The Top 10 Percent After the Global Financial Crisis

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ABSTRACT

We conducted a review of developments in the top 10 percent share of income after the global financial crisis of 2007-2008 in 42 countries, seeking to identify the influential factors. The top 10 share declined after the crisis in most of the countries analyzed (most notably, in the Latin American countries), but increased in the most highly developed economies (the U.S., Germany, the U.K., France). However, two-thirds of the countries that recorded a decline were already on a declining trend before the crisis, while half of the countries in which inequality rose were characterized by either a stagnation or a fall in inequality before the crisis, implying that the overall decline in inequality after the crisis is due to a continuation of the pre-crisis trend, not due to the effect of the crisis. Turning to the factors that may have caused these developments, the analysis suggests that the reduction in the top 10 percent share of income after the crisis is stronger in countries with higher labour force participation, with an improvement in the control of corruption, with smaller stock exchange recovery and with higher inflation.

JEL classification: D31, G01

Keywords: inequality, income distribution, global financial crisis

I. Introduction

Many have pointed at rising inequality as the fundamental cause of the global financial crisis of 2007-2008. The main idea is that the shift of income towards the rich and the fall of the middle class in the U.S. created political pressures that were accommodated by easier credit. This created a credit boom and eventually led to a financial crisis in the U.S., which spread to the rest of the world (see Stiglitz (2009), Milanovic (2009), Wade (2009), Fitoussi and Saraceno (2010) and Rajan (2010)). Ranciere and Kumhof (2010) develop a dynamic stochastic general equilibrium model in which this happens.

It is, therefore, interesting to see what has happened with respect to income inequality after the crisis, in order to evaluate whether this allegedly "fundamental cause" of the crisis is still operative, and might lead to future crises. In addition, it would be very useful to know if changes in income inequality can be correlated with certain policy measures, country characteristics, or broader economic developments.

Numerous studies have reviewed changes in income inequality after the global financial crisis. Piketty and Saez (2013) discuss trends in the top percentile/decile share in income in several developed countries. They find that the decline in inequality of 2008 and 2009 was reversed in 2010 and argue that the long-term trend of rising inequality is unlikely to change in the future, unless significant policy reforms are undertaken. The volume edited by Jenkins et al. (2013) provides a detailed and thorough analysis of how income distribution changed with the crisis in 21 OECD countries. The primary finding is that it changed a little between 2007 and 2009, due to government support via tax and benefit systems, but that this scenario is likely to change in the following years towards greater inequality, due to fiscal consolidation measures. Agnello and Sousa (2012), **?** and Ball et al. (2013) focus explicitly on the effects of ongoing fiscal consolidation, arguing that it is likely to increase inequality in the develooped countries.

While the issue of how inequality changed with the global financial crisis has not been ne-

glected by the mentioned studies, existing studies have focused on a limited set of *developed* countries, leaving developments in income distribution in *developing* countries uninvestigated. To address this shortcoming, this study will examine changes in income inequality after the crisis in 42 countries, both *developed and developing*. In addition, this study will provide some insights about factors that may explain the various movements in different countries, as a way to initiate future research on causal links and mechanisms.

The top 10 percent share of income declined in most of the countries analyzed. However, two-thirds of the countries that experienced a decline in inequality were already going through a process of a falling inequality before the crisis. On the other hand, half of the countries that recorded a rise in inequality were characterized by either a stagnation or a fall in inequality before the crisis. Latin American countries were leaders in the decline in inequality, while the most developed economies in the sample (the U.S., Germany, the U.K., France) recorded an increase in inequality.

Regarding factors that may have caused the changes in inequality, the analysis indicates that the top 10 share is likely to have declined in countries with faster average decline in the top 10 share before the crisis, higher labour force participation, an improvement in the control of corruption during the crisis, a lesser stock exchange recovery after the crisis, and higher inflation. Some policy measures that are conventionally considered to be effective in alleviating inequality, such as increases in the highest marginal tax rate or social benefits, turn out to be insignificant in our analysis, as well as changes in labour market regulations, or monetary policy measures. Due to potential endogeneity problems, more research is needed in order to be able to interpret these associations as causal.

The paper is structured as follows: Section II reviews the related literature; section III discusses the data; section IV looks at changes in inequality in the analyzed countries; section V presents the econometric analysis; section VI offers conclusions.

II. Related literature

The literature on the crises–inequality nexus and on determinants of inequality is rather rich. While a comprehensive overview is outside of the focus of this study, we will refer to certain studies that are important for our analysis.

Existing literature does not provide a clear answer about the relationship between crises and inequality. Galbraith and Jiaqing (1999) analyze whether financial crises increase income inequality, based on a sample of approximately 60 countries from 1970-2000, using the UTIP (University of Texas Inequality Project) database, which measures inequality using the Theil's T statistics. They find that crises typically increase inequality, more so in less developed countries, and more so in regions that are more liberal in their policy regimes. Lustig (2000) finds that financial crises in Latin American countries in the 1980s and 1990s have been accompanied by *increased* inequality (measured by the Gini coefficient). Honohan (2005) analyzes developments in inequality (Gini coefficient) in the 1980s and 1990s after 43 banking crises in developing countries. He finds that when the crisis is accompanied by a general economic downturn, inequality increases, but not otherwise, since the higher-income groups temporarily experience disproportionate losses of income. He also finds differences between Latin American and Asian countries, with inequality increasing in the former, but not in the latter. In a panel of 16 advanced economies, analyzed throughout the 20th century, Roine, Vlachos and Waldenström (2009) find that banking crises are likely to *decrease* inequality (measured by the top income share from the World Top Incomes Database (WTID) of Alvaredo et al. (2013)). Bordo and Meissner (2011), analyzing the same group of countries from 1880 until 2000, find that inequality in general *rises* after crises, exception being the inter-war period, when it declined. Atkinson and Morelli (2011) survey changes in inequality after 37 crises, finding that, despite the heterogeneity, crises in general tend to *increase* inequality.

Piketty and Saez (2013) discuss developments in the top percentile and top decile share in income (from the WTID) after the 2007-2008 financial crisis in several developed countries. They find that the decline in inequality of 2008 and 2009 was reversed in 2010, and argue

that the long-term trend of rising inequality is unlikely to change in the future, unless significant policy reforms, such as tax changes, are undertaken. The volume edited by Jenkins et al. (2013) provides a comprehensive analysis of how income distribution changed with the Great Recession in 21 OECD countries. The main finding is that it changed a little between 2007 and 2009, due to government support via tax and benefit systems, but that it is likely to change in subsequent years towards greater inequality, due to fiscal consolidation measures. Closely related group of studies have focused explicitly on the effects of ongoing fiscal consolidation (see Agnello and Sousa (2012), **?**, Ball et al. (2013)), concluding that consolidation is likely to increase inequality in the developed countries.

Two general approaches to analyzing changes in inequality can be identified. The first uses household-survey data and identifies which sources of income have changed for different households (see Jenkins et al. (2013), Chapter 1, for explanation of this approach, or Chapters 3-8, for illustration). The second approach uses cross-country macroeconomic data on inequality and tries to explain changes in them, using econometric techniques. An example of the second approach is found in Roine, Vlachos and Waldenström (2009). They analyze determinants of top percentile and top decile share in 16 countries throughout the 20th century, using panel regressions, on five-year averages, which effectively gives approximately 100 observations. As explanatory variables for the top income share, they consider: GDP per capita growth, financial development, population, government spending, trade openness, and banking crises. They find that economic growth and financial development have tended to be advantageous to those who are already rich, differently from the banking crises, which have decreased the top income share. Government size and marginal tax rates have also been negatively associated with the top income share. In a similar manner, using the same data on inequality, five-year averages and panel techniques of estimation, Scheve and Stasavage (2009) investigate if leftist governments and wage bargaining affect top income shares, finding a negative answer. Afonso, Schuknecht and Tanzi (2010) analyze, among other things, whether public spending, education, and institutions affect income distribution in 22 OECD countries. They use simple cross-country regressions, with approximately 20 observations (depending on data availability) considering transfers and subsidies, social spending, tax

rates, per capita income, bureaucracy, initial inequality, unemployment, and education as explanatory variables. They find that all of these variables matter for inequality, except taxes.

III. Data on poverty and inequality

Studies that have analyzed changes in poverty and inequality after the global financial crisis used the first approach mentioned above, a detailed analysis of household survey data, which contain an abundance of information on income and consumption (see Jenkins et al. (2013), chapters 3-8, for instance). One downside of this first-best approach, however, is that it limits the analysis to a handful of advanced countries, since those are the ones for which household survey data are freely available. Another limitation is that surveys are usually available only after some time lag. As a result, the studies mentioned that have analyzed changes in income inequality after the global financial crisis end in 2009.

The alternative approach, using econometric analysis of cross-country macroeconomic data on inequality, is certainly subject to identification problems, but has the advantage of being able to incorporate more countries and provide answers about cross-country differences. Our study will analyze 42 countries, both developed and developing, from all continents except Africa, including: Argentina, Austria, Belgium, Bulgaria, Canada, Colombia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Moldova, Netherlands, New Zealand, Norway, Paraguay, Peru, Poland, Portugal, Romania, Singapore, Slovakia, Slovenia, Spain, Sweden, United Kingdom, United States, and Uruguay.

The change in inequality after the financial crisis will be measured as the difference between the last available data point (2010 or 2011) with respect to the average for 2005-2007. Inequality will be measured by the share of income going to the top 10 percent. We chose to work with the top 10 percent (instead of the top 1 percent, for instance) since data on the top 10 percent are available through several different sources, which increases the

number of observations. Three different sources will be used: the WTID of Alvaredo et al. (2013), Eurostat, and the World Development Indicators (WDI) of the World Bank. For the countries that have data in more than one database, the primary source is the WTID, and then Eurostat.[1] The sources differ in their methodology: the WTID compiles the data from tax records, the other two, from surveys. As a result, there are significant differences across databases, for countries that are present in two of them. For instance, 10 countries are accounted for both in the WTID and the Eurostat. For all of them, the top 10 share is much higher in the former than in the latter (see Figure 1). However, it can be also noted that the difference between the two is relatively stable.[2] Since our focus is on the within-country change in inequality (i.e. we do not compare levels of inequality across countries, but changes in inequality), the use of different methodologies does not represent a significant problem for our analysis. Table 1 shows the last data point and the data source for each individual country, as well as the change in the top 10 share after the crisis.

1. Exceptions are countries on which the WTID has data only until 2009, and Eurostat until 2010 or 2011. These countries are represented by the Eurostat data. These are: Finland, France, Ireland, Italy, Norway, Switzerland, and the U.K.

2. Exception is Norway, for which the two data sources display some divergent movements in 2006 and 2007.

FIGURE 1: COMPARISON OF THE TOP 10 PERCENT SHARE OF INCOME IN THE TWO DATABASES (%)

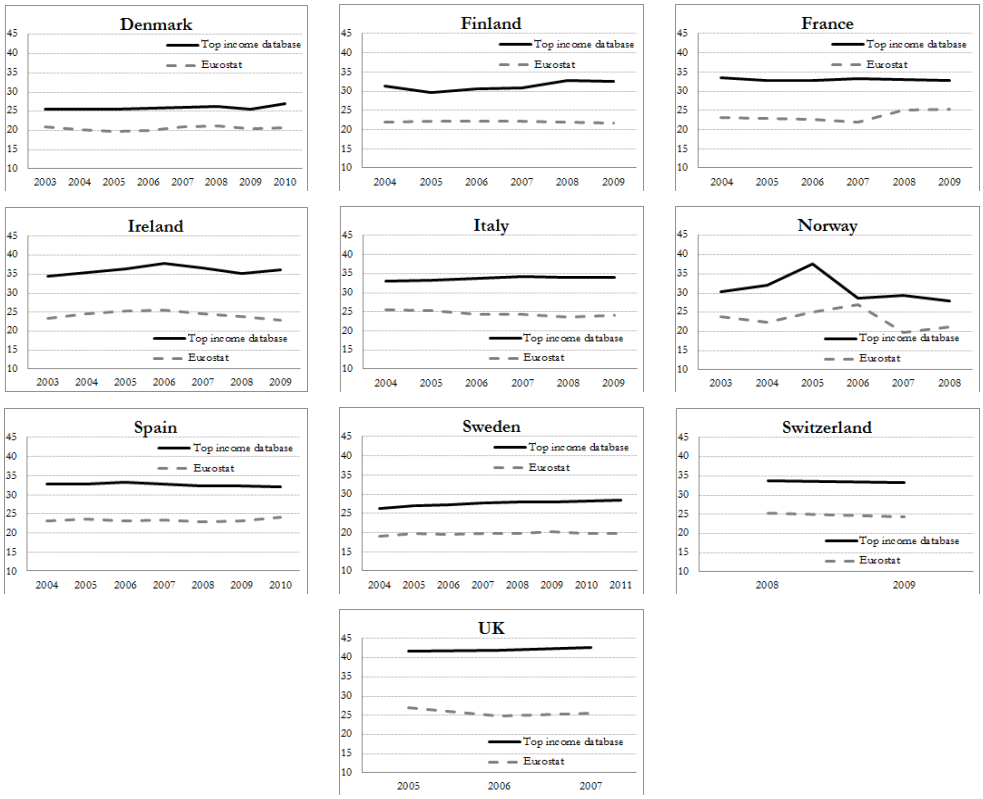

Table 1: Change in the top 10 share after the crisis across countries

Country	Change	Last point	Source	Country	Change	Last point	Source	Country	Change	Last point	Source
Ecuador	-4.43	2010	WDI	Poland	-1.43	2011	Eurostat	Czech R.	-0.17	2011	Eurostat
Norway	-4.33	2011	Eurostat	Slovakia	-1.30	2011	Eurostat	Cyprus	-0.07	2011	Eurostat
Romania	-4.00	2011	Eurostat	Uruguay	-1.16	2010	WDI	Slovenia	0.03	2011	Eurostat
Dominican R.	-3.33	2010	WDI	Netherlands	-1.13	2011	Eurostat	Germany	0.13	2011	Eurostat
Peru	-3.29	2010	WDI	Belgium	-1.13	2011	Eurostat	UK	0.27	2011	Eurostat
Argentina	-2.82	2010	WDI	Paraguay	-1.07	2010	WDI	Austria	0.30	2011	Eurostat
Iceland	-2.63	2011	Eurostat	Spain	-0.99	2010	WTID	Malta	0.80	2011	Eurostat
Portugal	-2.47	2011	Eurostat	Finland	-0.70	2011	Eurostat	Sweden	0.99	2011	WTID
Lithuania	-2.27	2011	Eurostat	Greece	-0.63	2011	Eurostat	Denmark	1.08	2010	WTID
Hungary	-2.23	2011	Eurostat	Luxembourg	-0.57	2011	Eurostat	Ireland	1.13	2010	Eurostat
Moldova	-1.97	2010	WDI	Colombia	-0.54	2010	WDI	US	1.17	2011	WTID
New Zealand	-1.94	2010	WTID	Italy	-0.53	2011	Eurostat	Singapore	1.18	2010	WTID
Estonia	-1.77	2011	Eurostat	Canada	-0.49	2010	WTID	Bulgaria	1.30	2011	Eurostat
Latvia	-1.57	2011	Eurostat	Japan	-0.30	2010	WTID	France	3.43	2011	Eurostat

IV. Movements in poverty and inequality

Looking at the raw figures, it can be observed that the top 10 share declined after the global financial crisis in 30 of the 42 countries analyzed. The largest declines in inequality are observed in the Latin American countries, followed by most of the Scandinavian and Eastern European countries. The remaining 12 countries noted a rise in the top 10 share, including in the largest analyzed economies – the U.S., Germany, the U.K., and France.

Many of the movements, however, are rather small, and are lower than the "salient" variation of Atkinson and Morelli (2011). Following them, we classify changes smaller than 1 percentage point (in absolute terms) as insignificant (i.e. a stagnation). Therefore, 19 countries recorded a decline in the top-10-share (mainly Latin American, Eastern European, and Scandinavian countries), and 6 countries recorded a rise (including the U.S. and France).

Table 2 compares the change in the top-10-share defined in this way after the global financial crisis, noting the trend present before the crisis. The trend before the crisis is measured as the average annual change in the five years before the crisis (2003-2007). Following the same logic as previously, changes smaller than 0.2 percentage point per year (in absolute terms) are treated as insignificant. Hence, changes are classified in three categories: increase (marked by the / sign), stagnation (marked by =) and decline (marked by \).

Table 2: Changes in the top-10-share after the crisis

		After			
		/	=	\	**Total**
	/	3	5	4	12
Before	=	1	8	2	11
	\	2	3	13	18
	Total	6	16	19	41

The majority of observations lie on the main diagonal (24 out of 41[3]), indicating that the trend in existence pre-crisis continued afterwards, in most of the countries. From the

3. Romania drops out from the analysis here, because there are no data on the top 10 share for Romania before 2007, as a result of what it is impossible to calculate the pre-crisis trend.

19 observations that recorded a decline in the top-10-share post-crisis, 13 were already on a declining trend. On the other hand, half of the 6 countries observed that experienced an increase in the top-10-share after the crisis were characterized by either stagnating or falling top-10-share. All this suggests that despite the overall decline in the top-10-share after the crisis, the effect of the crisis seems to be towards an increase in inequality, rather than a decrease.

V. Econometric analysis

V.A. Model and methodology

We next turn to examining the factors which may have caused the different developments in inequality in different countries. In accordance with the literature surveyed in section II, the model we postulate links the change in inequality after the crisis in any given country to: 1) severity of the crisis; 2) speed of recovery after the crisis; 3) country's characteristics; 4) policy measures undertaken after the crisis. More specifically, the model is:

$$
\begin{aligned}
\Delta top10_j \;=\; & \beta_1 + \beta_2 * fall\_GDP_j + \beta_3 * fall\_SE_j + \beta_4 * revovery\_GDP_j + \beta_5 * recovery\_SE_j \\
& + \beta_6 * initial\_top10_j + \beta_7 * trend\_top10_j + \beta_8 * GDP\_pc_j + \beta_9 * gov\_size_j \\
(1) \quad & + \beta_{10} * inflation_j + \beta_{11} * openness_j + \beta_{12} * banking_j + \beta_{13} * corruption_j \\
& + \beta_{14} * labour\_reg_j + \beta_{15} * participation_j + \beta_{16} * schooling_j + \beta_{17} * tax\_top_j \\
& + \beta_{18} * left_j + \beta_{19} * \Delta benefits_j + \beta_{20} * \Delta IR_j + \beta_{21} * \Delta M2_j + \beta_{22} * \Delta labour\_reg_j \\
& + \beta_{23} * \Delta tax\_top_j + \beta_{24} * \Delta corruption_j + \epsilon_j
\end{aligned}
$$

where Δ denotes changes after the crisis with respect to the pre-crisis level, the subscript j indexes the countries, and the definitions of the variables are given in Table 3.

TABLE 3: VARIABLES

Name	Definition	Source	Measuring
Δtop10	Change in the top 10 share 2011 (or 2010, analogously to the last available data point) and the average for 2005-2007.	WTID*, Eurostat, WDI**	
fall_GDP	Annual change in real GDP per capita in 2009.	WDI	shock
fall_SE	Annual change in the market capitalization of listed companies (as a % of GDP) in 2008. The data for 2008 was selected instead of 2009 because the financial shock occurred in 2009.	WDI	shock
recovery_GDP	Annual change in real GDP per capita in 2010, or average for 2010-2011, analogously to the last data point.	WDI	recovery
recovery_SE	Change in the market capitalization of listed companies, as a % of GDP, in 2010 (or 2011) with respect to 2009.	WDI	recovery
initial_top10	Initial inequality, i.e. top 10 share in 2005-2007.	WTID, Eurostat, WDI	charact.
trend_top10	Average annual change in the top 10 share in the 5 years before the crisis (2003-2007).	WTID, Eurostat, WDI	charact.
GDP_pc	GDP per capita, PPP (constant 2005 international $), 2010 or 2010-2011.	WDI	charact.
gov_size	General government consumption in 2010 (or 2010-2011), as a percent of GDP.	WDI	charact.
inflation	CPI inflation, 2010 or 2010-2011.	WDI	charact.
openness	Exports of goods and services, as a percent of GDP, 2010 or 2010-2011.	WDI	charact.
banking	Domestic credit provided by banking sector (% of GDP). Different from the other variables measuring countries' characteristics, this variable is measured for the period 2005-2007, because its purpose is to capture exposure to the financial shock.	WDI	charact.
corruption	Control of corruption index, in 2010 (or 2010-2011). Higher value = higher control.	WGI***	charact.
labour_reg	Labour market regulation index in 2010 or 2010-2010. Higher index=less regulated.	EFW****	charact.
participation	Labour participation rate, total (% of total population ages 15+), 2010 or 2010-11.	WDI	charact.
schooling	School enrollment, secondary (% gross), 2010 or 2010-2011	WDI	charact.
tax_top	Top marginal tax rate in 2010 (or 2010-2011).	EFW	charact.
left	Dummy if the country had a leftist government in 2010 or 2011.	DPI*****	charact.
Δbenefits	Real growth in subsidies and other government transfers in 2010 (or 2010-2011), with respect to 2009.	WDI	policy
ΔIR	Money market rate, 2010 (or 2010-2011) minus 2009. In real terms. For the euro-area countries, it is the euro-area data.	IFS******	policy
ΔM2	M2, % of GDP, 2010 (or 2011) vs. 2009.	WDI	policy
Δlabour_reg	Change in labour market regulation index in 2010 or 2010-2011, with respect to 2009. Higher value = made less regulated.	EFW	policy
Δtax_top	Change in the top marginal tax rate in 2010 (or 2010-2011), with respect to 2009.	EFW	policy
Δcorruption	Change in the control of corruption index, in 2010 (or 2010-2011) with respect to 2009. Higher value = improvement in the control.	WGI	policy

*WTID stands for the World Top Income Database of Alvaredo et al. (2013)
**WDI stands for the World Development Indicators of the World Bank
***WGI stands for the Worldwide Governance Indicators of the World Bank
****EFW stands for the Economic Freedom of the World dataset of Gwartney, Lawson and Hall (2013)
*****DPI stands for the Database on Political Institutions of Beck et al. (2001)
******IFS stands for the International Financial Statistics of the IMF

The number of potential explanatory variables for the change in inequality is 23, which is rather high for a sample of 41 observations. This is a natural environment for a Bayesian model averaging (BMA) exercise. BMA has gained prominence in recent years in cases where numerous explanatory variables are available. Most of these analyses are cross-country studies, where the number of observations at the same time is small. As an illustration, Masanjala and Papageorgiou (2008) use 25 variables in a sample of 37 countries, while Feldkircher (2012) uses 97 variables, in a sample of 63 countries. Some of the areas where BMA has been applied include economic growth (Fernandez, Ley and Steel (2001), Leon-Gonzalez and Montolio (2004), Sala-i Martin, Doppelhofer and Miller (2004), Masanjala and Papageorgiou (2008), Eicher, Papageorgiou and Raftery (2011), Durlauf, Kourtellos and Tan (2008)), crime rates (A.E., D. and J.A. (1997)), returns to education (Tobias and Li (2004)), modelling of inflation (Cogley and Sargent (2005)), evaluation of macroeconomic policy (Brock, Durlauf and West (2003)), monetary policy transmission lags (Havranek and Rusnak (2012)), crisis incidence (Babecky et al. (2012)), crisis severity (Cuaresma and Feldkircher (2012)) and post-crisis recovery Abiad et al. (2009), Jovanovic (2012)). It is also very often used in forecasting inflation and GDP (Eklund and Karlsson (2007), Koop and Potter (2003)).

BMA is essentially appropriate in empirical analyses in which there is uncertainty about the right theoretical model. Most analyses of determinants of cross-country outcomes fall in this category. BMA addresses the problem of uncertainty regarding the correct model by considering information from all available models (i.e. combinations of the variables). Instead of selecting only one model, BMA estimates many of the potential models (sometimes even all the possible models) and then draws inferences by weighting their results. For instance, if there are 20 candidate explanatory variables, there are 2^{20} =1,048,576 possible models (i.e. there are 1,048,576 different combinations of the 20 available variables), which can often produce conflicting results. BMA will estimate many (or all) of the possible model combinations using Bayesian techniques, whereby the researcher's prior information/expectations about the model parameters are combined with information from the data, to obtain the posterior parameter estimates. Then each of the estimated models will be weighted by its posterior probability (a measure of the goodness of fit). Inferences will then be based on the weighted averages of the posterior means and standard errors of the candidate variables, and on the posterior inclusion probability (PIP), which can act as

a measure of the significance of the variable.

A comprehensive explanation of BMA can be found in Hoeting et al. (1999)). Here we provide the basic technical details:

The model of interest, presented in Equation (1), can be rewritten as:

$$y = \alpha\iota_n + X\beta + \sigma\epsilon \tag{2}$$

where y stands for the change in inequality after the crisis, ι_n is an n-dimensional vector of ones (n representing the number of countries, i.e. observations), α is the intercept, X is an $n \times k$ matrix of the k candidate explanatory variables, β is a k-dimensional vector of regression coefficients, ε is the error term and σ is a scale parameter.

BMA estimates regressions of the following type:

$$y = \alpha\iota_n + X_i\beta_i + \sigma\epsilon \tag{3}$$

where X_i is a certain combination of the candidate explanatory variables, denoted as model M_i, and β_i are the respective coefficients. There are 2^k such regressions.

BMA calculates the posterior probability distribution of any parameter of interest, θ, as:

$$p(\theta|y) = \sum_{i=1}^{2^k} p(\theta|M_i, y)p(M_i|y) \tag{4}$$

where i indexes the k possible models M. Equation (4) essentially states that the posterior distribution of a parameter ($p(\theta|y)$) is the weighted sum of its posterior distribution conditional on the assumption that the model M_i is the correct model ($p(\theta|M_i, y)$), where the weights are the corresponding normalized posterior model probabilities ($p(M_i|y)$).

The normalized posterior model probabilities ($p(M_i|y)$) are obtained according to the standard Bayesian formula:

$$p(M_i|y) = \frac{p(y|M_i)\overline{p}(M_i)}{\sum_{j=1}^{2^k} p(y|M_j)\overline{p}(M_j)} \tag{5}$$

which states that the standardized posterior model probability of a model M_i is the product of the marginal likelihood of the model ($p(y|M_i)$) and the model prior ($\overline{p}(M_i)$) (i.e. the posterior model probability of a model M_i), divided by the sum of the posterior model probabilities of all the 2^k models.

The marginal likelihood ($p(y|M_i)$) is again calculated according to the standard Bayesian formula:

$$p(y|M_i) = \int p(y|\alpha, \beta_i, \sigma, M_i)p(\alpha, \sigma)p(\beta_i|\alpha, \sigma, M_i)d\alpha d\beta_i d\sigma \tag{6}$$

where $p(y|\alpha, \beta_i, \sigma, M_i)$ is the model corresponding to Equation (3), and $p(\alpha, \sigma)$ and $p(\beta_i|\alpha, \sigma, M_i)$ are priors.

The application of BMA requires: 1) the setting of priors for the model parameters ($p(\alpha, \sigma)$ and $p(\beta_i|\alpha, \sigma, M_i)$); 2) the setting of priors for the models ($\overline{p}(M_i)$); and 3) the determination of how to choose from all the available 2^k models (since estimating all the $2^{23} = 8388\,608$ models would consume too much time).

For $p(\alpha, \sigma)$, as standard in the literature (see Fernandez, Ley and Steel (2001) and Masanjala and Papageorgiou (2008), for instance), we use an improper non-informative prior:

$$p(\alpha, \sigma) \propto \sigma^{-1}$$

Following the literature, again, we set $p(\beta_i|\alpha, \sigma, M_i)$ as k-dimensional Normal distribution:[4]

$$p(\beta_i|\alpha, \sigma, M_i) = N_k(\beta_i|0, \sigma^2 g(X_i'X_i)^{-1}) \tag{7}$$

4. The elements of β which do not appear in the model M_i are set to zero.

where N_k stands for the density function of a k-dimensional Normal distribution.

The parameter g controls the variance of the conditional distribution of the model parameters and, hence, affects the posterior model probabilities (i.e. the overall results). The choice of g can affect the results to a great extent, with high values of g giving more weight to the few best models, and low values of g spreading the weights among more models. Several proposals have been suggested in the literature for g. Kass and Wasserman (1995), for instance, suggest the unit information prior (UIP), which sets $g = n$ (n is the number of observations). Instead of being a fixed number, g can also be "flexible", i.e. data- and model- dependent. For instance, Hansen and Yu (2001) propose local empirical Bayes g, i.e. they propose setting a different g for each separate model on the grounds of the marginal likelihood of the model (i.e. so that it achieves the best fit). Similarly, Liang et al (2008) propose setting g as a hyperprior, i.e. as a probability distribution, not as a fixed number. They propose a distribution on g such that the shrinkage factor $g/(1-g)$ follows a Beta distribution:

$$\frac{g}{1-g} \sim Beta(1, \frac{a}{2} - 1) \tag{8}$$

where the parameter a controls the distribution of g, and hence the overall results. As suggested by Liang et al. (2008), we set $a = 2.1$.

The crucial difference between a fixed and a flexible g is that with a fixed g, BMA works in a model selection way: it tries to determine which model is more likely to have generated the data, i.e. it concentrates the posterior mass on the few best models, while with flexible priors the posterior mass is spread more evenly across different models (see Feldkircher and Zeugner (2009)). To avoid this super-model effect, our first choice would be the two flexible g priors mentioned above. For the sake of robustness, we will also use the fixed g UIP prior of Kass and Wasserman (1995).

Regarding the model prior $\overline{p}(M_i)$, we use three approaches. The first treats all possible models as equally possible, which results in $\overline{p}(M_i) = 2^{-k}$ (i.e. a uniform model prior). The second, proposed by Ley and Steel (2009), sets $\overline{p}(M_i) = \eta^{k_i}(1-\eta)^{k-k_i}$, where η is set as a Beta distribution:

$$\eta \sim Beta(1, \frac{k}{m} - 1) \tag{9}$$

determined by the parameter m, the expected model size, which we set to 10.[5]

The third option for the model prior is that suggested by George (1999):

$$\overline{p}(M_i) = |R_i|\eta^{k_i}(1-\eta)^{k-ki} \tag{10}$$

where $|R_i|$ is the determinant of the correlation matrix corresponding to model M_i, and $\eta = 1/2$ (as in the uniform prior). This prior penalizes models that exhibit a high degree of multicollinearity (the higher the correlation, the smaller the determinant), and is used in situations when multicollinearity may be a problem (see Durlauf, Kourtellos and Tan (2008), and Feldkircher (2012)).

The final thing that needs to be determined is how to choose which of the potential models to estimate. Even though in our case it is technically possible to estimate all the possible models, this would be highly inefficient.[6] Therefore, we approximate the posterior model probability $p(M_i|y)$ by the MC^3 methodology of Madigan and York (1995). This methodology adopts the Metropolis-Hastings algorithm to generate a sequence of random samples from all the possible models.

Inferences will be based on the weighted average of the posterior means of the candidate variables, and on the posterior inclusion probability (PIP). The PIP of a given variable is the sum of the posterior model probabilities of all models that include that variable. As standard in the literature, variables with a PIP higher than 0.5 will be considered significant.

V.B. Results and discussion

The results of BMA estimations are presented in Table 4.[7] The baseline results, shown in the column entitled 'Baseline', set g as a *hyperprior* (Liang et al. (2008)), use the *uniform*

5. In terms of this expression, the uniform prior is equivalent to $\eta = 1/2$.

6. Estimating all the 8388 608 models would take several hours. Since we repeat the estimation exercise nine times, the whole process would take several days.

7. The BMA estimation is applied using the BMS library in R, developed by Feldkircher and Zeugner (2009).

prior for the model prior, draw 50.000 models with 5.000 burn-ins, and calculate the parameters of interest on the grounds of the best 1.000 models. The following columns show the results when one of these variables is changed, with the change indicated in the column's title. The first sub-column of each column presents the weighted posterior mean, while the second sub-column presents the posterior inclusion probability.

The same group of variables appears to be significant in almost all of the estimations – labour force participation, pre-crisis trend in inequality, change in the control of corruption, stock exchange recovery, and inflation. More precisely, the reduction in the top-10-percent share of income after the crisis is stronger in countries with higher labour force participation, with faster average decline in the top-10-share before the crisis, with an improvement in the control of corruption, with smaller stock exchange recovery after the crisis, and with higher inflation.

Table 4: Determinants of the change in the top 10 percent share of income

Variables	Baseline		100.000 draws		10.000 burn-ins		100 best models		Expected model size = 10*		Multicollinearity prior**		Empirical Bayes prior*** g		UIP prior**** g	
	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP	Post. Mean	PIP
participation	**-0.09**	**1.00**	**-0.09**	**1.00**	**-0.08**	**1.00**	**-0.09**	**1.00**	**-0.08**	**0.96**	**-0.08**	**0.99**	**-0.09**	**1.00**	**-0.10**	**0.94**
trend_top10	**0.61**	**1.00**	**0.66**	**1.00**	**0.61**	**0.99**	**0.71**	**1.00**	**0.60**	**0.95**	**0.65**	**0.99**	**0.60**	**1.00**	**0.87**	**0.95**
Δcorruption	**-2.76**	**0.83**	**-2.81**	**0.84**	**-2.56**	**0.79**	**-2.95**	**0.87**	**-1.71**	**0.54**	**-1.96**	**0.64**	**-2.96**	**0.88**	-1.69	0.42
recovery_SE	**0.02**	**0.78**	**0.02**	**0.85**	**0.02**	**0.78**	**0.02**	**0.93**	**0.01**	**0.61**	**0.02**	**0.66**	**0.02**	**0.77**	**0.02**	**0.63**
inflation	**-0.14**	**0.73**	**-0.13**	**0.69**	**-0.13**	**0.67**	**-0.14**	**0.72**	-0.08	0.44	**-0.10**	**0.52**	**-0.15**	**0.77**	-0.07	0.30
ΔIR	-0.04	0.41	-0.03	0.33	-0.04	0.43	-0.03	0.32	-0.03	0.27	-0.03	0.31	-0.05	0.45	-0.03	0.17
openness	0.00	0.34	0.00	0.21	0.00	0.33	0.00	0.15	0.00	0.14	0.00	0.14	0.00	0.38	0.00	0.09
recovery_GDP	0.03	0.34	0.02	0.29	0.03	0.34	0.02	0.19	0.01	0.19	0.01	0.10	0.04	0.40	0.00	0.06
ΔM2	0.00	0.32	0.00	0.26	0.00	0.35	0.00	0.22	0.00	0.12	0.00	0.14	-0.01	0.42	0.00	0.07
fall_GDP	0.01	0.29	0.01	0.19	0.01	0.26	0.00	0.12	0.01	0.21	0.01	0.20	0.01	0.29	0.00	0.07
schooling	0.00	0.26	0.00	0.18	0.00	0.22	0.00	0.11	0.00	0.10	0.00	0.11	0.00	0.26	0.00	0.06
gov_size	0.01	0.25	0.01	0.20	0.02	0.30	0.00	0.07	0.01	0.13	0.00	0.08	0.02	0.27	0.00	0.08
Δbenefits	0.00	0.25	0.00	0.19	0.01	0.29	0.00	0.07	0.00	0.19	0.00	0.11	0.01	0.30	0.00	0.11
labour_reg	0.03	0.24	0.02	0.17	0.02	0.19	0.02	0.15	0.03	0.21	0.02	0.18	0.03	0.24	0.02	0.10
left	-0.07	0.23	-0.07	0.24	-0.05	0.18	-0.04	0.14	-0.04	0.14	-0.05	0.16	-0.06	0.20	-0.04	0.09
initial_top10	0.00	0.22	0.00	0.18	0.00	0.19	0.00	0.14	0.00	0.11	0.00	0.07	0.00	0.18	0.00	0.07
Δlabour_reg	0.10	0.19	0.10	0.19	0.13	0.27	0.04	0.10	0.23	0.33	0.17	0.27	0.10	0.24	0.24	0.24
corruption	0.03	0.18	0.02	0.11	0.03	0.16	0.02	0.12	0.02	0.13	0.01	0.07	0.04	0.25	0.01	0.07
GDP_pc	0.00	0.17	0.00	0.12	0.00	0.19	0.00	0.08	0.00	0.08	0.00	0.09	0.00	0.16	0.00	0.05
Δtax_top	0.00	0.16	0.00	0.14	0.00	0.18	0.00	0.13	0.00	0.11	0.00	0.15	0.00	0.18	0.00	0.05
fall_SE	0.00	0.15	0.00	0.17	0.00	0.15	0.00	0.01	0.00	0.09	0.00	0.05	0.00	0.20	0.00	0.05
tax_top	0.00	0.12	0.00	0.13	0.00	0.11	0.00	0.10	0.00	0.09	0.00	0.08	0.00	0.13	0.00	0.05
banking	0.00	0.11	0.00	0.10	0.00	0.13	0.00	0.11	0.00	0.12	0.00	0.07	0.00	0.15	0.00	0.07

Variables with PIP higher than 0.5 can be treated as significant. They are in bold.

* These results are obtained using the Ley and Steel (2009) model prior, with m=10.

** These results are obtained using the George (1999) model prior.

*** These results are obtained using the empirical local Bayes prior for the model parameters, suggested by Hansen and Yu (2001).

**** These results are obtained by setting g=n in the model parameter prior (the UIP prior of Kass and Wasserman, 1995)

The strength of the association of each of the variables is given in Table 5, which presents the change in the top-10-share associated with a one standard deviation change in the significant explanatory variables.[8] As can be seen, the associations are not negligible.

Table 5: Strength of the association

Variable	Posterior Mean	Standard deviation	Product	% of mean of the dependent variable (in abosolute terms)
participation	-0.09	6.70	-0.60	65
trend_top10	0.61	0.70	0.43	46
Δcorruption	-2.76	0.09	-0.25	27
recovery_SE	0.02	20.40	0.41	44
inflation	-0.14	2.10	-0.29	32

The finding that faster *stock exchange recovery* increases inequality is not surprising, since it is usually the more affluent who hold stocks. The finding that *improvement in the control of corruption* decreases inequality may be due to better allocation of both government transfers and, in general, resources in the economy with lower corruption. Several explanations can be offered for the finding that higher *labour force participation* is associated with a lower increase in inequality. First, the crisis of 2007-2008 was primarily a financial crisis, and the shock to labour was only indirect. Furthermore, countries with higher participation rates are likely to have lower unemployment, and unemployment benefits may have been cut during or after the crisis. Finally, countries with higher participation may have experienced an increase in participation before the crisis, due to favorable shocks to certain sectors (i.e. manufacturing). If these positive shocks have continued after the crisis, this may have resulted in an increase in wages as a share of income and a decline in inequality. The *pre-crisis trend in inequality* is included only to control for various possibly omitted factors, so does not deserve greater explanation.

The finding that higher inflation is associated with a stronger decline in inequality may come as a surprise. The positive correlation between inequality and inflation is a relationship fairly well-established in the literature (Beetsma and van der Ploeg (1996), Dolmas,

8. The descriptive statistics of the variables is presented in Table 7 in the Appendix.

Huffman and Wynne (2000), Easterly and Fischer (2001), Bulir (2001), Albanesi (2007), Crowe (2006)). However, this correlation between inequality and inflation is about the level of inequality, not about the change in inequality, as in this study. In addition, the positive correlation between inflation and inequality does not necessarily mean that higher inflation causes higher inequality. There may be a third factor that leads to both higher inflation and higher inequality, such as government capability. Higher inequality may also cause higher inflation, for political reasons. As Beetsma and van der Ploeg (1996) argue, in democratic societies with high inequality, the median voter would prefer pro-poor policies, i.e. policies that redistribute income from the rich to the poor. Unanticipated inflation may be one of those policies, which would imply that higher inequality may result in higher inflation. A similar mechanism is proposed by Dolmas, Huffman and Wynne (2000), who argue that with higher inequality, the median voter prefers higher inflation as a way of financing higher government expenditures. Crowe (2006) and Albanesi (2007) also provide models in which higher inequality leads to higher inflation, although for different reasons. In their models, greater income inequality leads to greater inequality in political influence, with the rich having greater political power. If the rich perceive that inflation will favour them, because the inflation tax may hurt the poor disproportionately more, they may push for inflationary policies.

The literature identifies several channels through which inflation may affect inequality (see Kane and Morisett (1993), Crowe (2006), Doepke and Schneider (2006)). The first channel is through the different indexation of lower and higher wages. Lower-income individuals are usually considered to have less power for bargaining wage indexation, as a result of which, they will be hurt more by inflation. The second channel is through the different access to inflation-hedged assets. The poor, usually keep more of their assets in cash, while the rich hold more of their assets in inflation-proof products, resulting in the burden of inflation tax falling disproportionately on the poor. The third channel is through the allocation of subsidized loans, i.e. loans with low and fixed interest rates, which are disproportionately allocated to the poor, which would make them benefit from higher inflation. The fourth channel is through the redistribution from lenders (i.e. the rich) to borrowers (i.e. the poor), when the inflation is unanticipated, which would make the poor benefit from higher inflation. The fifth channel is through government expenditure. At moderate levels, inflation may serve as a windfall for the government, due to the erosion of public debt,

which may lead to higher social transfers, benefiting the poor. At higher levels, however, inflation may reduce real government spending, because of decreasing government revenues due to time lags in collection (the Olivera-Tanzi effect). This effect is likely to benefit the net taxpayers (i.e. the rich).

The issue of how inflation affects income inequality, then, boils down to which of these channels is likely to dominate in a given situation. Bach and Stephenson (1974) find that inflation in the US in 1946-1971 has shifted income from business profits to wages and salaries, and from lenders to borrowers, and, hence, has affected equality favorably. Cardoso (1992), Kane and Morisett (1993), Easterly and Fischer (2001), Erosa and Ventura (2002), on the other hands, find that inflation increases inequality, through the inflation tax, which is a regressive form of tax that hits the poor and middle class hardest, or through wage erosion of the poor.

Therefore, the finding that higher inflation after the global financial crisis has been associated with a stronger decline in inequality can be explained in several ways: the wage erosion channel for low-income workers may have been less effective, due to stronger trade unions in countries with higher inflation, which have pushed for indexation; 2) inclusive financial development may have enabled even low-income individuals to have access to inflation-proof assets; 3) inflation in 2010-2011 may have been unanticipated, and has redistributed income from lenders to borrowers; 4) the levels of inflation during 2010-2011 have been lower than the inflation from the '80s and '90s to which Cardoso (1992), Kane and Morisett (1993), Easterly and Fischer (2001), Erosa and Ventura (2002) refer. As Bulir (2001) argues, inequality falls when inflation is reduced from hyperinflation to moderate levels, but not as much when it is reduced from moderate to very low levels; 5) there may be an omitted variable leading both to inflation and to a decline in the top-10-share, such as productivity growth. As Dew-Becker and Gordon (2005) argue, recent growth in productivity, which lowers inflation, has been skewed towards top-income individuals. A slowdown in productivity growth may, therefore, lead at the same time to a rise in inflation and to more equal distribution. We leave the assessment of the relative merit of these alternative explanations to future research. It should also be noted that Coibion et al. (2012) have also recently argued that higher inflation is likely to lead to lower inequality in the U.S.

One intuitive way to illustrate the importance of the variables in explaining developments in inequality is through a comparison of certain groups of countries. We will compare

the largest economies in the sample (the U.S., Germany, the U.K., France) that experienced an increase in the top-10-share, by 1.2 percentage points on average, with the Latin American countries (Argentina, Colombia, Dominican Republic, Ecuador, Paraguay, Peru, and Uruguay), where the top-10-share declined, by 2.4 percentage points on average. The comparison is shown in Table 6. The factors to which most of the difference can be associated is labour participation: Latin American countries have a higher participation rate than the largest countries by approximately 7 percentage points, which contributes with 0.7 percentage points to the difference in the change in the top-10-share between the two groups. The second most important variable appears to be inflation, which contributes with 0.4 percentage points to the difference in the inequality change between the two groups of countries.

Table 6: Contributions to differences in change in inequality after the crisis between the big economies and Latin America

Variable	Posterior Mean	Value of variable for the big economies	Value of the variable for the Latin American economies	Contribution to difference
participation	-0.09	60.40	67.7	-0.66
trend_top10	0.61	0.11	-0.46	-0.35
Δcorruption	-2.76	0.00	0.02	-0.06
recovery_SE	0.02	19.20	10	-0.18
inflation	-0.14	2.50	5.1	-0.36

It is also worthwhile noting which of the potential determinants do not appear to be significantly associated with the change in inequality after the crisis. Some of the policy measures that are usually considered effective in alleviating inequality, such as increases in the top marginal tax rate and social benefits, turn out in our analysis to be insignificant. Changes in labour market regulations, as well as monetary policy measures, also appear to be insignificant. This may also be due to insufficient variability in the data.

The results would imply that, in order to prevent rising inequality during crises, governments should try to decrease corruption, encourage labour force participation, and become more tolerant towards inflation. One needs to be cautious with policy implications, though, due to potential problems with endogeneity in the econometric analysis, which make the

findings difficult to interpret in a causal way.

VI. Conclusion

This paper surveys developments in the change in the top 10 percent share of income after the global financial crisis in 42 developed and developing countries, and tries to provide some insights about the factors that may have caused these changes, with the purpose of initiating further research on the issue. The top-10-share declined in most (20) of the countries analyzed, remained materially the same after the crisis as before it in 16 countries, and increased in 6. This should not be interpreted, however, as an indication that the crisis led to a decline in inequality. The developments after the crisis are to a large extent a continuation of the underlying developments in inequality that were present in these countries prior to the crisis, as two-thirds of the countries that noted a decline after the crisis were already on a downward trend before the crisis, and 60 percent of the countries experienced same movement after the crisis as the pre-crisis trend. On the other hand, half of the countries that noted an increase in inequality after the crisis were either declining or stagnating before the crisis. Hence, the allegedly fundamental cause of the crisis, according to Stiglitz (2009), Milanovic (2009), Wade (2009), Fitoussi and Saraceno (2010) and Rajan (2010), rising inequality, is still present in the world economy.

A Bayesian model averaging analysis suggests that the factors that are most likely to be associated with the change in inequality after the crisis are the pre-crisis trend, labour force participation rate, improvement in the control of corruption, stock exchange recovery, and the inflation. More precisely, the reduction in the top-10-percent share of income after the crisis is likely to be higher in countries with faster average decline in the top-10-share before the crisis, with higher labour force participation, stronger improvement in the control of corruption, slower stock exchange recovery and higher inflation. The associations are strongest for labour force participation and the inflation. Some policy measures that are usually considered to be effective in alleviating inequality, such as increases in the top marginal tax rate and social benefits, as well as changes in labour market regulations or monetary policy measures, turn out to be insignificant in our analysis,. Further analysis is required in order to determine whether these associations can be interpreted as causal, and to derive policy recommendations.

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VII. Appendix

Table 7: Descriptive statistics of the variables

	Δtop10	trend_top10	fall_GDP	recovery_GDP	fall_SE	recovery_SE	Δbenefits	tax_top
mean	-0.94	-0.13	-4.83	2.75	-49.70	9.22	1.07	47.64
sd	1.68	0.70	4.01	3.61	42.24	20.41	7.56	10.40
min	-4.43	-1.32	-17.55	-6.11	-202.26	-19.86	-28.41	20.00
max	3.43	2.20	2.08	12.75	-0.18	70.28	29.17	69.50
p25	-1.97	-0.65	-6.06	0.50	-65.51	-1.99	-1.27	41.00
p75	0.13	0.27	-3.00	4.36	-19.01	19.27	3.60	54.00
N	42	41	42	42	39	40	39	42

	Δtax_top	labour_reg	Δlabour_reg	gov_size	corruption	Δcorruption	ΔIR	ΔM2
mean	0.80	6.58	-0.03	19.08	0.91	-0.01	-2.24	-4.12
sd	4.54	1.24	0.33	4.76	1.02	0.09	2.91	19.39
min	-12.00	4.31	-0.80	7.51	-0.89	-0.25	-12.69	-105.49
max	19.00	9.03	1.18	28.65	2.38	0.19	3.07	26.65
p25	0.00	5.69	-0.16	16.40	-0.03	-0.06	-2.72	-7.75
p75	1.00	7.53	0.10	21.34	1.69	0.06	-0.65	3.18
N	42	42	42	42	42	42	41	42

	banking	openness	GDP_pc	schooling	participation	top10_initial	inflation
mean	109.09	106.90	25211.90	101.02	60.85	28.94	3.06
sd	73.41	71.65	13567.62	11.94	6.73	7.59	2.07
min	15.83	29.18	2793.38	67.86	41.00	19.77	-0.95
max	308.95	385.92	68569.03	124.72	76.00	45.37	10.78
p25	46.53	56.56	14362.62	95.20	57.10	22.77	1.83
p75	154.93	136.92	33147.13	109.10	64.80	35.12	3.88
N	42	42	42	39	42	42	42