitory shock, on the other hand, the opposite will be true in a fully integrated small open economy. A transitory positive income shock will generate an increase in saving which will be fully invested in foreign assets, resulting in a current account surplus and net capital outflows for the country that has experienced the shock regardless of the country's initial net foreign asset position. In our model, because of full diversification and hence no risk premia, relative investment will be determined by relative productivity with no role for state-specific savings rates. Hence, both debtor and creditor countries can attract capital on net and run current account deficits if they are hit by positive persistent productivity shocks. As an empirical matter, reliable estimates of state-level savings are hard to come by. Given these arguments we prefer not to condition our predictions on models of saving.

4 Robustness

4.1 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.

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

[26]Random walks are not mean reverting, but time series tests can not separate random works from, say, mean reverting AR(1) processes with a coefficient to lagged productivity very close to unity.

to "state-level GNI," is to calculate "state income," which is the income that 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). We approximate GNI as "State income" plus retained corporate earnings. Retained corporate earnings are not available by state and we impute the state-level numbers from aggregate data.[27] 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 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). These estimates are based on personal 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

[27]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.

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.

We show that our results are robust to all these different definitions of income. This is true both for the level and the change regressions. These robustness exercises are available upon request and also on www.uh.edu/skalemli.

4.2 Additional Control Variables

We show in an earlier version (available on www.uh.edu/skalemli) that the results are robust to the inclusion of other variables that are likely to be correlated with ownership and productivity. We consider the following variables.

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.[28]

Sectoral Shares other than oil: Historically, agricultural areas have often been laggards

[28] 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 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.

Human Capital: Residents in states with a relatively high number of educated individuals may have higher output relative to 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).

4.3 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 7 we show regressions for 10-year intervals, 7-year intervals, and 5-year intervals. The panel data setting is also ideal for further examining the final prediction of our model, that the output/income ratio is mean reverting. If our interpretation of the results are correct the coefficient to the lagged output/income ratio should decline as we look at shorter intervals.

Column (1) replicated the third column of Table 6. The estimated coefficient to lagged growth is slightly larger in columns (2) and (3) and significant at the 5 percent level. 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. The panel regressions do not give meaningful results at, say, the annual frequency. This is to be expected as we ignore business cycle variations and adjustment costs in our model. 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.

5 Conclusion

In spite of the surge in international capital flows in the last decade their magnitude is still below what typical models predict and some countries even the direction of the flows is "wrong" in the sense that capital flows from poorer countries to richer countries. Recent theoretical work has shifted the attention to portfolio models of current account in order to solve this dilemma.

We adopt a different approach. We develop a simple DSGE model with persistent productivity shocks and full diversification of capital income. Hence, relative investment is determined by relative productivity levels, independently of relative savings. Our model predicts—as the new portfolio models—that net foreign ownership positions are mean-reverting. Essential for our result is that capital is fully diversified such that net flows are not primarily determined by consideration of risk.

An advantage of our framework is that it is easily related to the data. We test the model using data from the U.S. states. The model predicts that capital flows to fast growing states from slow growing states and as a result high growth states pay capital income to other states. With persistent productivity shocks high output—"rich"—states end up being net debtors.

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. Nonetheless, almost all countries hold amounts of foreign assets below the level of GDP (with Ireland being a notable exception). Why countries do this is one of the biggest puzzles in international finance, as argued by Kraay and Ventura (2003). The evidence that we present suggests that capital flows and ownership patterns of U.S. states are consistent a simple frictionless neoclassical model. Therefore, the small size and "wrong" direction of net international capital flows is likely due to frictions in international financial markets associated with national borders.

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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.[29]

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

[29] See Beemiller and Downey (2001).

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 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.

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: **Net Capital Income Flows: Simulated Data**

Dependent Variable: Log of Average Output/Income T–19 to T

	(1)	(2)
Log Average Output	0.06	0.10
T–23 to T–19	(0.02)	(0.02)
Lagged Ownership Share	–	–8.42
T–61 to T–51	–	(2.40)

Notes: The table reports the results of cross-sectional regressions for 50 "states" on simulated data. The specification parallels the regressions using actual data reported in Table 5. A constant was included but not reported. The coefficient estimates are averages over 200 simulations and average estimated standard errors are reported in parentheses. The simulated data are calibrated to match long-run trends in the aggregate U.S. economy and state-level output data. The data are simulated for T=100 "years" (see the text for parameter values). The left-hand side is the logarithm of the ratio of GDP to GNI averaged over years T–19 to T and "Log Average Output" is the logarithm of the level of GDP averaged over years T–23 to T–19. "Lagged Ownership Share" is the share of ownership of the aggregate capital stock averaged over years T–61 to T–51. This parallels the choice made when using actual U.S. data to limit collinearity between ownership and output.

Table 2: **Change in Net Capital Income Flows: Simulated Data**

Dependent Var.: Avg. Out./Inc. T–9 to T minus Avg. Out./Inc. T–19 to T–10

	(1)	(2)
Output Growth	0.08	0.13
T–19 to T–10	(0.03)	(0.03)
Output/Income Lagged	–	–0.41
	–	(0.09)

Notes: The table reports the results of cross-sectional regressions for 50 "states" on simulated data. The specification parallels the regressions using actual data reported in Table 6. Since we do not have population growth in our simulations the table does not include this as a regressor. A constant was included but is not reported. The coefficients are averages over 200 simulations and average estimated standard errors are reported in parentheses. The simulated data are calibrated to match long-run trends in the aggregate U.S. economy and state-level output data. The data are simulated for T=100 "years" (see the text for parameter values). The left hand side is the logarithm of the ratio of GDP to GNI averaged over years T–9 to T minus the ratio of GDP to GNI averaged over years T–19 to T–10. "Output Growth T–19 to T–10" is the logarithm of state GDP in year T–10 minus the logarithm of state GDP in year T–19. "Lagged Output/Income" is ratio of GDP to GNI averaged over the years T–19 to T–10.

Table 3: **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 4: **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 5: **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	0.29	0.43	0.29	0.24	0.24
1977−1980	(3.12)	(5.93)	(4.95)	(4.41)	(4.44)
Log Average Div&Int	–	–0.09	–0.06	–0.05	–0.05
Income 1939−1949	–	(5.71)	(3.97)	(3.35)	(3.44)
Log Average Oil Share	–	–	0.56	0.54	0.55
1977−1980	–	–	(3.14)	(3.47)	(3.52)
Log Retirees/Population	–	–	–	–0.11	–0.10
1980	–	–	–	(2.72)	(2.25)
Average Population Growth	–	–	–	–	0.15
1977−1980	–	–	–	–	(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 6: **Change in Net Capital Income Flows**

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

	(1)	(2)	(3)
States	47	47	47
GSP Growth	0.30	0.28	0.08
from 1980 to 1990	(3.12)	(3.26)	(1.75)
Population Growth	–	0.08	0.02
from 1980 to 1990	–	(1.34)	(0.49)
Output/Income Lagged	–	–	–0.42
	–	–	(1.83)
R^2	0.41	0.43	0.78

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. Output/Income Lagged is the average of the ratio over 1981−1990 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 7: **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.