GENUINE SAVINGS IN LATIN AMERICA: ESTIMATES FOR 1973-97

Jeffrey R. Vincent
(Harvard University)

1 Introduction

Many resource-rich countries have achieved slow or no long-term improvements in their standard of living (Sachs and Warner 1995). One possible explanation is that they have failed to offset the depletion of their natural resource stocks with sufficient investments in physical capital (equipment, structures, infrastructure) and human capital (knowledge and skills). Consequently, their total wealth—the sum of physical, human, and natural capital—has declined. A basic result in the economics of sustainable development is that wealth accumulation is a necessary condition for raising long-term consumption levels.[1]

"Green accounting" refers to adjustments that expand the conventional definition of wealth in the national accounts. Through these adjustments, green accounting seeks to generate macroeconomic measures that can serve as leading indicators of long-run economic outcomes. This paper reports estimates of one such measure—genuine savings—for a set of thirteen Latin American countries during 1973-97. Genuine savings measures the change in total wealth: the difference between wealth in one period and the next. A 1997 report by the World Bank

[1] See Asheim (2000) for a recent review of the literature on this topic.

presented the first comprehensive set of cross-country estimates of genuine savings (World Bank 1997). The Bank has included genuine savings estimates in its World Development Indicators database since the year 2000 version (i.e., the WDI 2000). The estimates reported in this paper were constructed independently of the Bank's estimates, using methods that we believe better capture changes in the value of a country's natural resource stocks.

In principle, genuine savings should reflect changes in all forms of capital, not just natural capital. In practice, estimates of genuine savings are inevitably partial. The estimates in this paper are no exception. They include changes in physical and natural capital, but not human capital. Moreover, they include changes related to just three categories of extractive natural resources: fossil fuels, metal ores, and roundwood. They exclude such important resources as agricultural land, freshwater, and marine resources, not to mention environmental services related to air and water quality.

Although the estimates are therefore partial, empirical findings reported in another paper (Vincent 2001a) indicate that they do indeed have predictive power, in the following sense: average future consumption tends to be higher than current consumption in countries with positive levels of genuine savings, and lower in countries with negative levels. "Current consumption" refers to a country's aggregate consumption expenditure in the current year. "Average future consumption" refers to the weighted average of consumption expenditure during the subsequent decade, where the weights are based on discount rates.

This paper is organized as follows. In the next section, we describe the scope of the analysis, the general approach used to estimate genuine savings, and the principal data sources. The following section then presents the main findings. The final section discusses some implications of those findings.

2 Methods

2.1 Scope of the analysis

As indicated above, we estimated genuine savings for 1973-97. Generating estimates for earlier years does not appear to be possible, due to the general lack of reliable cross-country data on resource extraction costs before the early 1970s (Vincent 2001a).

We generated estimates for the following thirteen countries:

1. Argentina
2. Bolivia
3. Brazil
4. Chile
5. Colombia
6. Ecuador
7. Guyana
8. Mexico
9. Paraguay
10. Peru
11. Suriname
12. Uruguay
13. Venezuela.

This list includes virtually every country in South America, plus Mexico.

We estimated changes in the value of the commercially most important nonrenewable and renewable resources in the region. Adjustments for nonrenewable resources pertained to three fossil fuels,

1. oil
2. natural gas
3. coal,

and nine metal ores,

4. bauxite
5. copper
6. gold
7. iron ore
8. lead
9. nickel
10. silver
11. tin
12. zinc.

Adjustments for renewable resources pertained to forests as a source of commercial and noncommercial roundwood. We analyzed four types of roundwood,

13. fuelwood
14. pulpwood and particles
15. sawlogs and veneer logs
16. other industrial roundwood,

from both coniferous and nonconiferous trees.

As noted in the introduction, the resources on these lists do not encompass all forms of natural capital in the region. To the extent that agricultural soils and freshwater and marine resources have become depleted over time, and environmental quality has degraded, our estimates of genuine savings are biased in a positive direction.

2.2 General approach

We defined genuine savings in year *t* as

$$\tilde{S}_t = (GNP_t - E_t) - \delta_t K_t + \Delta V_t \,.$$

The first two of the three terms on the right-hand side give the change in physical capital. *GNP* is gross national product at market prices, and *E* is aggregate consumption expenditure. The difference between these variables is conventional national savings, broadly defined. We drew data on these variables from the WDI 2000. All are expressed in constant U.S. dollars, at 1987 prices and exchange rates.

δ is the depreciation rate for physical capital. Following Nehru and Dhareshwar (1993), we set it equal to 4 percent in all years. Nehru and Dhareshwar estimated *K*, the value of the total physical capital stock, for a large sample of countries around the world. Their sample included all the Latin American countries listed above except Suriname. Their estimates covered the period 1950-90. We used their estimates for 1973-80. We generated updated estimates for 1981-97 using data on gross domestic fixed investment from the WDI 2000 and the capital stock identity,

$$K_t = (1-\delta)K_{t-1} + I_{t-1} \,.$$

I is gross domestic fixed investment. This expression implicitly defines K_t as the value at the beginning of year *t*. We used this identity to calculate all values for Suriname, under the assumption that the *I/K* ratio in Suriname in 1960 equaled that in Guyana.

The last term on the right-hand side of the genuine savings expression, ΔV_t , is the change in the value of natural resource stocks. Estimating this term consumed most of the research effort. We defined the change as

$$\Delta V_t = V_{t+1} - V_t \, .$$

Like K_t , V_t is the value at the beginning of a year. Hence, ΔV_t gives the change that occurs during year t.

For all resources, we defined V_t as the discounted sum of current and future rents,

$$V_t = \sum_{s=t}^{t+10} R_s /(1+i)^{s-t} \, .$$

i is the discount rate. We used two values of i, 2 percent and 5 percent. These correspond approximately to the median values of the spotty data on the real deposit and lending interest rates in WDI 2000. We defined rent in year t, R_t , as

$$R_t = q_t \, (p_t - c_t) \, .$$

We obtained data on resource output (q), price (p), and average total cost (c) from various sources. Another paper, Vincent (2001b), describes those sources in detail. The next section provides a summary description.

The World Bank (1997) set $\Delta V_t = -R_t$ for nonrenewable resources; $\Delta V_t = 0$ for countries where timber harvests (h) were less than timber growth (g); and $\Delta V_t = (1-\alpha)R_t$, where $\alpha = g/h$, for countries where timber harvests exceeded growth. These short-cut expressions yield accurate estimates of ΔV_t only under very special circumstances (Vincent 2000). These circumstances are unlikely to occur in Latin America, and that is the main reason we constructed our own genuine savings estimates instead of using the Bank's.

As the summation sign indicates, we calculated V_t using a 10-year time horizon. We selected this interval because a longer time horizon did not substantially change ΔV_t for most countries and most years. Calculating V_t for $t > 1987$ required projecting resource rents beyond the end of the sample period (i.e., beyond 1997). We projected aggregate rents in each country by using the estimated equations from vector autoregressions of historical rents. The equations had the following form:

$$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 t + \beta_4 d + \varepsilon_t \,.$$

d is a dummy variable equaling 1 during 1973-85 (the oil-shock period) and 0 otherwise. Hence, our estimates of ΔV_t, and genuine savings, are within-sample estimates for 1973-86 but out-of-sample estimates for 1987-97.

2.3 Natural resource data

Resource output, q, refers to production quantities actually used by humans. It excludes unused portions of production, such as roundwood that is damaged during logging or natural gas that is flared. It includes noncommercial uses, however, such as direct household consumption of fuelwood. We obtained data on roundwood output from the U.N. Food and Agriculture Organization's website (www.fao.org). We obtained data on fossil fuel output from the websites of the U.S. Energy Information Administration (www.eia.doe.gov), the International Energy Information Agency (www.iea.org), and BP Amoco (www.bpamoco.com/worldenergy). We supplemented the online data with data from various yearbooks of the same organizations. We obtained data on metals output from the website of the U.S. Geological Service (www.usgs.gov), yearbooks of the same agency and the now-defunct U.S. Bureau of Mines, and the UNCTAD *Yearbook of International Commodity Statistics*.

We set price, *p*, equal to the unit value of a country's exports of a given resource. If data were not available for a particular country, we set price equal to the unit value for aggregate exports by other Latin American countries. The sources listed in the previous paragraph provided most of the data on export values and quantities. Two additional useful sources were the UNCTAD *Commodity Yearbook 1989* (for the years 1983-87) and the UNCTAD *Handbook of World Mineral Trade Statistics* (for the years 1992-97).

Data were most difficult to obtain for average total cost, *c*. We defined average total cost as variable cost plus a normal return to capital. We excluded depreciation of capital used in resource extraction, because the δK_t term in the genuine savings expression implicitly includes it along with consumption of other physical capital. We began with the data sources listed in Appendix B of Kunte et al. (1998). We augmented these sources with various other information, including:

(i) point estimates for the 1990s from several studies on logging costs in individual countries or regions (in particular, the Brazilian Amazon);

(ii) time series estimates of production and development costs for oil during 1960-85 from Adelman and Shahi (1989);

(iii) a cross-country study by the Copper Commission of Chile (Picozzi B. 1996); and

(iv) production cost estimates for individual mines in the 1990s from the World Mine Cost Data Exchange (WMCDE).[2]

---

[2] We are grateful to Michael Farrell of WMCDE for providing the mine models at a reduced rate.

Even with this additional information, direct estimates were not available for many years. For all resources except oil, we filled in the missing data by assuming a constant ratio of average total cost to price. The ratio varied from resource to resource and country to country. This assumption was supported reasonably well by the available data. For oil, we assumed that average production cost in years with missing data equaled the data value in the nearest year, in real terms.

3 Results

Figures 1-4 and Tables 1-3 present the principal results of the analysis. Figure 1 shows the percentage of resource rents coming from nonrenewable resources for each country in each year. Table 1 summarizes these results by presenting median values for three periods: 1973-78 (the first oil shock), 1979-85 (the second oil shock), and 1986-97 (post-oil shocks). Nonrenewable resources were a more important source of resource rents in most countries in most years, with rent shares generally between 60 and 100 percent. Exceptions were Uruguay (0 percent for the entire period), Paraguay (10-40 percent for the entire period), and Brazil (above 60 percent only in 1984-85). These exceptions aside, resource rents were mainly from sources that are ultimately unsustainable. This signals the importance of investing in physical and human capital to offset the depletion of natural capital. Even in Uruguay, Paraguay, and Brazil, continued rent flows are not guaranteed. They require sustainable management of the renewable resources generating them (forests in this analysis).

Figure 2 shows aggregate resource rents as a percentage of GDP. Resource rents are part of value added, but they are not explicitly identified in conventional national accounts. Instead, they are combined with returns to capital (profits) under the heading “gross operating surplus.” Viewed over the long haul, resource rents have become relatively more important to countries in the region. For most countries, resource rents reached the highest percentage of GDP during the oil shock periods 1973-85) and were at lower values afterwards. According to this measure, at least, most countries are now less dependent on natural resources than they were in the 1970s and 1980s.

Table 2 shows median values for the three periods. Ecuador and Venezuela are the only countries with double-digit percentages during all three periods. Bolivia, Chile, Colombia, Guyana, Mexico, Paraguay, and Peru all had percentages of 5 percent or more in at least two periods. Countries in the region thus appear to fall into three groups in terms of the relative importance of resource rents:

Ratio: Resource rents/GDP		
Low	*Medium*	*High*
Argentina Brazil Suriname Uruguay	Bolivia Chile Colombia Guyana Mexico Paraguay Peru	Ecuador Venezuela

Figure 3 shows genuine savings as a percentage of GNP. The estimates in the figure are for the 2-percent discount rate. Estimates for the 5-percent discount rate differed from those in Figure 3 by negligible amounts, typically just 1-2 percentage points. What immediately catches the eye are the large negative values for Guyana and, to a lesser extent, Brazil, Peru, and Bolivia (in that order) during most of the period, especially the 1980s and 1990s. These are the countries where evidence of a decline in national wealth—at least, the portion comprised of physical and natural capital—is strongest.

Genuine savings tended to be positive in other countries during most of the period. This was especially true during 1973-78. Genuine savings tended to decline during 1979-85 and to recover during 1986-97, though generally not to 1973-78 levels. These trends are easiest to discern from the median values in Table 3. Chile and Colombia were the only countries with median genuine savings rates higher during 1986-97 than during 1973-78.

Because the genuine savings estimates for 1987-97 are based on estimates of natural capital constructed using out-of-sample estimates of resource rents, some caution is required in drawing conclusions from differences between the median values for 1986-97 and median values for the earlier two periods. Taken at face value, the median values suggest that the countries fall into four groups:

Median genuine savings rate (% of GNP)			
< 0% in 1986-97	*≥ 0% in 1986-97*		
	< 5% in 1986-97 *AND* *< 0% in 1979-85*	*> 5% in 1986-97 OR > 0% in 1979-85*	
		Decreasing	*Increasing*
Bolivia Brazil Guyana Peru	Colombia Ecuador Uruguay	Argentina Paraguay Venezuela	Chile Mexico Suriname

Countries in the first column are ones where the genuine savings estimates suggest that per capita consumption is most likely to be lower in the future than during 1986-97, while countries in the fourth column are ones where the estimates suggest that per capita consumption is most likely to be higher in the future. Countries in the middle two columns are ones where the estimates suggest that consumption growth will either be slow (the second column) or decelerating (the third column).

A comparison of these groups to the three groups for the relative importance of resource rents does not immediately suggest any relationship between resource richness and genuine savings. Nor does Figure 4, which shows the within-sample (1973-86) estimates of genuine savings as a percentage of GNP from Figure 3 plotted against the corresponding estimates of resource rents as a percentage of GDP from Figure 2. An econometric analysis revealed, however, that there is a statistically significant, negative relationship between these variables: countries that are more resource-rich tend to have lower genuine savings rates.[3] A failure to make sufficient investments to offset the depletion of natural resources might therefore be part of the explanation for relatively poor economic performance of resource-rich countries.

4 Discussion

The analysis in this paper has both policy implications and methodological implications. On the policy side, it provides evidence that recent consumption levels in four countries—Bolivia, Brazil, Guyana, and Peru—are not sustainable. These countries must take action to increase investment in reproducible capital to offset the depreciation of physical capital and the depletion of natural resources. Because the analysis excludes any consideration of what is arguably the most important form of reproducible capital—human capital—it surely exaggerates the threat of unsustainability. Still, the generally poor long-term growth performance of resource-rich countries suggests that this evidence of unsustainability should not be downplayed. Several other countries—Argentina, Colombia, Ecuador, Paraguay, Uruguay, and Venezuela—also appear to be at some risk of slow or decelerating consumption growth.

[3] A generalized least-squares regression of the ratio of genuine savings to GNP on the ratio of resource rents to GDP yielded an intercept of 0.0606 (standard error = 0.000391) and a coefficient of –0.216 (standard error = 0.00286) on the rent/GDP ratio. Both coefficients were significant at the 0.1 percent level. Errors were heteroscedastic, with cross-country correlations and first-order, country-specific serial correlation.

On the methodological side, the analysis demonstrates that calculation of genuine savings is feasible, at least for commercial natural resources. With the exception of the projections of future resource rents for 1998-2007, the calculations are routine. They require data that are already available to national accountants: output, prices, and production costs for natural resource sectors. Indeed, national accountants have access to much better data than we used.

We projected aggregate future resource rents for each country by using econometric methods. This approach does not explicitly take potential physical constraints on the availability of individual resources into account. We did not create a set of physical accounts that track additions to resource stocks, such as forest growth or discoveries of mineral deposits, or subtractions, such as extraction or, in the case of forests, losses due to logging damage, fires, and pest outbreaks. We did, however, compile recent estimates of timber stocks and mineral reserves. These estimates indicate that during the 10-year projection period, physical availability will not be a significant constraint on the production of oil and other resources that have been the major sources of resource rents.

Constructing projections for individual resources on the basis of detailed physical accounts and detailed analyses of future supply and demand conditions was beyond the scope of this paper. It is probably well within the capability of resource management agencies in the countries concerned, however. For example, projecting logged areas and harvest levels is a standard part of planning exercises undertaken by forestry agencies. Such agencies less commonly forecast future market conditions, but this function could be served by economists from local universities or research institutes or by local or international market research firms. More sophisticated projection methods than the ones employed in this paper are certainly possible.

Literature cited

Adelman, Morris A., and Manoj Shahi. 1989. "Oil development-operating cost estimates, 1955-85." *Energy Economics* 11(1):2-10.

Asheim, Geir. 2000. "Green accounting: why and how?" *Environment and Development Economics* 5(1&2):25-48.

Kunte, Arundhati, Kirk Hamilton, John Dixon, and Michael Clemens. 1998. "Estimating national wealth: methodology and results." Environment Department, World Bank. Washington, D.C.

Nehru, Vikram, and Ashok Dhareshwar. 1993. "A new database on physical capital stock: sources, methodology and results." *Revista de Análisís Económico* 8(1):37-59.

Picozzi B., Aldo. 1996. "Costos de operacion de la industria del cobre mundo occidental." Comision Chilena del Cobre.

Vincent, Jeffrey R. 2001a. "Are greener national accounts better?" CID Working Paper No. 63. Center for International Development, Harvard University.

Vincent, Jeffrey R. 2001b. "Guide to Latin America natural resource data." www.cid.harvard.edu.

Vincent, Jeffrey R., Theodore Panayotou, and John Hartwick. 1997. "Resource depletion and sustainability in small open economies." *Journal of Environmental Economics and Management* 33:274-286.

World Bank. 1997. *Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development.* Washington, D.C.

Table 1. Percentage of resource rents from nonrenewable resources: median values by period.

Period	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Guyana	Mexico	Paraguay	Peru	Suriname	Uruguay	Venezuela
1973-78	91%	91%	25%	73%	74%	89%	71%	94%	26%	72%	90%	0%	100%
1979-85	96%	95%	46%	79%	87%	95%	73%	99%	18%	92%	70%	0%	100%
1986-97	88%	79%	48%	74%	84%	82%	55%	97%	15%	73%	59%	0%	99%

Table 2. Resource rents as a percentage of GDP: median values by period.

Period	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Guyana	Mexico	Paraguay	Peru	Suriname	Uruguay	Venezuela
1973-78	2%	10%	3%	3%	5%	16%	7%	4%	5%	3%	4%	1%	23%
1979-85	4%	9%	4%	6%	5%	20%	8%	14%	4%	8%	3%	0%	23%
1986-97	2%	5%	2%	5%	5%	13%	10%	5%	6%	2%	2%	1%	20%

Table 3. Genuine savings as a percentage of GNP: median values by period (2% discount rate).

Period	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Guyana	Mexico	Paraguay	Peru	Suriname	Uruguay	Venezuela
1973-78	23%	8%	-5%	11%	1%	8%	-9%	15%	14%	0%	21%	7%	13%
1979-85	7%	-6%	-14%	-3%	-5%	-1%	-25%	2%	17%	5%	-1%	-2%	5%
1986-97	4%	-13%	-16%	14%	3%	4%	-36%	8%	8%	-11%	7%	0%	5%

Figure 1. Percentage of rents from nonrenewable resources

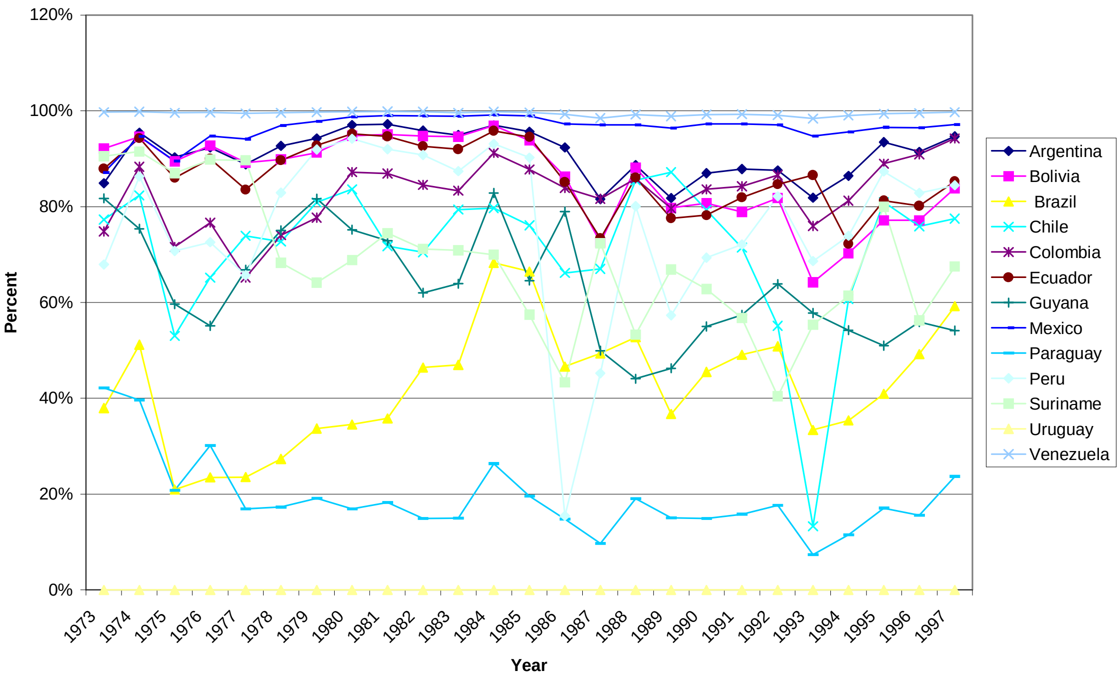

Figure 2. Resource rents as a percentage of GDP

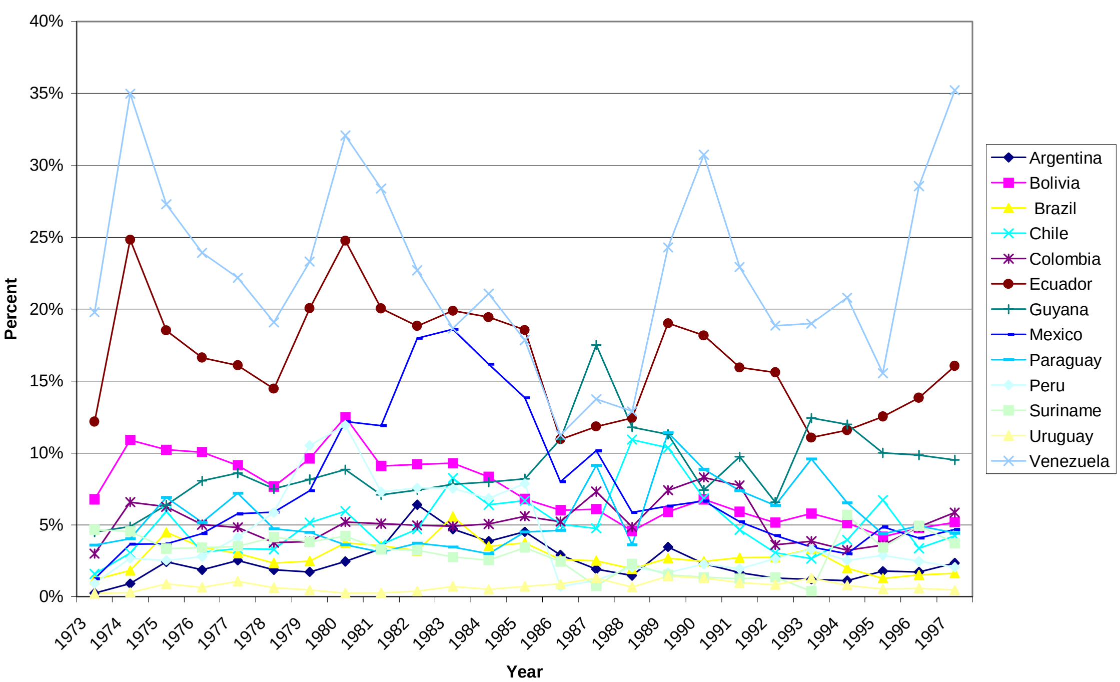

Figure 3. Genuine savings as a percentage of GNP

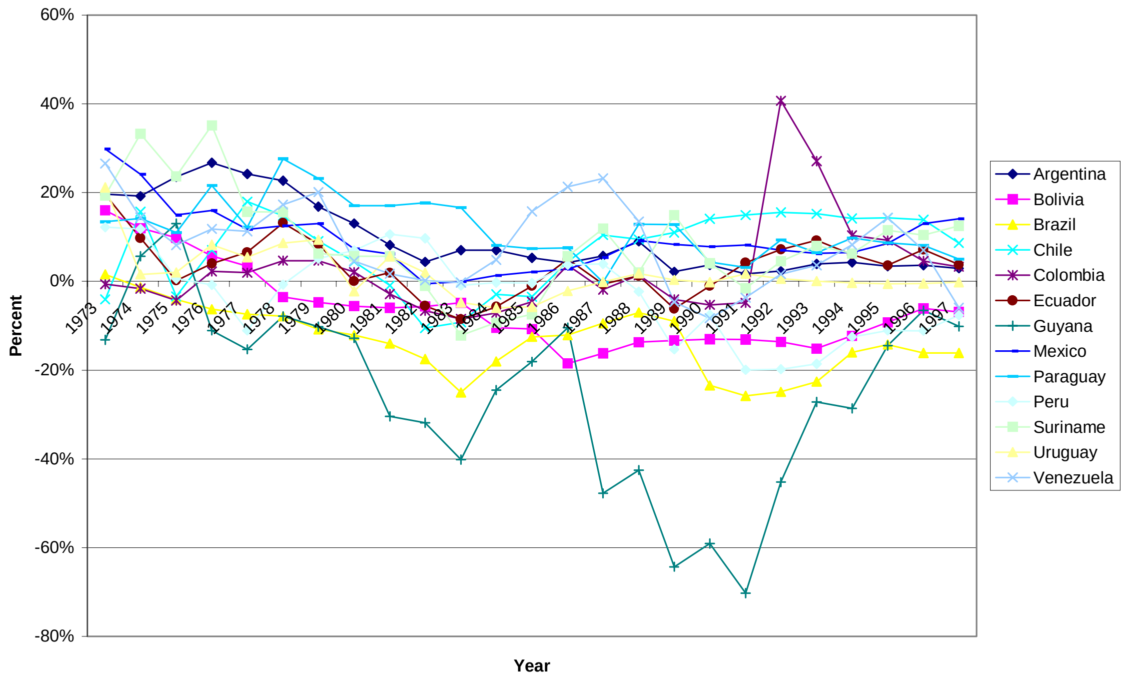

Figure 4. Scatter plot: Genuine savings/GNP vs. Resource rents/GDP