Why Does Capital Flow to Rich States? *

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Abstract

International capital flows do not fit neoclassical models well which might be due to deficiencies in the model or to barriers to capital flows. The United States has a fully integrated frictionless capital market with 50 small open economies and we ask if a very simple frictionless open economy neoclassical model can explain capital flows between the U.S. states. Our empirical results match the predictions of the model well. Consequently, the main explanation for the small size and the "wrong" direction of international capital flows is more 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 raising renewed interest in their determinants. One salient fact of this recent increase is the small size of net capital flows relative to gross flows: limited "development finance" relative to "diversification finance" in the language of Obstfeld and Taylor (2004). In addition to the low levels of net flows, capital has been flowing "uphill" from poorer to richer countries to such an extent that the large asset holdings of, in particular, east Asian countries are considered symptoms of global imbalances. These empirical patterns are anomalies relative to theoretical benchmarks. Gourinchas and Jeanne (2007) is an important example of papers that try, with limited success, to extend the neoclassical framework to fit the data while other authors focus on a new models with incomplete markets and portfolio choice at the center stage. Examples are Kraay and Ventura (2000, 2003), Evans and Hnatkovska (2005), and Tille and van Wincoop (2008); however, this body of research have empirical predictions that are hard to take to the data.

The goal of this paper is 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 very simple frictionless open economy neoclassical model show that it fits the data for U.S. states well. We assume that capital markets are fully integrated such that 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.

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.[1] In spite of its simplicity, the model predicts important empirical patterns that can be directly carried to the data. Capital will flow to fast growing states (high TFP) from slow growing states and as a result high growth states pay "dividends" to other states. More precisely, capital pays capital income in the form of dividends, interest, and transfers within

[1]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.

multi-state companies.[2] With persistent productivity shocks high output—"rich"—states end up being net debtors. Our goal is to examine if the broad implications of the model in terms of observable variables hold in U.S. state-level data. The main implications that we examine are 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. Our empirical results match the predictions of the model well. Consequently, the main explanation for the "small size" and the "wrong direction" of international capital flows is more likely due to "frictions" associated with national borders that lead to de-facto incomplete international markets, rather than due to the simple neoclassical model being misleading.[3]

We do not have data on state level current accounts but income flows (dividends) between states reflects past net investment flows. However, dividend payments between states are also not directly observed. 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").[4] 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. The ratio of output to income ("output/income") is then an indicator of net capital income. This ratio has been used before to infer past net capital flows between U.S. states by Atkeson and Bayoumi (1993) who found large inter-regional net capital flows within the U.S.; however, they did not systematically match their finding to a model. At the country 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

[2]Capital income flows to and from other states provide risk sharing and 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.

[3]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).

[4]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.

where the historical capital flows data of interest are not observed.

We regress the output/income ratio averaged over 20 years on the initial level of output and find that capital tends to flow to rich states. A positive coefficient to initial output indicates that high output states are net debtors; i.e., net recipients of capital from other states. In order to evaluate how well these results correspond to the model we estimate the same regression on simulated data based on the model and find similar coefficients.[5] We also find that states with high growth in the 1980s experienced an increase in the output/income ratio—indicating an inflow of capital—from the 1980s to the 1990s of the magnitude the model predicts. The data further confirms the prediction that the output/income ratio converges to unity when relative growth differentials are controlled for with a coefficient similar to the one estimated on simulated data.

In the next section, we derive and simulate 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 Growth Model

Consider states $i = 1, ..., N$, with labor force L_{it}. Output at time t is Cobb-Douglas: $GDP_{it} = A_{it}K_{it}^{\alpha}L_i^{1-\alpha}$, where K_{it} is capital *installed* in state i. The aggregate capital stock installed is K_t, because we consider the United States to be a closed economy.[6] K_t is also a nationwide mutual fund; i.e., total capital *owned*. State i owns a positive share ϕ_{it} in the fund so capital *owned* is $\phi_{it}K_t$ where $\Sigma\phi_{it} = 1$ and $K_t = \Sigma K_{it}$.

Under market integration the ex ante gross rate of return to investment is R_t for all states. 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

[5] 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).

[6] 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.

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. 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 economy. Other cases can easily be interpolated or 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 equilibrium condition is illustrated in Figure 1. The MPK schedule shows how marginal product varies as the capital stock increases. For given labor force, productivity, and depreciation rate (δ), an increase in the capital stock will reduce its marginal product due to the law of diminishing returns. The aggregate interest rate is constant—in our application with many regions the interest rate can be considered given for individual regions, akin to a small open economy assumption. The domestic capital stock is determined by the equation $MPK = R$. The relative stock of capital installed will then satisfy: $\frac{K_{it}}{K_{jt}} = \frac{L_{it}}{L_{jt}}(\frac{A_{it}}{A_{jt}})^{\frac{1}{1-\alpha}}$.[7] Thus, the equilibrium capital-labor ratio is higher in region 2 with higher productivity than in region 1. In Figure 1, the MPK schedule for the high productivity region is given by the dashed line and the MPK schedule for the lower productivity region is given as the solid line.

We show the deterministic version of our model in order to facilitate the exposition. A more detailed model would allow for uncertainty, but under the assumption that capital ownership is fully diversified risk premiums would 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 the data. 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.[8] On the other hand, poorer regions might become competitive due do "recent" changes in technology or human capital accumulation and "catch-up growth" may be observed where low output regions have higher growth than more developed regions and, as a result, are attracting capital from other regions; an example is the U.S. southern states in the 1950s.[9]

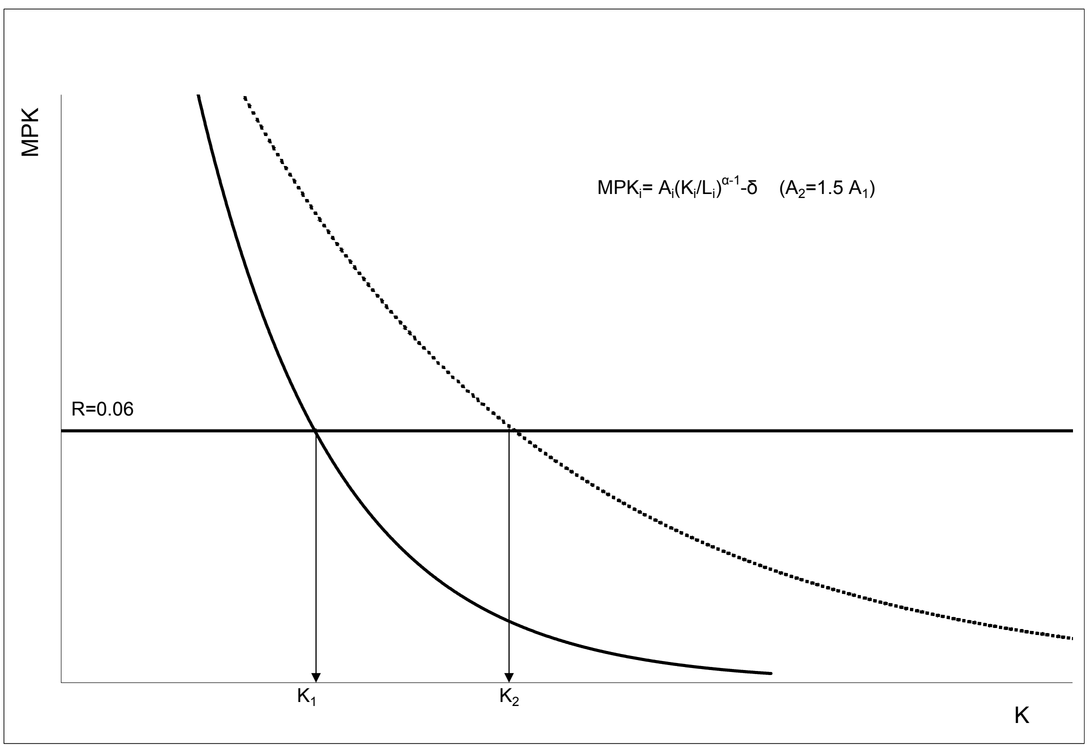
In the absence of productivity shocks the GDP/GNP ratio reverts to 1 over time, assum-

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

[8]Kraay and Ventura (2002) develop a model where investment risk is high and diminishing returns are weak. The implication of their model is such that current account response should be equal to the savings generated by the positive productivity shock multiplied by country's share of foreign assets in total assets. This implies that positive productivity shocks lead to deficits in debtor countries and surpluses in creditor countries. Our model is consistent with this, though in our case debtor countries can have higher output than in their model because we assume full diversification while they assume no diversification and therefore high required risk premia.

[9]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.

Figure 1: Equilibrium Capital Stock as a Function of Productivity



ing 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.

2.2 Regressions on simulated data

We simulate the model for 50 open economies, "states," for 25 years. Each state receive a persistent mean zero random productivity shock with a standard deviation that is 3 percent of the initial productivity level, every 5 "years". We assume $\alpha = .3$ and a savings rate of 0.15 and a depreciation rate of 0.08. We are interested in the quantitative behavior of the model for reasonable parameter values. We performed 6 iterations.

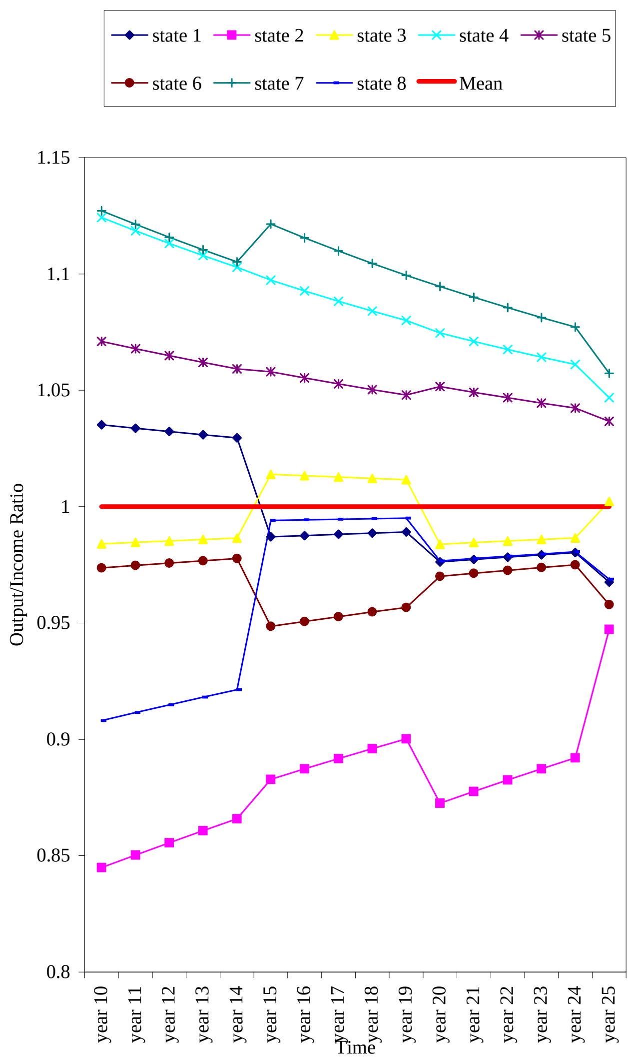
Figure 2 shows the simulated output/income ratio for 8 random states for the last 15 years of the simulation.[10] For all the 8 states, the ratio converges to the average value of 1 in the long run as predicted. With random productivity shocks that can be positive and negative some states are net creditors and some are net debtors. The striking feature of this figure is that it looks very similar to the one where we use real data (figure 3), as will be explained in detail next.

Table 1, column (1) displays results from regressing the log of average output/income ratio in the second decade on log average output from the first decade, using simulated data. We find a positive significant coefficient of 0.26 as predicted by the model, hence high output states are net debtors. In column (2), we add the ownership share, the parameter ϕ. The estimated coefficient on output turns out to be 0.21 so it is still the case that we have high output states as receiving capital flows on net. However the coefficient on ownership turns out to be positive, 0.20. This is not a statistically significant coefficient though.

Table 2 shows results of a regression of the change in the output/income ratio from second to last decade on the average growth in output over the second to last decade, all

[10] We start from an arbitrary capital stock and hence the first 5-10 years are not very informative.

Figure 2: Simulated Output/Income Ratio, plotted for 8 random states



in simulated data. Based on the analytical result displayed above we expect a coefficient near 0.30 and we find 0.24. Column (2) shows that if we add the output/income ratio of the previous decade we find a coefficient of 0.29 to lagged growth and a coefficient to the lagged output income ratio of –0.32. This implies a half-life for output-income deviations (from the average of unity) of about 20 years.

The coefficients from simulated data regressions are very close to the ones obtained from regressions that are performed using real data as will be discussed in detail next. As we will see, in the empirical part of the paper, we regress the log of the average output/income ratio in 1981–2000 on the log of the average level of output in 1977–1980. For the changes regressions, we regress the change in average output/income ratio from the decade of the 1980s to the decade of the 1990s.

2.3 Some empirical issues

We average over decades in order to avoid issues related to adjustment costs of capital and business cycles. At the same time, we avoid using as a regressor output data for the same sample as we use for the output/income ratio for the simple reason that output is used in the numerator of this ratio and measurement error would lead to a spurious positive correlation of output with the output/income ratio.

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. 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.[11]

We interpret TFP very broadly to include taxes, insurance, cost of heating/cooling,

[11] 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.

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.

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. 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.

Last but not least, 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), intertemporal approach to current account implies that if there is 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 (via slow adjusting capital) as a result of the permanent shock, which in turn will induce a fall in saving. Hence given the random walk nature of country-specific shocks for OECD countries, they argue that the finding of a much larger investment response than the current account constitutes a puzzle. They justify this implied "no-fall" in saving by a slow mean reverting process that governs the shocks.

In case of a transitory shock, on the other hand, the opposite will be true in a fully integrated small open economy. The 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. Kraay and Ventura (2000) debate this "traditional" rule and they propose a model where countries invest the saving generated by the transitory shock according to their existing portfolio shares. The main reason for this is that they assume investment risk is strong and diminishing returns are weak so there is no incentive to change the existing portfolio allocation. Hence a positive productivity shock will lead to a current account deficit in the debtor countries and a surplus in the creditor countries. Kraay and Ventura (2003) find, however, that the "new" rule holds much better in the data in the long-run (shown by between regressions on 30 year averaged data) than in the short-run (shown by within regressions). This finding of course confirms the persistent nature of shocks as shown by Glick and Rogoff (1995). Kraay and Ventura (2003) interpret their result as an indication of much less portfolio reallocation in the long-run compared to portfolio re-balancing in the short-run, which will imply that in the short-run countries do not invest according to the existing portfolio shares. Tille and van Wincoop (2008) argue that there will be a change in the portfolio allocation in equilibrium since the productivity shocks affect the expected return. Hence they show that there will be positive outflows and negative inflows for the country that has experienced the positive shock as a result of the allocation of new savings to foreign assets.

In our model, a permanent productivity shock leads to current account deficit and hence capital inflows, where the investment is, financed by the entire U.S. savings under full diversification. Hence state savings has no role and assumed to be constant. As an empirical matter reliable estimates of differences in savings behavior across states are hard to come by. Given all this we prefer not to condition our predictions on models of saving.

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.[12] We

[12] 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.

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 a descriptive sense.

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). Then we can 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.[13] One last modification, that will make the difference between SPI and

[13]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

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). 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

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.

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 Graphical Evidence: 1963–2000

Figure 4 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.[14] 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 4 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,

[14] 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.

1960s)—see Romans (1965). Therefore, New England was 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. This is a straightforward prediction of the model. It can easily be shown that the ratio will be above unity if there is 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 4. 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 5 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 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.

4.3 Specification of Regressions

We estimate regressions with real data similar to the ones in tables 1 and 2 that use simulated data. We basically run cross-sectional regressions with data averaged over long time spans. 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.

The main regressors are lagged output, lagged growth, and the lagged output-income ratio for which direct equivalents exists in the data. 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

Figure 3: Output/Income Ratio, U.S. Regions

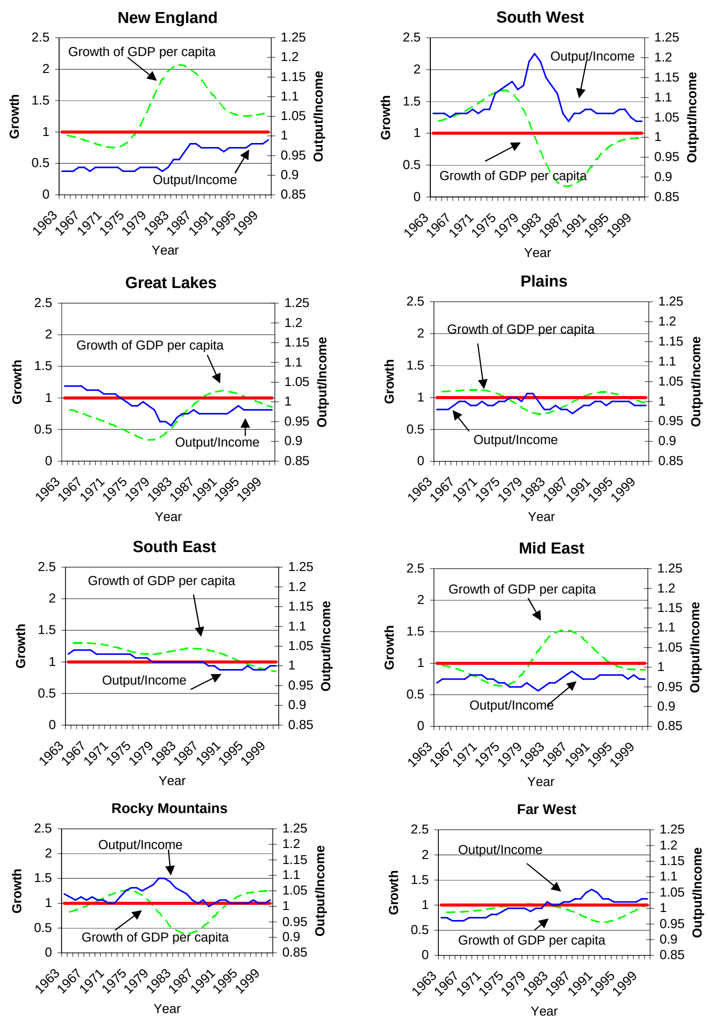
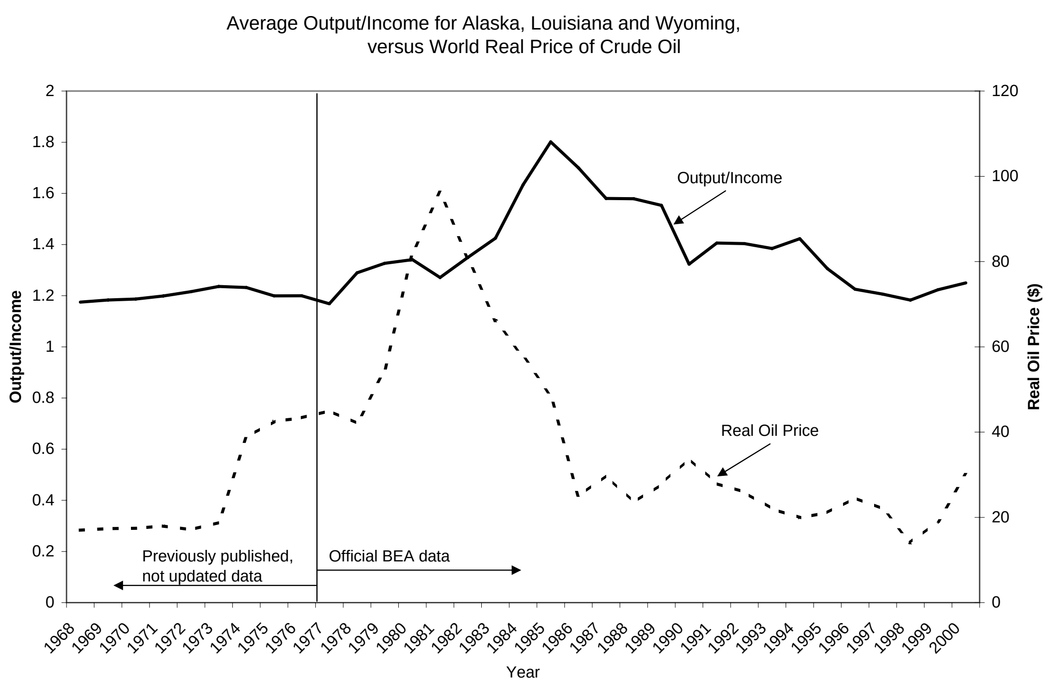


Figure 4: Output/Income Ratio, Oil Regions



1939–1949) value of dividend and interest income by state.[15] 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.[16]

We include other controls that are not relevant in the simulated data but important in the real data: 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. We take the average 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 potential impacts 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.

[15] 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.

[16] 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.

4.4 Descriptive Statistics

In table 3, 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 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 4 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.

4.5 Correlation between Regressors

In table 5, 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.

4.6 Results from Cross-Sectional OLS Regressions

Level regressions

Our main results for the level regressions are presented in table 6. 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 7 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.[17] In section 2, we found the prediction that the output/income ratio will increase by about α times the percent change in GDP. The typical estimate 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.[18] While we are not able to run exactly the same regression as Glick and Rogoff (due to the fact that we

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

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

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.

Our estimate will suffer from downward bias due to the use of lagged output growth, especially if it is measured with error.[19] 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). Our model 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

[19] This is 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.

0.08. We cannot strictly reject (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.[20]

No other regressors were found to be significant as shown in detail in the robustness section, 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 8 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 6 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.

[20]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.

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 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 6. 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 our model. 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 9, 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 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.[21]

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.

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).

The first column of Table 10 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 6. Due to the somewhat limited number of degrees-of-freedom, we add each of these regressors one-by-

[21] 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.

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 10.) The results of table 10 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 11 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 7 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.[22] 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

When it comes to size and direction of international capital flows, there is a dilemma between the predictions of the standard neoclassical models and the empirical studies using country data. The goal of this paper is to solve this inconsistency. We have two innovations: 1) We develop the simplest frictionless open economy neoclassical model possible; 2) we test this model using the U.S. state level data, a fully integrated frictionless capital market with 50 small open economies, to give it the best chance. Our empirical results match the predictions of the model well. Consequently, the main explanation for "small size" or the

[22]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 **??**.

"wrong direction" international capital flows is more likely due to "frictions" associated with national borders.

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 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). Why countries do this is one of the biggest puzzles in international finance, as argued by Kraay and Ventura (2003). Our evidence shows that capital flows between and ownership patterns of U.S. states are consistent with the predictions of a simple frictionless neoclassical model.

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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.[23]

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

[23]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.

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

Dependent Variable: Log of Average Output/Income

	(1)	(2)
Log Average Output	0.26	0.21
	(0.02)	(0.06)
Log Average Ownership	–	0.20
	–	(0.26)

Notes: Simulations are based on 6 iterations, where the average value of the last 5 years is used. For each iteration there are 25 years and 50 states. Saving rate is 15%, depreciation rate is 8% and α is 0.3. Standard errors are reported in parentheses.

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

Dependent Variable: Change in Average Output/Income

	(1)	(2)
Output Growth	0.24	0.29
	(0.03)	(0.001)
Lagged Output/Income	–	–0.32
	–	(0.008)

Notes: Notes: Simulations are based on 6 iterations, where the average value of the last 5 years is used. For each iteration there are 25 years and 50 states. Saving rate is 15%, depreciation rate is 8% and α is 0.3. Standard errors are reported in parentheses.

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: **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 6: **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 7: **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	0.30	0.28
from 1980 to 1990	(3.12)	(3.26)
Population Growth	–	0.08
from 1980 to 1990	–	(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 8: **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 9: **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 10: **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	0.40	0.23	0.23	0.24	0.24
1977−1980	(6.45)	(3.69)	(4.57)	(4.48)	(3.88)
Log Average Div&Int	–	–0.04	–0.04	–0.05	–0.05
Income 1939−1939	–	(2.11)	(3.10)	(3.53)	(2.78)
Log Average Oil Share	–	0.55	0.54	0.59	0.53
1977−1980	–	(3.45)	(3.50)	(3.49)	(3.29)
Log Retirees/Population	–	–0.11	–0.11	–0.10	–0.10
1980	–	(2.21)	(2.39)	(2.02)	(1.89)
Average Population Growth	–	0.07	0.16	0.38	0.13
1977−1980	–	(0.14)	(0.42)	(0.68)	(0.35)
North	–	–0.01	–	–	–
	–	(0.28)	–	–	–
Log Tertiary/Population	–	–	–0.01	–	–
1989	–	–	(0.47)	–	–
Log Avg. Manufacturing	–	–	–	0.10	–
Share 1977−1980	–	–	–	(0.79)	–
Log Avg. Agriculture	–	–	–	–	–0.05
Share 1977−1980	–	–	–	–	(0.24)
R^2	0.64	0.77	0.77	0.77	0.77

Notes: See table 4 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 11: **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.