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Saikat Sarkar
Matti Tuomala

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Asset bubbles in explaining top income shares*

Saikat Sarkar
School of Administrative Studies,
York University, Toronto, Canada.
Email: sarkars@yorku.ca

Matti Tuomala
School of Management,
Tampere University, Tampere, Finland.
Email: matti.tuomala@uta.fi

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Abstract

Our empirical analysis provides support for the view that asset-bubbles together with economic fundamentals such as caused by increases in innovation-led growth are an important part of story in explaining increasing top income inequality. Moreover, top tax rates have played an important role. At the same time with large growth in top income shares over the past few decades, top tax rates on upper income earners have declined significantly in many advanced countries.

Keywords: Top income shares; bubbles and crashes; innovations; top tax rates.

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1 Introduction

The increasing share of the top income earners in total income has been a notable feature of the income inequality in the Anglo-Saxon countries while in continental Europe changes in top income shares have been less dramatic (see World inequality database, WID). This trend toward income concentration has also taken place in the Nordic countries, traditionally low inequality countries. Moreover, top income shares have also increased in the Nordic countries.

What causal forces could have produced such dramatic changes in top income shares in many advanced countries over the past three decades? Economists have formulated several hypotheses about causes of increasing inequality. They are the shift from manufacturing to service production, technological changes, increased international trade, less progressive taxation etc. Of these the most frequently cited explanation is that technological advances, particularly in the advent of computerized technologies, have created greater demand for higher skilled and more educated workers and diminished demand for less skilled and less educated workers. By means of a simple application of supply and demand, this theory posits that skill biased technological change has driven up the wages of the higher skilled and driven down those of the lower skilled. However, there is growing group of economists who suggest it is not the sole explanation[1]. For example, Piketty and Saez (2003) challenge the skill-biased technological change thesis on the ground that the timing of the shifts in income differences does not support it in the USA. Similarly, they contend that widening income differences cannot simply be a response to technical change or changes in the supply of educated workers, because the increase is highly concentrated among the very highest earners. The theory is not able to explain the rise of the working rich.

Piketty and Saez (2003) instead argue that changing social norms is an important factor in explaining the recent increase in income inequality, particularly in the rise of mega-incomes for the very top earners. In his book "The New Industrial State" J. K. Galbraith (1967) made important observations on the role of social norm in management. He writes: "management does not go out ruthlessly to reward itself - a sound management is expected to exercise restraint .... With the power of decision goes opportunity for making money.... The corporation would be a chaos of competitive avarice. But these are not the sort of thing that a good company man does; a remarkably effective code bans such behaviour".

[1] Atkinson, (1999, 2015).

Most authors have argued that dramatic increase in tax progressivity has taken place in the inter war period in many countries which remained in place at least until the recent decades, has been the important factor preventing top income shares from coming back to the very high levels observed at the beginning of the last century. In fact, Kuznets (1955) and Lampman (1962) already point out the role of progressive taxation as a central factor explaining the declined income and wealth inequality in the first half of the 20th century.

It is interesting to note in Piketty-Saez data for the United States[2] that the dot-com bubble in stocks in 2000 occurred when income inequality (including capital gains) hit a level very similar to that in 1929, particularly for the top 0.01%. The rise in income inequality accelerates from 1995-2000 as the dot-com bubble is inflating, and a similar concentration of income from 2003-2008 is evident as the housing bubble is inflating. Hence bubbles seem to occur during a period of time when income is becoming increasingly concentrated at the top. This then raises a question. Do large bubbles cause increasing top income shares, or do the larger top income shares cause the bubbles? Of course, it is possible that causation could be simultaneously run in both directions, or it could be that there is no causation at all and both bubbles and inequality are driven by a third factor. A third variable causes both or the relationship is spurious; but that seems unlikely to us. We argue in this paper that these asset-bubbles together economic fundamentals such as caused by increases in innovation-led growth (see Aghion et al (2015)) are an important part of story in explaining increasing top income inequality.

The paper is structured as follows. Section 2 considers the links between top incomes and asset bubbles. Section 3 covers the empirical evidence of bubbles on stock and housing market. Fundamental variables and empirical model are described in Section 4 and Section 5 respectively. Section 6 outlines the comparisons to related work on top income shares whilst section 7 studies the impact of bubbles and innovation on top income shares. Section 8 describes the robustness analysis and concluding comments are provided in Section 9.

[2]These temporary shifts in income inequality are for the changes of taxation policy in the United States. This supports the findings of Piketty and Saez (2007) where they state that tax changes may not produce a permanent surge in top income shares but can fabricate a transitory effect on income inequality.

2 Links between top incomes and asset bubbles

Those observations made in the introduction are already a good reason to take into account bubbles as an important factor seeking explanation for top income shares[3]. The rise in top income shares over the past three decades in many advanced countries, and especially in the U.S. case, has to a significant extent been the consequence of a series of asset-price bubbles. Whenever the market (the market in stocks, bonds, real estate or whatever) booms, the share of income going to those at the very top increases. People at the very top of income scale generate income from stock-based performance pay and through capital gains from their accumulated wealth. In addition, reductions in tax rates on capital income in recent decades, has increased the contribution of capital income to overall inequality. One possibility is that lower top taxes actually cause CEOs extracting higher pay for themselves. Hence we can identify two potential channels linking stock returns and top income shares. One channel is stock-based performance pay among top earners. Another one is through the financial wealth of top earners (or capital gains). It is well known that both channels -executive pay and private wealth- have differed widely both across countries and also over time. The search for high-return investment by those who benefited from the increase in inequalities led to the emergence of bubbles. As shown by Philippon and Reshef (2012) salaries in finance soared and causing a substantial part of explosion in top incomes[4].

Hence the asset bubbles generate both large wealth (or capital gains) income for the rich because they have disproportionately large asset holdings and most of them work in finance industry and get paid according to how the stock market develops. When the boom goes bust, that share drops somewhat, but then it comes roaring back (e.g. by macroeconomic policy such as Quantitative Easing) even higher with the next asset bubble.

In fact these asset-bubbles were not pure bubbles. Prices always began rising for some real economic reason, then got out of hand. The rise in top income inequality would be partly based on economic fundamentals (eg. caused by increases in innovation-led growth see Aghion et al (2015)), partly on financial market excess caused at least in part by rent

[3]Other researchers also consider cumulative return on equities/stock prices as a dependent variable (see Atkinson and Leigh (2013) and Atkinson, Gordon and Harrison (1989)).

[4]Luigi Zingales concluded in his 2015 presidential address to the American Finance Association 2015 address that "there is no theoretical reason or empirical evidence to support the notion that all of the growth of the financial sector in the last forty years has been beneficial to society". John Kay in his book Other People's Money asks, "But what do these people do (in financial sector)?" His answer: "To an extent that staggers the imagination, they deal with each other." So we can question whether wages in this sector actually fully reflect the true social marginal product of these activities.

seeking activities[5], although these activities are not directly observed in our aggregated income shares data. These activities could manipulate stock price and help to generate financial bubbles in the market[6]. It can be discerned that whenever stock market booms, share of income going to those at the very top increases while there is tendency to drop income shares in bear market. Naturally asset bubbles, partly generated by rent seeking activities, are an inevitable part of the story in explaining raising income inequality.

3 Empirical evidence of bubbles on stock and housing market

The popular approaches to detect explosive behavior in a time series are integration or cointegration tests (e.g., Diba and Grossman (1988)), variance bound tests (e.g., LeRoy and Porter (1981), Shiller (1981)), specification tests (e.g., West (1987)) as well as Chow and CUSUM-type tests (e.g., Homm and Breitung (2012)). However the newly developed bubble detecting technique, the Generalized Sup Augmented Dickey-Fuller test (GSADF), proposed by Phillips et al. (2015) performs better than other bubble detecting methods, reasonably the most appropriate for our research.

The idea of GSADF is based on Random Walk Hypothesis. This test presumes that the bubble injects the explosive component into prices and creates exuberance in the asset market. In the presence of a bubble, buyers are willing to pay prices increasingly higher than the fundamental-based price because they expect to be compensated through future price increases. Then the asset prices deviate from a random walk to an explosive regime. The moment of deviation from a random walk could be regarded as the origin or collapse of bubbles. Here we apply this test procedure to examine whether there is evidence of bubbles in historical real housing price and real stock price indices[7].

The real stock price index data is collected from global financial database and real housing price index data are collected from international house price database of the

[5] As pointed out by Stiglitz (2014) the evolution of top income inequality "will have to address directly changes in rents and their capitalised value". In fact, the trend towards greater income inequality in the past decades (as documented in WID-data) has taken place at the same time with a flow towards finance at the top of the income distribution.

[6] These activities could be in form of stock price manipulation (see for pump-and-dump schemes (see Khwaja & Mian (2004), Khanna & Sunder (1999)) or insider trading (see Jeng, Metrick, & Zeckhauser, (2003) among others), etc. Keys et al. (2010) also show that in the recent subprime crisis, securitization led to lax screening. In effect, lenders provided insufficient information regarding default risk when they could pass on the risk to others, thus generating and exploiting informational rents.

[7] GSADF is used here only to detect the explosive episodes in years and not for the purpose of estimating start date and end date of bubbles precisely in a quarterly data series, although this technique is very successful to detect to those dates (see Phillips et al. (2015)).

Table 1

Evidence of explosive behavior in the asset markets based on GSADF test statistics with lag order k is equal to 1. Quarterly real market price index is used to detect the bubble and crash period. Test statistics reported in first brackets. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

Panel A: Test Statistics

Countries	Stock market	Housing market	Countries	Stock market	Housing market
Australia	(2.428)**	(5.502)***	Malaysia	(1.146)	-
Canada	(2.324)**	(4.449)***	Netherlands	(5.039)***	(5.589)***
China	-	-	NewZealand	(2.310)**	(2.687)***
Colombia	(3.970)***	-	Norway	(1.310)	(3.135)***
Denmark	(2.181)**	(3.039)***	Portugal	-	-
Finland	(8.859)***	(2.908)***	Singapore	(0.383)	-
France	(3.015)***	(6.042)***	South Africa	(2.595)***	(4.638)***
Germany	(3.005)***	(2.346)**	Spain	(2.117)**	(3.973)***
India	(5.797)***	-	Sweden	(4.970)***	(3.836)***
Ireland	(3.737)***	(3.832)***	Switzerland	(4.211)***	(3.785)***
Italy	(1.128)	(1.156)	UK	(2.385)**	(3.925)***
Japan	(4.576)***	(4.811)***	USA	(4.493)***	(5.844)***
Korea(R)	(4.587)***	(0.290)			

Panel B: Critical Values

	Sample Size				
	164	169	202	216	224
90%	1.573	1.662	1.741	1.760	1.783
95%	1.807	1.898	1.984	2.001	2.046
99%	2.434	2.422	2.567	2.580	2.534

Notes: Size of the stock price index is 216 for Korea(R), 202 for Singapore, and 169 for Malaysia. Stock price index has a size of 224 for rest of the countries. Size of the housing price index is 164.

Federal Reserve Bank of Dallas[8]. The sample period for quarterly real housing price index is from 1975:Q1 to 2015:Q4, constituting 164 observations. The real stock price indices are also quarterly starting from 1960:Q1 to 2015:Q4 (contain 224 observations). The sampled period of real stock price index for Korea (R) is from 1962:Q1 to 2015:Q4 (contain 216 observations), for Malaysia is from 1973:Q4 to 2015:Q4 (contain 169 observations) and for Singapore is from 1965:Q3 to 2015:Q4 (contain 202 observations).

A typical assumption in economics literature is that the economic fundamentals follow either a stationary or an integrated process of order 1. So we have estimated test statistics

[8]For a detailed description of the sources and methodology issues see Mack and Martínez-García (2011).

Table 2

Description of important variables	
	Variable defination
Top1	Share of total income earned by those with the 1% highest incomes (P99-P100).
Top0.1	Share of total income earned by those with the 0.1% highest incomes (P99.9-P100).
Inverted Pareto (β)	The Inverted Pareto-Lorenz coefficient is a measure of income inequality among the rich. As a rule β is estimated from the top 0.1% share within the top 1% share: a = 1/ [log(Top1%/Top0.1%)/log(10)]. When the top 0.1% and top 1% shares are not available, the closest substitutes were used.
GDPpc	Log of gross domestic product per capita.
Bank deposits	Share of commercial and savings bank deposits in GDP.
Stk mkt Cap	Market value of publicly listed stocks devided by GDP.
Innovation	Number of total patent granted at the European patent office (EPO) per thousand of people.
Financial development	Total market capitalization as the sum of Bank deposits. and Stock market capitalization.
Tax rate	Top marginal tax: Statutory tax rate for each country.
Openness	Import plus export devided by GDP.
Govt Exp.	Central govt expenditure divided by GDP.
Population	Log of total population.

of GSADF for each country based on autoregressive lag length k = 1, reported in Panel A of Table1. Finite critical value of GSADF is also presented in Panel B of Table1. Finite sample critical values are obtained by generating 2,000 random walk processes with N(0, 1) errors[9]. The GSADF test shows strong evidence of explosive behavior present in real housing price and in real stock price indices in most of the countries. GSADF test is statistically insignificant at 5% level for Italy, Korea, Malaysia, Norway and for Singapore. That means that real housing price index of Italy and Korea and real stock price indexes of Italy, Malaysia, Norway and Singapore have no statistical evidence of explosive periods.

Next, to detect the periods of explosive behavior, we plot the time series of the backward SADF against the 95% SADF critical value, obtained from Monte Carlo simulations with 2,000 replications, along with real asset price index[10]. These figures successfully detect start and end date of bubble periods in real stock price indices and real housing

[9]International house price database of the Federal Reserve Bank of Dallas also includes SADF, GSADF, and BSADF test-statistics for real house prices for all available countries together with the corresponding critical values (see Pavlidis et al. (2013) for details).

[10]All these plots will be provided upon request.

price indices. But the procedure proposed by Phillips et al.(2015) fails to recognize crash period statistically at least for quarterly real stock price indices[11].Fortunately long history of stock market crash data is available and taken from Camen M. Reinhart's web site (see Reinhart and Rogoff (2011) for details) for our analysis. However date-stamping procedure works well in recognizing start and end date of crash periods in real housing price indices. Bubble/crash variable is equal to one for the exuberance period otherwise zero. For example, Japanese housing crash index, we give the value equal to 1 for years $2002 - 2006$ and for year 2014, otherwise it equals to zero. We follow the same procedure in developing stock market bubble and housing market bubble and crash indicies for other countries.

4 Fundamental variables

In this section we describe the variables included in the analysis and their sources. Table 2 defines the variables used Table 3 presents summary statistics and pair-wise correlations. Appendix A.1 to Appendix A.2 represents the availability of explanatory variables used in this research. We collect the top income shares including capital gain[12] and excluding capital gain[13] variables from world income database (WID) and use three measures of top income share, namely Pareto-Lorenz coefficient, Top0.1 and Top1. GDP per capita and population size variables are collected from Maddison (2006) and Bolt and van Zanden (2014). The rest of the variables including financial development, top marginal tax rate, globalization or openness and government expenditure are from Roine, Vlachos and Waldenström (2009). Financial development is updated from Financial Structure Database (FSD) and the variable top marginal tax rate is updated from OECD database. Top marginal tax rate of Colombia is from Alvaredo and Vélez (2013). The variable Patent is from OECD database for the period of 1980 to 2012 and globalization or openness and government expenditure variables are updated from World Bank Database. We use a linear interpolation to fill out the gaps in the data only when gap of the missing period is not more than five consecutive years and the gap in the data is rarely observed after the year 1960.

[11] Originally Phillips et al. (2015) applied monthly data to capture the crisis period, but monthly data is not available for real house price indexes for all available countries. So to maintain consistency, we also use quarterly stock market data in this research.

[12] Countries are Canada, Germany, Japan, Spain and Sweden, USA.

[13] Countries are Australia, Canada, China, Colombia, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, Malaysia, Netherlands, New Zealand, Norway, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, UK, USA.

Table 3

Panel A: Descriptive statistics of preliminary variables

	Top1	Top0.1	Pareto (β)	GDPpc	Stock.mkt	B. Deposit	Tax rate	Openness	Govt. exp	Popupation
Obs	1027	942	996	1021	1029	1018	951	1037	1037	1003
Mean	9.326	2.955	1.896	2.221	0.655	0.585	0.543	54.846	16.569	2.330
SD	3.479	1.719	0.356	0.102	0.536	0.315	0.168	57.936	5.375	0.136
Maximum	21.300	9.190	3.325	2.338	2.814	2.270	0.975	439.700	30.100	2.643
Minimum	2.670	0.460	1.224	1.861	0.000	0.083	0.115	3.400	3.200	2.078

Panel B: Correlation matrix

	Top1	Top0.1	Pareto (β)	GDPpc	Stock.mkt	B. Deposit	Tax rate	Openness	Govt. exp	Population
Top1	1									
Top0.1	(0.951)**	1								
Pareto (β)	(0.695)**	(0.871)**	1							
GDPpc	(-0.264)**	(-0.248)**	(-0.149)**	1						
Stock.mkt	(0.331)**	(0.305)**	(0.221)**	(0.201)**	1					
B. Deposit	(-0.026)	(-0.030)	(0.079)**	(0.518)**	(0.358)**	1				
Tax rate	(-0.260)**	(-0.330)**	(-0.425)**	(-0.167)**	(-0.112)**	(-0.276)**	1			
Openness	(0.040)	(0.023)	(0.072)**	(0.273)**	(0.406)**	(0.372)**	(-0.355)**	1		
Govt. exp	(-0.414)**	(-0.375)**	(-0.291)**	(0.593)**	(-0.106)**	(0.113)**	(-0.025)	(0.007)	1	
Popupation	(0.216)**	(0.229)**	(0.197)**	(-0.492)**	(-0.193)**	(-0.179)**	(0.174)**	(-0.477)**	(-0.318)**	1

**Indicate that the correlations are statistically significant at 5% level.

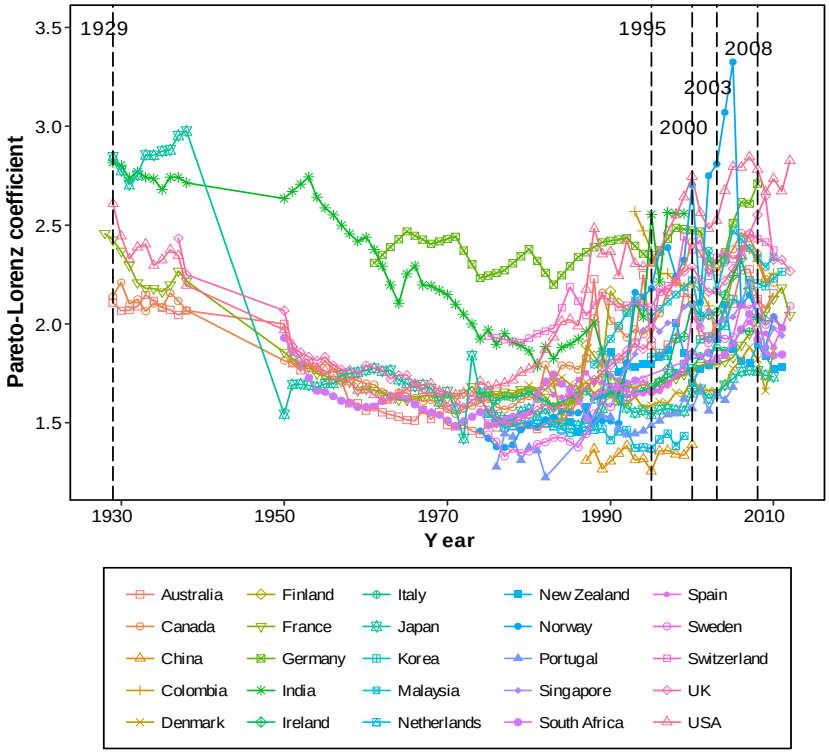

Figure 1: Inverted Pareto-Lorenz coefficients in 25 countries. Source World inequality database (Excluding capital gain). Sample period 1929-2012.

4.1 Top income shares

The Pareto-Lorenz coefficients, a measure of income inequality among the rich, are plotted in Figure 1 to look at the evolution of top income shares in recent period. The sample period, although different for different countries, includes a number of financial crisis, including the great depression of 1930, the two World Wars, periods of high inflation, dot-com crisis in early 2000, recent recession (2008-2012) among others. In the Figure1, we can see that income concentration among the rich accelerates in most of the countries (including Nordic countries) in the later part of 1990s and drops somewhat just after the crash of dot-com bubble in 2000 but then it comes roaring back again during the housing bubble period (mostly in 2003-2008). But that was not the story until mid-1970s. Wealth concentration among rich decreases during that period, stated in Figure 1.

5 Empirical model

Standard panel model analysis can help us unravel some of the economic factors which might trigger the recent uptrend of income inequality. This approach has already been applied by Atkinson and Leigh (2013) and Roine, Vlachos and Waldenström (2009). The

fixed effect panel regression equation is described as follows

$$y_{it} = \alpha_0 + \beta_1 y_{it-1} + \beta_2 \text{bubble}_{it} + \beta_3 \text{crash}_{it} + X_{it}^{/} \beta_4 + i + t + \epsilon_{it} \quad (1)$$

where the variable ϵ_{it} is the error term and the variable i captures the country specific effect and the variable t captures the time effect.

The variable y_{it} represents the top income shares. We are interested in the coefficient value of the stock market bubble variable. Bubble variable is equal to one for the exuberance period otherwise zero. It is expected that the bubble accelerate to elevate the income of the rich. Similarly stock market crash is a binary variable and is equal to one for crash period otherwise zero. This variable is collected from Reinhart and Rogoff (2011). It is expected that the coefficient of the crash variable will have a negative sign. The term $X_{it}^{/}$ represents the control variables. The $X_{it}^{/}$ variable includes gross domestic product per capita, financial development, innovation (Patent), openness or globalization, top marginal tax rate, government expenditure, and population.

We control time trend and time invariant country effect. This does not mean that we have fully addressed potential endogeneity problems. There could be reverse causality from top income shares to explanatory variables. This would be the case if, for example, top income shares would have a direct effect on asset bubbles, rather than the other way around. Similarly, economic growth might be effected by top income shares, rather than the way we specified. Of course, it is possible that causation could be simultaneously run in both directions. So proposed estimation method has its shortcomings and we keep aside the possibility of reverse causality for future research.

The most common way to estimate fixed effects models is to remove the fixed effect by time demeaning each variable (the so called within estimator). However, the inclusion of the lagged dependent variable might be problematic. It could be correlated with the unobserved fixed effects and generate biased estimates. This bias is reduced when sample size is large (Nickell, (1981)). The assumption of no auto-correlation in the error terms does not necessarily hold even after the inclusion of y_{it-1} and the variance of the error could be heteroskedastic. Thereby, we could get biased estimates. The standard way of dealing with the dynamic panel data problem is to use GMM-procedures (Arellano and Bond (1991) or Arellano and Bover (1995)). But these GMM-procedures are not appropriate in a setting with small N (country) and large T (time) such as ours (see Roodman, (2007)). So we apply GLS and allow for heteroskedasticity in the error terms (see Roine, Vlachos and Waldenström (2009) for details). However others used heteroskedasticity-and autocorrelation consistent (HAC) procedures while estimating their model (see Bertrand,

Table 4

Restricted panel regression with fixed effect estimates of the model parameter in equation (1) for the period 1929 to 2012. The GLS estimates are based on based on yearly data. Standard errors reported in first brackets. Country fixed effect dummies are added but not reported. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

Parameter	Include Capital gain			Exclude capital gain		
	IvP	Top	Top	IvP	Top	Top
Estimate	(β)	0.1	1	(β)	0.1	1
y_{it-1}	0.599***	0.575***	0.588***	0.882***	0.922***	0.891***
	(0.045)	(0.046)	(0.045)	(0.014)	(0.010)	(0.012)
GDPpc	0.026	-0.264	-0.698**	-0.042***	-0.114***	-0.229**
	(0.042)	(0.166)	(0.284)	(0.011)	(0.040)	(0.093)
T.capital	0.078***	0.387***	0.694***	0.024***	0.120***	0.343***
	(0.024)	(0.099)	(0.166)	(0.006)	(0.023)	(0.054)
Govt. exp	-0.029***	-0.115***	-0.173***	-0.000	-0.003	-0.014*
	(0.005)	(0.020)	(0.032)	(0.001)	(0.003)	(0.008)
Openness	0.001	0.004	0.010*	0.000***	0.000	-0.000
	(0.001)	(0.003)	(0.005)	(0.000)	(0.000)	(0.002)
Tax rate	-0.267***	-0.755***	-1.215***	-0.127***	-0.490***	-1.204***
	(0.074)	(0.265)	(0.397)	(0.019)	(0.061)	(0.145)
Population	0.321**	2.994***	4.969***	0.058***	0.146*	0.014
	(0.145)	(0.678)	(1.086)	(0.020)	(0.080)	(0.193)
Size	261	261	261	847	812	874
Countries	6	6	6	23	21	23

Duflo and Mullainathan (2004) and Atkinson and Leigh (2013).

6 Comparisons to related work on top income shares

Before estimating the full model, for comparative purposes the results from estimating restricted fixed effect panel model commonly adopted in empirical work are presented in Table 4. Estimated results state that the financial development benefits the rich, supports the findings of Rajan and Zingales (2003) and Roine, Vlachos and Waldenström (2009). Contrary to this statement, Claessens and Perotti (2007) claim that linear relationship between income inequality and financial development might be negative. The evidence of nonlinear relationship between income inequality and financial development is not uncommon though (see Greenwood and Jovanovic (1990), Clarke, Xu and Zou (2003), Beck, Kunt and Levine (2007)).

The effect of Gross domestics product per capita (GDPpc) on top income shares

Table 5

The GLS estimates are based on yearly data. Standard errors reported in first brackets. Country fixed effect dummies are added but not reported. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

Panel A: Estimates only with stock market bubble						
	Include Capital gain			Exclude Capital gain		
Parameter	IvP	Top	Top	IvP	Top	Top
Estimate	(β)	0.1	1	(β)	0.1	1
y_{it-1}	0.822***	0.848***	0.877***	0.884***	0.917***	0.919***
	(0.035)	(0.035)	(0.033)	(0.018)	(0.017)	(0.015)
Stock mkrt.	0.109***	0.376***	0.502***	0.029***	0.083***	0.208***
bubble	(0.024)	(0.096)	(0.147)	(0.006)	(0.017)	(0.037)
Panel B: Estimates only with innovation						
y_{it-1}	0.795***	0.813***	0.842***	0.863***	0.909***	0.901***
	(0.041)	(0.041)	(0.038)	(0.019)	(0.018)	(0.015)
Innovation	0.004	0.032	0.055*	0.005***	0.026***	0.058***
	(0.004)	(0.021)	(0.031)	(0.001)	(0.008)	(0.016)
Panel C: Estimates with stock market bubble and innovation						
y_{it-1}	0.806***	0.815***	0.837***	0.866***	0.896***	0.893***
	(0.036)	(0.038)	(0.036)	(0.018)	(0.018)	(0.016)
Stock mkrt.	0.116***	0.432***	0.610***	0.032***	0.097***	0.224***
bubble	(0.025)	(0.100)	(0.152)	(0.006)	(0.017)	(0.035)
Innovation	0.006	0.041**	0.073***	0.006***	0.033***	0.064***
	(0.004)	(0.019)	(0.028)	(0.001)	(0.008)	(0.015)

seems to inconsistent. Banerjee and Duflo (2003) also find no robust relationship between income inequality and growth when measuring inequality by the Gini coefficient, whereas Forbes (2000) finds a positive relationship between these two variables. Other variables like trade openness or globalization also has no power to explain the dynamics of top income shares[14].

But central government expenditure seems to have negative impact on top income shares. Stack (1978) also reports that government spending through government involvement in an economy could eliminate the problem of unemployment, which in turn reduces

[14]On the contrary Dollar and Kraay (2004) suggest that globalization leads to fastest growth and poverty reduction in poor countries. Tallo (2003) reports that there is a positive relationship between degree of openness and income inequality.

Table 6

The GLS estimates of Panel A and Panel B include country fixed effect but not reported. Standard errors reported in firrst brackets. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

Panel A: Estimates are based on yearly data

	Include Capital gain			Exclude Capital gain		
Parameter	IvP	Top	Top	IvP	Top	Top
Estimate	(β)	0.1	1	(β)	0.1	1
y_{it-1}	0.834***	0.847***	0.863***	0.862***	0.897***	0.895***
	(0.036)	(0.037)	(0.035)	(0.019)	(0.019)	(0.016)
Stock mkrt.	0.111***	0.424***	0.607***	0.032***	0.095***	0.216***
bubble	(0.024)	(0.099)	(0.151)	(0.006)	(0.018)	(0.036)
Stock mkrt.	-0.051**	-0.205**	-0.322**	-0.005	-0.029**	-0.067**
crash	(0.021)	(0.087)	(0.132)	(0.004)	(0.014)	(0.026)
Innovation	0.005	0.038**	0.067**	0.007***	0.031***	0.056***
	(0.003)	(0.017)	(0.026)	(0.001)	(0.007)	(0.014)

Panel B: Estimates are based on 3 year average data

y_{it-1}	0.720***	0.801***	0.804***	0.922***	0.979***	0.927***
	(0.077)	(0.087)	(0.082)	(0.044)	(0.039)	(0.032)
Stock mkrt.	0.342***	1.317***	1.876***	0.078***	0.222***	0.494***
bubble	(0.061)	(0.251)	(0.379)	(0.014)	(0.045)	(0.077)
Stock mkrt.	-0.117	-0.671**	-1.041**	-0.027*	-0.112**	-0.147
crash	(0.077)	(0.285)	(0.421)	(0.016)	(0.057)	(0.100)
Innovation	0.017*	0.104**	0.160**	0.009*	0.038*	0.019
	(0.010)	(0.050)	(0.080)	(0.004)	(0.022)	(0.044)

the degree of income inequality (see also Wolff and Zacharias (2007)). The estimated coefficient of top marginal tax rate is also negative, which states that the top marginal tax rates may have a negative impact on the rise of income shares. The quality of the results do not change much if we allow time dummy variables in the estimation process.

The empirical results from estimating the restricted panel models presented in Table 4 highlight three key findings.

First, financial market development where compensation has been rising rapidly plays an important role in explaining the dynamics of top income shares. So it would be important to have a deeper look at the role of asset market boom and burst on capital gain and on the top wage earners as well.

Two, the effect of some other determinants (for example economic growth and openness) on top income shares are not be statistically significant in some cases. That does

not necessarily mean that there is no relationship between those variables with top income shares. Theoretical relationship of those variables with top income shares seem to be very complex as stated previously and it depends on the model we considered. So the recommendations and the inferences on these relationships should be drawn with caution.

Third, most of the variables selected in the above empirical analysis are theoretically motivated. They are expected to have certain kind of relationship with top income shares although in some cases the empirical relationship seems to be inconsistent. Still those determinants of top income shares could be treated as important control variables for further empirical analysis.

7 Are asset bubble and innovation relevant in determining top incomes?

We begin the preliminary analysis with the use of restricted version fixed effect model[15] to look at the effect of innovativeness and bubble on top income shares, where innovativeness is measured by the number of total patent granted at the European patent office per thousand of people.

Table 5 and Table 6 present the results from regressing top income shares on the innovation and/or bubble. The effect of the innovation and bubble on the top income share is always positive and significant. The reported estimates are consistent with Aghion et. al (2015), where they report that the degree of innovativeness is lying behind the increase in income inequality and it is positively and significantly correlated with top income shares. These results are also consistent for 3-year window, reported in Panel B of Table 6.

These evidences state that the rise in income inequality would be partly based on economic fundamentals (eg. caused by increases in innovation-led growth), partly on asset bubble caused at least in part by rent seeking activities. However, stock market crash seems to impede the surge in income shares by reducing their income.

7.1 A deeper look at the relationship between bubble and the top incomes

Given the strong empirical evidence of asset bubble in explaining the rise in top income shares, this section analyzes the impact of asset market boom and brust or crash on top income shares from estimating the full model(eq.1), which includes all the control variables. The estimated results of this regression are reported in Table 7.

[15] OECD does not have records of patent information before 1980 for all countries considered.

Table 7

Panel regression with fixed effect estimates of the model parameter in equation (1). The GLS estimates are based on based on yearly data. Standard errors reported in first brackets. Country fixed effect and time dummies are added but not reported. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

	Include Capital gain			Exclude Capital gain		
Parameter	IvP	Top	Top	IvP	Top	Top
Estimate	(β)	0.1	1	(β)	0.1	1
y_{it-1}	0.615***	0.581***	0.585***	0.717***	0.819***	0.842***
	(0.055)	(0.062)	(0.062)	(0.030)	(0.028)	(0.025)
Stock mkrt.	0.111***	0.318***	0.400***	0.024**	0.076**	0.077
bubble	(0.029)	(0.116)	(0.174)	(0.009)	(0.031)	(0.057)
Stock mkrt.	-0.002	-0.033	-0.083	-0.002	-0.017	-0.076
crash	(0.023)	(0.094)	(0.142)	(0.008)	(0.027)	(0.047)
Innovation	-0.004	0.021	0.038	0.002	0.018*	0.025
	(0.005)	(0.021)	(0.032)	(0.002)	(0.011)	(0.020)
GDPpc	0.175	0.594	-0.291	0.195***	0.395*	0.546
	(0.169)	(0.693)	(1.042)	(0.054)	(0.215)	(0.434)
T. Capital	0.069*	0.201	0.247	0.035***	0.101**	0.298***
	(0.040)	(0.171)	(0.260)	(0.011)	(0.041)	(0.080)
Govt. exp	-0.017**	-0.058**	-0.090**	-0.006**	-0.020**	-0.023
	(0.007)	(0.026)	(0.041)	(0.002)	(0.009)	(0.017)
Openness	0.002	0.009	0.018*	0.000	-0.000	-0.000
	(0.001)	(0.007)	(0.011)	(0.000)	(0.002)	(0.003)
Tax rate	-0.397***	-1.311***	-1.960***	-0.126***	-0.299***	-0.641***
	(0.105)	(0.367)	(0.559)	(0.037)	(0.113)	(0.214)
Popupation	0.607*	5.478***	9.483***	0.139	0.710*	0.590
	(0.329)	(1.550)	(2.464)	(0.095)	(0.399)	(0.730)
Size	171	171	171	498	455	525
Countries	6	6	6	21	19	21

We have estimated same full model with two ways. First estimation is based only on individual effect not reported here.According to this estimate, both stock market bubble and the stock market crash have impact on top income shares. The coefficient of stock market bubble has a positive effect on top income shares while stock market crash hits hard to those at the top by reducing capital gain. But the strong effect stock market crash disappears while allowing time dummies in the estimation process, reported in Table 7. The positive effect of asset bubbles on top income shares remains the same and is statistically significant at 5% level. This means that bubbles help to produce the extra income for the people of upper fractile, which eventually accelerate income inequality. Table 7 also states that the government expenditure and the top marginal tax rates play

an important role in impeding the surge in income shares.

7.2 Are the effects of financial bubbles different in Anglo-Saxon countries?

Based on the previous literature review, it might be reasonable to state that the response of top incomes to the underlying determinants might not be homogeneous for each region as their growth dynamics of the top income shares are different, particularly the difference is prominent in Anglo Saxon countries from the rest of the world (e.g., Atkinson and Piketty (2007)). Panel estimation permits us to test for such specific hypotheses regarding the effect of different determinants on income inequality. We described the estimates but estimated results are not reported here. The estimates will be available upon request.

First, we estimate panel model with a dummy variable indicating a particular region (i.e., Anglo-Saxon) interacting with the main variables of interest (for example, bubble) whilst keeping the effects of other explanatory variables remain constant. We can test this hypothesis if the slope of interaction variable (i.e., bubble x Anglo-Saxon) differs between Anglo-Saxon and other countries. The coefficient of the interaction variable (bubble x Anglo-Saxon) is significant in some cases of top income shares. However the effect of stock market crashes on income inequality in Anglo-Saxon substantially differs from the rest of the countries considered. These evidences articulate that the stock market crash shrinks the surge in top income shares in Anglo-Saxon in compare to the rest of the world.

Similarly we interact innovation with the Anglo-Saxon indicator, the interaction term seems to positive and statistically significant at 5% level which supports that innovation, one of the most important determinant of top income shares, is lying behind the recent surge in top income shares in Anglo Saxon Region (see also Aghion et. al (2015)). Similar results could be found when we interact financial development with the Anglo-Saxon indicator.

We also re-examined the effect of economic growth or trade openness with the updated dataset and state that there are systematic distributional effects from economic growth and trade openness that differ between Anglo Saxon countries from the rest of the world. These results contradicts with the findings of Roine, Vlachos and Waldenström (2009).

8 Some robustness checking

In this section we discuss the robustness of our regression results.

1. The role of housing market bubble

The stock market booms in 1990s morphed into the real estate boom of the current decades with low interest rates, lower mortgage interest rates, and relaxed standards for mortgage loans. Eventually these key factors accelerate the growth of the financial market and the key players of this market (such as CEO, trader and broker etc) collects the benefit from the real estate boom (see Philippon and Reshef (2012)). Reasonably, it would be important to consider housing market bubble as an additional control while estimating the effect of stock market bubble on top income shares. The estimated results

Table 8

Panel regression with fixed effect estimates of the model parameter in equation (1). The GLS estimates are based on based on yearly data where stock market bubble estimates are based on GSADF procedure with autoregressive lag length k=3. Standard errors reported in first brackets. Country fixed effect and time dummies are added but not reported. The statistical significance of the estimates is denoted with asterisks ***, ** and * correspond to 1% , 5% and 10% levels of significance respectively.

	Include Capital gain			Exclude Capital gain		
Parameter	IvP	Top	Top	IvP	Top	Top
Estimate	(β)	0.1	1	(β)	0.1	1
y_{it-1}	0.595***	0.577***	0.584***	0.717***	0.821***	0.842***
	(0.057)	(0.062)	(0.062)	(0.030)	(0.028)	(0.024)
Stock market	0.097***	0.311**	0.404**	0.026***	0.067**	0.039
bubble	(0.031)	(0.127)	(0.191)	(0.010)	(0.033)	(0.063)
Stock market	-0.011	-0.049	-0.093	-0.003	-0.021	-0.080*
crash	(0.024)	(0.093)	(0.140)	(0.007)	(0.027)	(0.047)
Innovation	-0.002	0.029	0.046	0.002	0.019*	0.025
	(0.005)	(0.021)	(0.031)	(0.002)	(0.011)	(0.020)
GDPpc	0.230	0.753	-0.086	0.194***	0.379*	0.540
	(0.176)	(0.698)	(1.035)	(0.053)	(0.212)	(0.432)
T. Capital	0.088**	0.247	0.292	0.034***	0.104**	0.303***
	(0.040)	(0.167)	(0.252)	(0.011)	(0.041)	(0.081)
Govt. exp	-0.016**	-0.051**	-0.083**	-0.006**	-0.019**	-0.025
	(0.007)	(0.026)	(0.040)	(0.002)	(0.009)	(0.017)
Openness	0.003*	0.012*	0.021**	0.000	-0.000	-0.001
	(0.001)	(0.006)	(0.010)	(0.000)	(0.002)	(0.003)
Tax rate	-0.396***	-1.287***	-1.933***	-0.120***	-0.267**	-0.601***
	(0.106)	(0.359)	(0.542)	(0.036)	(0.107)	(0.206)
Popupation	0.790**	5.907***	9.959***	0.145	0.698*	0.545
	(0.325)	(1.529)	(2.422)	(0.093)	(0.401)	(0.735)
Size	171	171	171	498	455	525
Countries	6	6	6	21	19	21

reveal that the effect of stock market bubble on top income shares does not appear to be very sensitive.

2. Choice of lags in detecting explosive behavior in the asset price index.

As previously stated, a typical assumption in economics literature is that the economic fundamentals follow either a stationary or an integrated process of order 1 process. So we have previously reported the GSADF test statistics for each country based on autoregressive lag length k = 1. To evaluate the sensitivity to the lag length specification, GSADF test also estimated with autoregressive lag length k = 3. Our findings about the presence of explosive behavior in the stock market do not appear to be very sensitive. Now we redo our main analysis with the re-estimated bubble and crash variables, reported in Table 8. Our findings re-confirm that the stock market development along with the financial bubbles seem to be the important drivers of the observed increases in top income shares[16].

3. Choice of longer window.

To capture the transitory positive effect of stock market bubble on top income shares, annualized data probably the most appropriate to use. However we use 3-year averages of the data in our estimation process for further analysis. The effect of stock market bubble on top income shares seems to be positive and statistically significant at 5% level. But the transitory effect of stock market bubble on top income shares tend to diminish considerably whilst estimating the panel model with time dummy variables. The positive effect of stock market bubble on top income shares also starts to disappear for average data longer than 3-year window.

9 Concluding remarks

The paper empirically analyses the response of the top incomes to the underlying determinants. Traditional determinants of income inequality like economic growth, trade openness, and government expenditure might have an influence in explaining the dynamics of top income shares; but the effect of these variables, particularly the effect of economic growth, on top income shares is inconsistent. Our empirical analysis provides support for the view that asset-bubbles together economic fundamentals such as caused by increases in innovation-led growth are an important part of story in explaining increasing top income inequality. Asset bubbles accelerate to elevate the income of the rich

[16] We also re-estimated the proposed panel model with stock market bubble where stock market bubble estimates are based on GSADF procedure with autoregressive lag length k = 2. The quality of the findings remain the same. The estimates are available upon request.

and super rich people which in turn raises income inequality. The variable innovation, measured by the annual flow of patents, has positive effect on top income shares. Furthermore, top marginal tax rates play an important role in impeding the surge in top income shares. Needless to say, this paper leaves many stones unturned. For example, we could have direct reverse causality from top income shares to asset bubbles. This would be the case if income shares would have an impact on asset bubble, rather than the other way around. Such kind of research in this direction might improve our understanding of the drivers of observed increases in top income shares.

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A Appendix

A.1 Basic exlanatory variables.

Country	GDPpc	Bank deposits	Stok. mkt. cap.	Tax rate	Openness	Govt. expenditure	Population
Australia	1921-2010	1922-1938[a] 1945-2010[a]	1929-1938[a] 1950-2010	1921-2010	1922-1938[a] 1950-2010	1922-1938[a] 1945-2010[a]	1921-2009
Canada	1920-2010	1920-1938[a] 1945-2008[a]	1929-1938 1950-2008	1920-2008[a]	1920-1938[a] 1950-2008	1920-1938[a] 1945-2008[a]	1920-2009
China	1986-2003	1987-2003	1987-2003	1986-2003	1987-2003	1986-2003	1986-2003
Colombia	1993-2010	1993-2010	1993-2010	1993-2010	1993-2010	1993-2010	1993-2009
Denmark	1917-2010	1920-1938[a] 1945-2010[a]	1929-1938 1950-2010	1975-2010[a]	1920-1938[a] 1950-2010	1920-1938[a] 1945-2010[a]	1917-2009
Finland	1920-2009	1920-1938[a] 1945-2009[a]	1983-2009	1975-2009[a]	1920-1938[a] 1950-2009	1920-1938[a] 1945-2009[a]	1920-2009
France	1915-2010	1920-1938[a] 1945-2011[a]	1929-1938 1950-2011	1915-2011[a]	1920-1938[a] 1950-2011	1920-1938[a] 1945-2011[a]	1915-2009
Germany	1891-2008	1900-1913[a] 1925-1938[a] 1948-2008[a]	1929-1938 1950-2008	1958-2008	1900-1910[a] 1920-1938[a] 1950-2008	1900-1913[a] 1925-1932[a] 1950-2008	1891-2008
India	1922-1999	1922-1938[a] 1945-1999[a]	1929-1938 1950-1999	1974-1999[a]	1922-1938[a] 1945-1999[a]	1922-1938[a] 1945-1999[a]	1922-1999
Ireland	1923-2009	1925-1938[a] 1948-2009[a]	1995-2009	1974-2009[a]	1925-1938[a] 1948-2009[a]	1925-1938[a] 1948-2009[a]	1923-2009
Italy	1974-2009	1974-2009	1974-2009	1975-2009[a]	1974-2009	1974-2009	1974-2009
Japan	1886-2010	1900-1913[a] 1920-1938[a] 1945-2010[a]	1929-1938 1950-2010	1900-2010[a]	1900-1910[a] 1920-1938[a] 1950-2010	1900-1913[a] 1920-1938[a] 1945-2010[a]	1886-2009
Korea	1979-2010	1979-2011	1990-2011	1979-2012[a]	1960-2012	1960-2011	1979-2009
Malaysia	1947-2010	1961-2011	1989-2011	-	1960-2012	1960-2011	1947-2009

[a]There are not more than five consecutive years with missing values in this subperiod. Linear interpolation could be used between these years while estimating the model.

A.2 Basic exlanatory variables.

Country	GDPpc	Bank deposits	Stok. mkt. cap.	Tax rate	Openness	Govt. expenditure	Population
Nether-lands	1914-2010	1920-1938[a] 1945-2011[a]	1950-2011	1975-2012[a]	1920-1938[a] 1950-2011	1920-1938[a] 1945-2011[a]	1914-2009
New-Zealand	1921-2010	1922-1938[a] 1945-2010[a]	1985-2010	1921-2010	1922-1938[a] 1950-2010	1922-1938[a] 1945-2010[a]	1921-2009
Norway	1892-2010	1900-1913[a] 1920-1938[a] 1945-2006[a]	1929-1938 1950-2006	1975-2011[a]	1920-1938[a] 1950-2006	1900-1913[a] 1920-1938[a] 1945-2006[a]	1892-2009
Portugal	1936-2005	1945-2005[a]	1977-2005	1976-2005[a]	1950-2005	1945-2005[a]	1936-2005
Singapore	1950-2010	1964-2011	1989-2010	-	1960-2012	1960-2011	1950-2009
South Africa	1924-2010	1920-1938[a] 1945-2011[a]	1950-2011	1913-2007	1920-1938[a] 1945-2011[a]	1920-1938[a] 1945-2011[a]	1950-2009
Spain	1933-2010	1945-2010[a]	1976-2010	1975-2010[a]	1950-2012	1945-2012[a]	1933-2009
Sweden	1903-2010	1905-1913[a] 1920-1938[a] 1945-2011[a]	1929-1938 1950-2011	1903-1920[a] 1930-2013[a]	1905-1910[a] 1920-1938[a] 1950-2013	1905-1913[a] 1920-1938[a] 1945-2011[a]	1903-2009
Switzer-land	1933-2010	1945-2010[a]	1970-2010	1975-2010[a]	1950-2010	1945-2010[a]	1933-2009
United Kingdom	1908-2010	1910-1913[a] 1920-1938[a] 1945-2005[a]	1929-1938 1950-2005	1908-2012	1920-1938[a] 1950-2012	1910-1913[a] 1920-1938[a] 1945-2012[a]	1908-2009
USA	1913-2010	1920-1938[a] 1945-2011[a]	1929-1938 1950-2011	1913-2013	1920-1938[a] 1950-2011	1920-1938[a] 1945-2011[a]	1913-2009

[a]There are not more than five consecutive years with missing values in this subperiod. Linear interpolation could be used between these years while estimating the model.