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# Fisher Variables and Income Inequality in the BRICS

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<sup>1</sup> This research was prepared by the author in his personal capacity. The opinions expressed in this article are the author's own and do not necessarily reflect the views of the United States Postal Service or the United States government.

## **Abstract**

In this paper we empirically investigate how the evolution of the three Fisher Variables (income growth, interest rates, and the price level) have driven income inequality across a variety of countries, with particular focus on Brazil, Russia, India, China, and South Africa (known as the BRICS economies), during the period 2001 to 2015. The results suggest that increases in inflation and real income growth contribute to increases in income inequality. We find some evidence that increases in real interest rates correspond with higher income inequality. The results also reveal that the relationship between the three Fisher Variables and income inequality for the BRICS economies is stronger compared to the full sample. Interestingly, for these five economies, the relationship between real interest rates and income inequality is negative.

# 1. Introduction

Many studies have analyzed the impact of inflation, interest rates, and income growth on income inequality, but rarely all together in a dynamic setting. Further, relatively few have investigated developing countries. Early work by Kuznets (1955) suggests that, during the course of a country's development, income inequality initially increases in the early stages of development and then declines over time. Similarly, Paukert (1973) finds evidence that intra-country income inequality rises and then declines with economic development. Summers et al. (1984) examine inter-country inequality and show that income inequality dropped sharply across industrialized countries from 1950 to 1980, declined slightly for middle income countries, and rose slightly for low income nations. Greenwood and Jovanovic (1989) show in a theoretical framework that, as income levels rise within a country, the financial sector becomes larger, which further supports economic growth and widens the income gap between rich and poor. They also present that, as the economy develops a fully formed financial sector, it will reach a more stable distribution of income and have a higher growth rate than in its early stage of development. However, based on more recent data, income inequality across countries, particularly OECD countries, is at its highest level in the past half century<sup>2</sup>. Given this information, we expect that the benefits of economic growth across countries have not been equally distributed, leading to higher income inequality.

This paper adds to the existing literature by empirically investigating how the evolution of the three Fisher Variables (income growth, interest rates, and the price level) have driven income inequality across a variety of countries during the period 2001 to 2015. We also contribute to the

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<sup>2</sup> <http://www.oecd.org/social/inequality.htm>

existing literature by specifically examining how the three Fisher Variables impacted income inequality in Brazil, Russia, India, China, and South Africa (known as the BRICS economies). Since these five countries are the biggest and fastest growing emerging markets and have accounted for fully 56 percent of global growth since 2008<sup>3</sup>, our analysis shows how changes in the three Fisher Variables within and across the BRICS countries have impacted their distribution of income. We are also interested in potential differences in the impact of the three Fisher Variables on the BRICS countries compared to the entire sample. To preview, our results suggest that increases in inflation and real income growth contribute to increases in income inequality. For the entire sample, we find some evidence that increases in real interest rates correspond with higher income inequality; however, not all of the results are statistically significant. The results also reveal that the relationship between the three Fisher Variables and income inequality for the BRICS economies is stronger compared to the full sample. Interestingly, for these five economies, the relationship between real interest rates and income inequality is negative. This suggests that it is lower interest rates that have contributed to higher income inequality across the BRICS economies.

The rest of the paper is structured as follows. Section 2 covers the literature relating to the three Fisher Variables and income inequality. Section 3 describes the data used and the modeling technique. Section 4 presents results, and Section 5 concludes.

## **2. Literature Review of the “Fisher Variables”**

Fisher (1933) explains the interaction of changes in income, interest rates, and the price level with the existing level of debt. Mason and Jayadev (2014) break down the contribution of

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<sup>3</sup> <https://www.ineteconomics.org/perspectives/blog/the-growing-brics-economies-an-inet-series>

inflation, income growth, and interest rates on the net levels of U.S. consumer debt. They show that, since 1980, the effective interest rate in the U.S. has been higher than income growth and inflation, increasing real debt burdens. Das (2011) conducts an analysis comparable to Mason and Jayadev (2014) using data from the United Kingdom and the United States and gets broadly similar results. Although these authors focus on how income growth, inflation, and interest rates affect debt levels, we expand the focus to income inequality.

The possible channels through which the Fisher Variables can impact income inequality are as follows. First, if the interest rate increases, households face higher debt service on their mortgages and other liabilities. Since the top 1% in the income distribution typically have little debt<sup>4</sup> and more savings, then increases in interest rates could harm those at the bottom and help those at the top of the income distribution (through a higher returns on savings and minimal effect on the lower debt service levels for higher income households)<sup>4</sup>. Also, it should be noted that lower-income households are more likely to be unemployed if monetary contractions occur and slow economic growth. This is known as the earnings heterogeneity channel through which monetary policy can impact income inequality (Coibion et al. (2012)). However, as presented by Colciago et al. (2018), low interest rates may increase income inequality (by boosting capital gains). Auclert (2017) also claims that low rates can increase asset prices, which then may exacerbate income inequality. This is known as the financial segmentation channel of monetary

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<sup>4</sup> It should be noted that debt-to-equity and debt-to-income ratios are not equally distributed across households at different levels of the income distribution. Wolff (2010) reports that the debt-to-equity and debt-to-income ratios for the top 1% of the income distribution declined from 1983 to 2007 but increased for the next 19% of the income distribution and the middle quintiles. Saez (2017) suggests that large increases in debt for households in the bottom 90% of the income distribution implies that these households have been saving 0% of their income over the last 30 years.

policy. The financial segmentation channel can increase income inequality when an expansionary monetary policy shock occurs.

Similarly, rising inflation means the real value of income is being eroded relatively faster. Romer and Romer (1999) show cross-sectional evidence that low inflation and stable aggregate demand growth are associated with the improved well-being of the poor in the long run. Easterly and Fischer (2001) find that the well-being of the poor and inflation are negatively correlated in pooled cross-country regressions. They also document that the poor are more likely than the rich to mention inflation as a top concern. Bhattacharya et al. (2001) show that high income households have a larger share of their savings in real assets, so low income households are relatively more vulnerable to inflation. Li and Zou (2002) show that inflation worsens the distribution of income by increasing the income share of the rich. Albanesi (2007) also shows that increases in inflation correspond with increases in income inequality. The positive correlation between inflation and inequality remains strong even after controlling for GDP per capita. Further, Balcilar et. al (2017) show that, for U.S. states, inflation above around 3 percent is harmful to income inequality but levels below the 3 percent level can help reduce income inequality. Considering all the evidence, we expect that higher prices further exacerbate income inequality across the countries analyzed.

Lastly, economic growth could increase or reduce income inequality depending on one's perspective. As mentioned in the introduction, Kuznets (1955) suggests that income inequality initially increases in the early stages of development (when incomes are rising most rapidly) and then declines over time. Paukert (1973) reported a similar result to Kuznets. Similarly, Greenwood and Jovanovic (1989) show, as income levels rise within a country, the financial sector becomes more extensive, which further supports economic growth and can widen the income gap between rich and poor. However, in many developed nations such as the U.S. and U.K., income inequality

has been rising along with overall economic growth. Thus, it is not clear what the expected effect of economic growth may be on the BRICS nations' levels of income inequality.

### **3. Data and Summary Statistics**

We build a country-level panel dataset that includes information on income inequality, real interest rates, inflation, and real income growth. The countries in the sample and the years covered are summarized in Table 1. The data are annual and span from 2001 to 2015, providing 480 country/year observations<sup>5</sup>. We believe that cross-country data provides us with an adequate number of observations and allows us to use more recent data to understand the relationship between the three Fisher Variables (inflation, income growth, and the real interest rate) and income inequality. As such, we will be able to uncover any robust relationship between the three Fisher Variables and income inequality.

Our key measure of income inequality is the pre-tax national income share of adults in the Top 1% of the income distribution. This data is from the World Inequality Database. The measure is calculated as the sum of all pre-tax personal income flows accruing to the owners of the production factors, labor and capital, before taking into account the operation of the tax/transfer system (but taking into account pension holdings). The population is comprised of individuals over age 20. The base unit is the individual (rather than the household) but resources are split equally within couples. From Table 2, we can see that, on average, 13.2% of pre-tax national income has gone to adults in the Top 1% of the income distribution. Figures 1 and 2 show time series of the Top 1% for the entire sample and specifically for the BRICS economies. Figure 1 indicates that the income share of the Top 1%, on average, increased from 12% (in 2001) to almost 14% (in

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<sup>5</sup> Due to data availability we could not analyze a longer sample.

2007). After that, due to the global economic crisis of 2008-2009, the income share of the Top 1% dropped to roughly 13.2% and remained steady at this level for almost 5 years. From 2014 to 2015, we observe increases in the income share of the Top 1%; however, the level was still below the pre-crisis level. Interestingly, from Figure 2, the pre-tax national income share going to the Top 1% has been relatively larger for the BRICS economies. Particularly, the income share of the Top 1%, on average, was 19% and increased to 22% in 2007. The global economic crisis of 2008-2009 led to slight decreases in the income share of the Top 1% for the BRICS nations. Since then, the income share for the Top 1% has remained relatively steady within the BRICS economies.

The real interest rate is calculated as the difference between the nominal interest rate and the inflation rate. *Immediate rates: Less than 24 Hours* is used as a measure for the nominal interest rate. The percentage change in the *Consumer Price Index: All Items* is used to measure inflation. All the data used to calculate real interest rates and inflation were retrieved from FRED. From Table 2, we can see that, on average, real interest rates across the countries analyzed have been around 1%. Figures 3 and 4 present the time series of real interest rates from the entire sample and the BRICS economies, respectively. In both scenarios, we observe a downward trend in real rates from 2001 to 2010, where they reached negative values. The trend reversed for the entire sample, but rates remain relatively low and did not reach positive values until 2015. For the BRICS economies, real interest rates reached negative values briefly but became positive more quickly than for the entire sample.

Income growth is defined as the percent change in real GDP per capita. Again, the data are retrieved from FRED. Table 2 indicates that income growth across the entire sample has been around 2%. From Figures 5 and 6, we can see that, prior to the Great Recession, economic growth was trending up for both the entire sample and the BRICS economies. Looking at Figure 6, annual

growth rates for the BRICS economies increased from 4% to 8%. Then, due to the Great Recession, we observe economic growth slowing, but the income growth rate never goes negative for the BRICS economies. However, the average annual income growth rate for all the countries included in the sample reached -2% in 2009, but the trend quickly reversed and has stayed around 2% since that time.

As mentioned earlier, the percentage change in the *Consumer Price Index: All Items* is used to calculate inflation. From Table 2, we can see that inflation, on average, has been around 3.4%. Figure 7 shows that the inflation rate was in decline from 2001 to 2005. Then, there was an increase in prices from 2005 to 2008. After that, prices start to drop again, most likely due to the overall drop in aggregate demand from the Great Recession. Interestingly, looking at Figure 8, we can see that the BRICS economies, right after 2010, experienced short-term disinflation. After, that inflation picks up again.

## 4. Model Specification and Empirical Results

### a) Model Specification

To examine the relationship between the three Fisher Variables and income inequality, the following model is estimated:

$$Inequality_{i,t} = \lambda_i + \delta_t + \beta_1 Infl_{i,t} + \beta_2 Income_{i,t} + \beta_3 Realrates_{i,t} + \varepsilon_{i,t} \quad (1)$$

where  $Inequality_{i,t}$  is the pre-tax national income share of adults in the Top 1% of the income distribution for country  $i$  in period  $t$ .  $Infl_{i,t}$ ,  $Income_{i,t}$ , and  $Realrates_{i,t}$  capture the inflation rate, real income growth, and the real interest rate for country  $i$  in period  $t$ . As stated earlier, due to constraints on data availability, the empirical analysis in this paper is limited in terms of countries and the time period.  $\lambda_i$  and  $\delta_t$  are country and year-specific effects that measure unobserved

heterogeneity across countries and years that might be correlated with the regressors in (1). In addition,  $\delta_t$  controls for a time trend in case such a trend might drive the association among the variables analyzed in (1). As such, model (1) allows us to analyze the within and cross-country variation of income inequality due to changes in inflation, income growth, and real interest rates.

To accommodate any potential cross-country heterogeneity in the income inequality dynamics, we also estimate a mean group estimator as in Pesaran and Smith (1995). The mean group estimator does not require that the dynamics of income inequality and the transmission mechanisms of changes in income growth, inflation, and the real interest rate in the model specification be the same, which could introduce estimation bias in specification (1). The method of Pesaran and Smith allows us to consider differences across countries in the transmission of changes in the three Fisher Variables on the variation in income inequality. In addition, we use the common correlated effects estimator, from Ditzen (2016) and the package he created in STATA (xtdcce2). The common correlated effects (CCE) estimator is used to evaluate the following equation:

$$y_{i,t} = \alpha_i + \beta_i x_{i,t} + u_{i,t} \quad (2)$$

$$u_{i,t} = \gamma_i f_t + e_{i,t} \quad (3)$$

where  $f_t$  is an unobserved common factor and  $\gamma_i$  is a heterogeneous factor loading (Ditzen (2016)).  $y$  is the income inequality measure and  $x$  includes the three Fisher Variables. The heterogeneous coefficients are randomly distributed around a common mean such that  $\beta_i = \beta + v_i$  where  $v_i \sim IID(0, \Omega_v)$ . Equation 2 can be estimated consistently by approximating the common factors with cross-section means  $\bar{x}_t$  assuming the strict exogeneity of the  $x_{i,t}$ . Further, to distinguish the impact of the three Fisher Variables on income inequality for the BRICS economies, in model 1

we introduce a dummy variable that takes a value of 1 when the country is part of the BRICS group, and zero otherwise.

*b) Empirical Results*

Figures 9, 10, and 11 display the scatter plots between the sample mean of the Top 1% income share and the three Fisher Variables. On average, higher real rates correspond with lower income inequality, suggesting that lower real rates have driven up income inequality within the countries and time period analyzed. We also see that income growth and the Top 1% measure are positively associated, confirming that the benefits of economic growth during the last 20 years have not been equally distributed. Surprisingly, the scatter plot shows that the association between inflation and income inequality is negative.

To better understand how the three Fisher Variables have impacted income inequality, in Table 3 we present the results from various specifications of Model 1. Column 1 shows the magnitude of the association between the three Fisher Variables and income inequality without controlling for country and year effects. Columns 2 and 3 show the magnitude of the association when we control for country effects (Column 2) and country and year effects (Column 3). Across all three specifications, the inflation rate corresponds with higher income inequality. Particularly, from Columns 1 and 2, we see that per one standard deviation (4.3%) increase in inflation, income inequality increases by about 0.3 percent. Once we control for both country and year effects (Column 3), the magnitude of the association increases. Per one standard deviation increase in inflation, income inequality increases by approximately 0.5 percent. Even though, the results are not statistically significant across all four estimated models, there is some evidence that higher real interest rates correspond with higher income inequality across and within the countries analyzed. The results also show that increases in income growth are associated with higher income

inequality, showing evidence that economic growth over the last two decades has mainly benefited individuals in the upper end of the income distribution. Per one standard deviation increase in income growth (3.3%), income inequality increases by about 0.3 percent. As before, the magnitude of the association increases once we control for both country and year effects (Column 3). Since Kuznets (1955) suggests that income inequality initially increases in the early stages of development (when incomes are rising most rapidly) and then declines over time, in model 1 we included income squared to capture the “Kuznets effect.” The estimated coefficient is not statically significant. As such, given our sample and time period, we do not find any statistical evidence that advances in development drive income inequality down. In fact, the coefficient is positive<sup>6</sup>.

MG and DCCE estimators from columns 4 and 5, allow for cross-country heterogeneity and do not require that the dynamics of the economies in the panel be the same, which could introduce bias in the fixed-effect panel estimates. Overall, the results are consistent with the earlier findings. Per one standard deviation increase in inflation, income inequality increases by 0.55 percent (Column 4). Similarly, per one standard deviation increase in income growth, income inequality increases by 0.26 percent (Column 4). The results again show that increases in real interest rates correspond with higher income inequality. Results from the MG estimator indicate that per one standard deviation increase in real interest rates (3.1%), income inequality increases by 0.35 percent. However, the DCCE estimator is not statistically significant

Columns 6 and 7 show the results for the BRICS economies. As discussed earlier, these five countries are the biggest and fastest growing emerging markets and have accounted for fully 56 percent of global growth since 2008. The results show that the magnitude of the association

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<sup>6</sup> These results are available upon request.

between the three Fisher Variables and income inequality within the BRICS economies is larger. Particularly, per one standard deviation increase in inflation, income inequality within the BRICS countries increases by almost 1 percent. Similarly, per one standard deviation increase in income growth, income inequality within the BRICS countries increases by about 0.95 percent. Interestingly, the results show that increases in real interest rates correspond with lower income inequality within the BRICS countries. So, it is lower real interest rates that have contributed to further increases in income inequality in the BRICS economies. Particularly, per one standard deviation increase in real interest rates, income inequality decreases by about 0.3 percent.

## **5. Conclusion**

Many prior studies have analyzed the impact of inflation, interest rates, and income growth on income inequality. However, few studies have focused on developing countries. Early work by Kuznets (1955) suggests that countries initially experience increases in income inequality as they develop but, over time, income inequality may eventually decrease. There is not a clear consensus on inflation's impact on income inequality although some studies such as Balcilar et al. (2017) suggest that inflation may be beneficial up to a certain level and worsen inequality at higher levels. Real interest rates may also either increase or decrease income inequality.

Our results show that increases in inflation and real income growth contribute to increases in income inequality. Across the entire sample, we find some evidence that increases in real interest rates correspond with higher income inequality; however, not all of the results for the real interest rate are statistically significant. The results also show that the relationship between the three Fisher Variables and income inequality for the BRICS economies is stronger compared to the full sample. Interestingly, for these five economies, the relationship between the real interest rate and income

inequality is negative. This suggests that lower interest rates have contributed to higher income inequality in the BRICS nations. Further research on how monetary policy impacts income inequality in the BRICS and other developing nations may be useful as data becomes available.

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Countries	mean(Top 1%)	mean(income)	mean(infl)	mean(rir)	sd(Top 1 %)	sd(income)	sd(infl)	sd(rr)
Australia	8.55	1.46	2.77	1.73	0.53	0.94	0.86	1.10
Brazil	27.89	1.76	6.70	7.20	0.84	2.75	2.64	4.21
Canada	13.97	0.96	1.79	0.67	0.74	1.58	0.59	1.35
Chile	22.40	3.09	6.09	-1.27	1.86	2.18	2.22	0.96
China	14.00	9.07	2.38	0.93	1.20	1.99	2.02	1.91
Colombia	19.69	3.03	4.87	1.20	1.13	1.68	2.00	1.70
Czech Republic	9.26	2.53	2.19	-1.00	0.83	3.12	1.68	1.36
Denmark	6.00	0.49	1.83	0.00	0.40	1.99	0.84	1.36
Finland	8.06	0.79	1.58	0.73	0.71	3.26	1.27	1.49
France	11.10	0.54	1.51	0.27	0.45	1.34	0.80	1.28
Germany	12.73	1.23	1.49	0.27	1.15	2.56	0.68	1.28
Hungary	9.59	2.29	4.49	2.60	0.40	3.06	2.61	1.35
India	19.78	5.75	6.95	-0.13	1.86	2.08	2.90	2.88
Ireland	9.95	3.23	1.98	-0.40	0.70	6.86	2.61	1.80
Italy	9.43	-0.40	1.93	-0.13	0.17	2.15	1.00	1.25
Japan	10.45	0.77	0.07	0.27	0.57	2.11	1.01	0.96
Korea	10.77	3.39	2.76	0.53	1.22	1.74	1.12	0.99
Lebanon	22.66	0.52	3.98	1.73	0.97	4.96	2.52	2.99
Netherlands	6.58	0.74	1.94	-0.20	0.33	1.93	0.96	1.26
New Zealand	8.26	1.66	2.28	2.47	0.51	1.43	1.07	2.00
Norway	8.90	0.66	1.90	1.40	2.44	1.49	0.91	2.03
Poland	12.20	3.68	2.39	3.27	0.90	1.71	1.74	3.35
Portugal	9.65	0.17	2.10	-0.33	0.25	1.87	1.55	1.35
Russian Fed.	22.84	3.88	11.29	0.73	2.36	4.68	4.35	2.79
Slovenia	7.05	1.71	3.18	-0.13	0.23	3.73	2.58	1.19
South Africa	18.39	2.92	5.35	2.53	1.11	1.98	2.66	2.72
Spain	9.68	0.52	1.91	-0.13	1.21	2.29	1.26	1.13
Sweden	8.69	1.48	1.24	0.60	0.64	2.72	1.23	0.91
Switzerland	10.52	0.82	0.46	0.07	0.74	1.72	0.88	0.88
Turkey	20.05	3.66	14.72	5.73	1.66	4.82	14.75	10.74
United Kingdom	13.92	1.06	2.04	0.61	1.01	1.91	0.91	2.38
United States	19.16	1.03	2.16	-0.55	1.20	1.58	1.17	1.47

**Table 1:** Summary statistics for countries in sample, 2001-2015

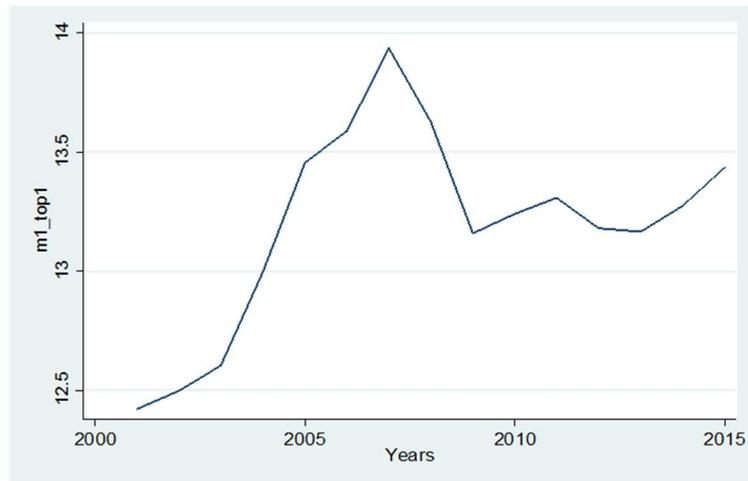
**Table 2:** Summary statistics for the entire sample

<b>Variable</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>
Top 1 %	480	13.19	5.77
Inflation	480	3.38	4.30
Real Int. Rate	480	0.97	3.13
Income Growth	480	2.01	3.28

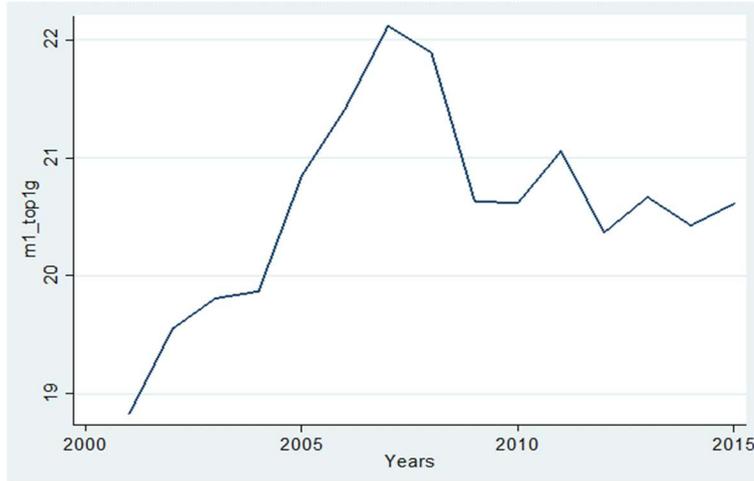
**Table 3:** Empirical results

	Dependent variable: $(Top\ 1\%)_{it}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$(inflation)_{it}$	0.0836*** (0.0226)	0.0794** (3.48)	0.114*** (5.44)	0.128* (2.11)	0.168** (3.25)	0.0454* (0.025)	0.043** (0.02)
$(real\ int.\ rate)_{it}$	-0.0145 (0.0224)	-0.015 (-0.67)	0.0354* (1.87)	0.0459 (0.66)	0.114** (2.15)	0.0151 (0.017)	0.0157 (0.017)
$(real\ income)_{it}$	0.0861*** (0.0302)	0.084** (2.80)	0.118** (2.82)	0.081*** (3.45)	0.065*** (3.81)	0.047*** (0.016)	0.047** (0.016)
<b><i>BRICS inflation</i></b>						0.179*** (0.056)	0.154** (0.021)
<b><i>BRICS real int. rates</i></b>						-0.089** (0.042)	-0.107** (0.045)
<b><i>BRICS real income</i></b>						0.242*** (0.037)	0.237*** (0.039)
Fixed effects		✓	✓				✓
Time effects			✓				
DCCE				✓			
MG					✓		
Trend				✓	✓		
Observations		407	407	407	407	407	407

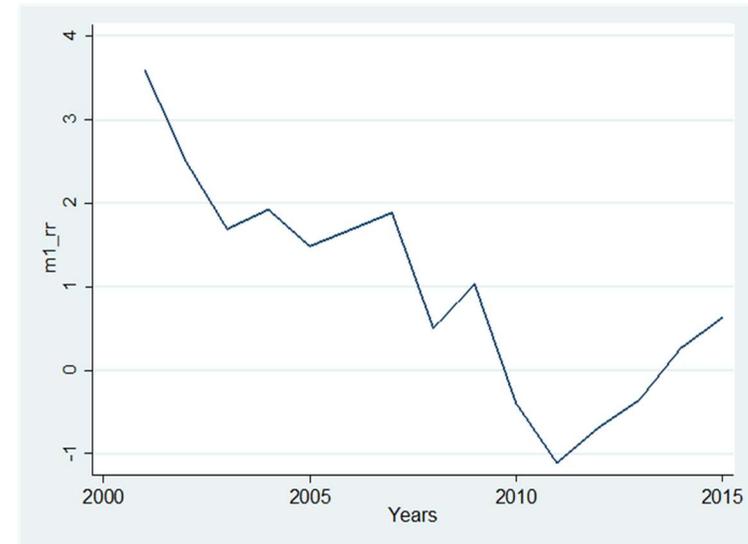
**Figure 1:** Top 1% income share, entire sample



**Figure 2:** Top 1% income share, BRICS only



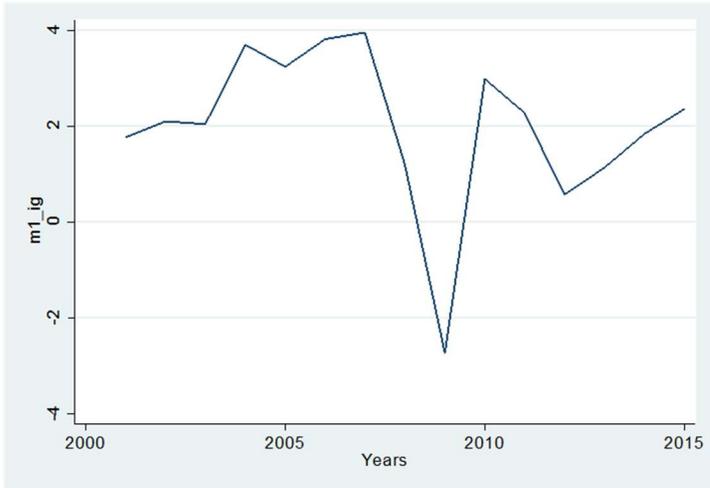
**Figure 3:** Real interest rate, entire sample



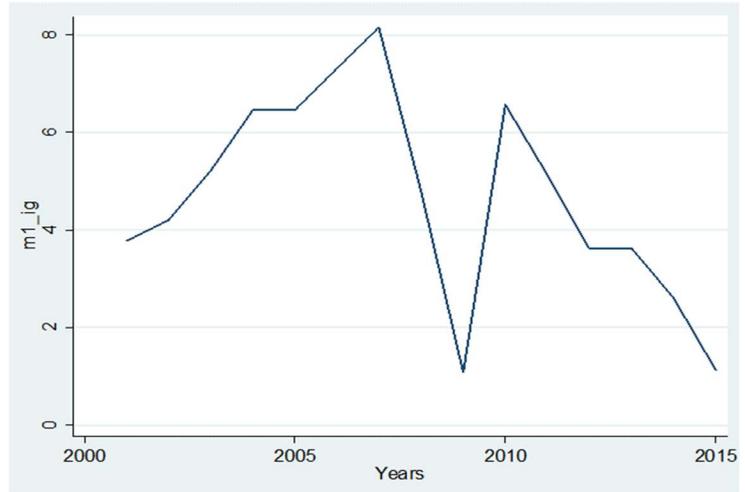
**Figure 4:** Real interest rate, BRICS only



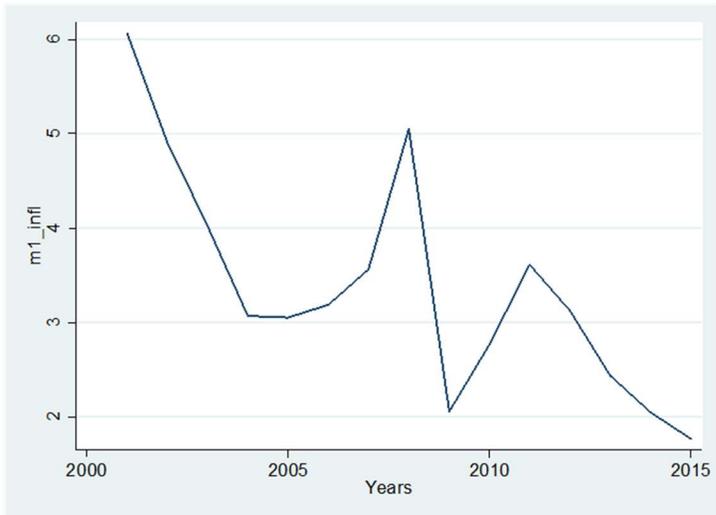
**Figure 5: Income growth, entire sample**



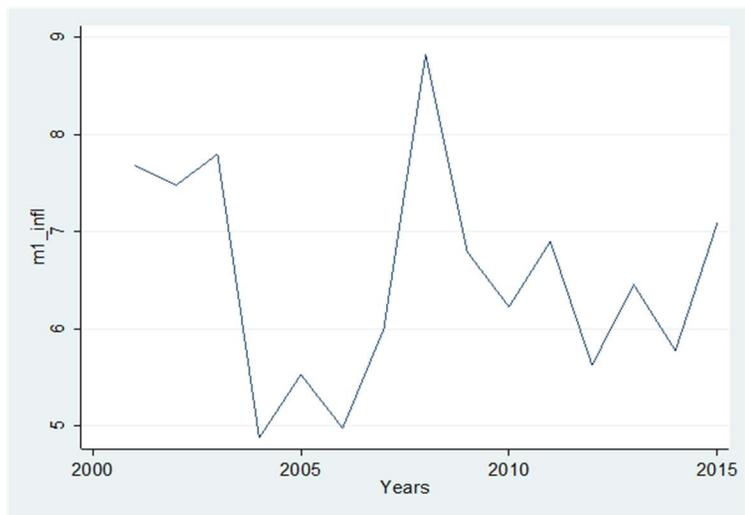
**Figure 6: Income growth, BRICS only**



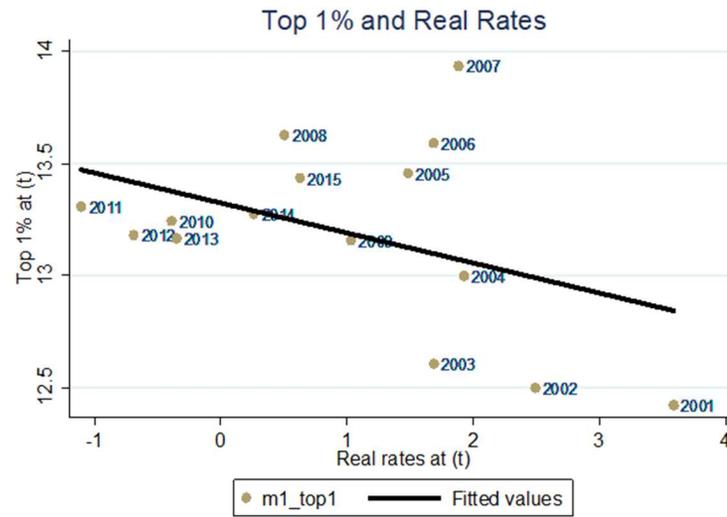
**Figure 7: Inflation, entire sample**



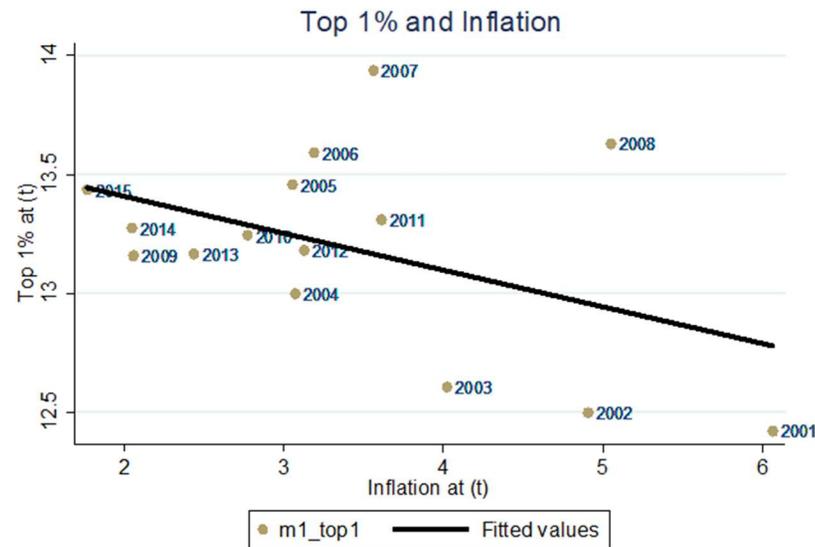
**Figure 8: Inflation, BRICS only**



**Figure 9:** Cross-sectional averages by year, Top 1% and real interest rates



**Figure 10:** Cross-sectional averages by year, Top 1% and inflation



**Figure 11:** Cross-sectional averages by year, Top 1% and income growth

