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The Effects of Financial Crises on Income Inequality: Evidence in the Long Run of History

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Abstract

Using a panel of 24 countries, this paper empirically examines the long-run relationship between financial crises and income inequality. Financial crises are subdivided into banking crises, currency crises and twin crises. The time period covered is separated into three sub-periods: the pre-World War 1 period (1880–1913); the Interwar period (1920–1939); and the post-World War 2 period (1950–2012). Banking crises and twin crises have an increasing effect on income inequality in the pre-World War 1 and post-World War 2 periods, but are associated with narrowing income inequality in the Interwar period. Currency crises increase inequality in the first two periods under analysis, but decrease top incomes in the years 1950-2012. In addition, evidence is supporting the theoretically proposed mechanisms (the availability of credit to the corporate sector, the price of household credit and the terms of trade) through which banking and currency crises affect the income distribution.

1: Introduction

Although the relationship between income inequality and economic growth has always been an important topic in economics, Thomas Piketty's (2014) book 'Capital in the Twenty-First Century' brought a revival of this issue into the public debate. With his conclusion that wealth is increasingly concentrated in the hands of the rich, inequality was cemented as a pivotal topic in the economic community. This was further spurred by the aftermath of the most recent Global Financial Crisis of 2008, whose effects are still being felt in many countries. In today's economic environment, the question how financial crises affect income inequality is more relevant than ever before. Yet, no consensus on the relationship between financial crises and income inequality exists. In fact, most studies that touched upon this topic focused on the opposite causality: how does income inequality affect financial crises.

One of the most recent studies that examined the crisis-inequality relationship is the research of Roine, Vlachos and Waldenström (2009). They concluded that banking crises have a decreasing effect on income inequality, but they do not examine alternative crises types. Still, Roine et. al.'s study serves as an important fundament for this paper and parts of its methodology are used in the current analysis. More generally, the aftermath of currency crises has often been linked to increasing income inequality, whereas for banking crises the evidence remains inconclusive. When examining the impact of financial crises on inequality, empirical problems often arise. The effects must be evaluated over a longer time period, but data is usually only available for short time periods. Therefore, the lack of historical and systematic research is an important deficiency in the literature on the impact of financial crises on income inequality.

This paper examines empirically the long-term relationship between financial crises and income inequality, where financial crises are subdivided into banking crises, currency crises and twin crises. As these crisis types influence income inequality through different mechanisms, their effects might vary as well, making it crucial to distinguish between them. In addition, this research aims to test whether these mechanisms as proposed by theory hold in an empirical setting. Previous studies often focused on just one crisis episode. The unique contribution of this study is its long time period covered. This is achieved by using a panel of 24 countries for the period 1880–2012, divided into three sub-periods: the pre-World War 1 period (1880–1913); the Interwar period (1920–1939); and the post-World War 2 period (1950–2012). The empirical analysis examines how changes in income inequality measures are related to the outbreak of financial crises. Long run data on income inequality is retrieved from the World Wealth and Income Database for the Interwar and post-World War 2 periods,

where the share of top 1 percent of incomes serves as inequality proxy. For the pre-1950 years, the unskilled wages to GDP ratio represents income inequality.

Several conclusions can be drawn from this research. First, banking crises and twin crises are associated with an increase in income inequality in the pre-World War 1 and post-World War 2 period, but had a decreasing effect on income inequality in the Interwar period. Nominal wage rigidities combined with increased top income taxes are important factors in explaining the decrease in income inequality following banking and twin crises in the years 1920-1939. Results on currency crises indicate that they increase income inequality in the post-World War 1 and Interwar periods, but tend to narrow inequality in the years 1950-2012. However, when accompanied with an economic recession in the post-World War 2 period, currency crises are associated with an increasing effect on top incomes.

The empirical analysis on the mechanisms through which financial crises affect income inequality is in line with the corresponding theory. As predicted from theory, the price of household credit was found to increase top incomes when added to the regression equation specified for banking crises. The result that a decrease in the availability of credit to the corporate sector during episodes of banking crises increased income inequality was found to be statistically insignificant. In addition, according to the theory on the mechanisms of currency crises impacting income inequality, the terms of trade effects caused by currency crises lowered the real income of laborers, such that lower income classes are disproportionally affected by severe currency shocks. For all three periods under analysis, the regression results provide evidence supporting this theoretical framework for currency crises.

This paper proceeds as follow. Chapter 2 reviews previous literature on the effects of banking crises and currency crises on income inequality. Next, the definitions of the three crises types under analysis and their mechanisms through which they affect inequality are discussed in Chapter 3. Chapter 4 and 5 analyze the data (including a graphical analysis of country-level data) and introduce the methodology used in this paper. Finally, the empirical results are reported and discussed.

Chapter 2: Literature review

Bordo, Eichengreen, Klingebiel and Martinez-Peria (2000) concluded in their study on developments in the crisis problem over the last 120 years that banking crises, currency crises and twin crises occurred more frequent over time, although they did not become more severe. At the same time, top incomes in the United States have risen gradually since the beginning of the 1980s (Piketty & Saez, 2003). The suggested causal relationship between the incidence of

crises and the increase in income inequality has intrigued economists for many years. Both the earlier wave of financial crises in the 1970s and the recent Global Financial Crisis (GFC) have triggered a spark of academic literature on the impact of financial crises on the distribution of income. This section reviews the existing literature on the effect of banking- and currency crises on income inequality.

2.1: Banking crises

Williamson and Lindert (1980) were among the first to examine the crisis-inequality relationship. Their study focused on the long-term relationship between economic growth and income distribution in the United States, and they concluded that the Great Depression banking crisis period is associated with a decrease in income inequality. This is in line with Piketty and Saez's (2003) study on top incomes, which reported a fall in the income of the top percentile during the Great Depression years. Two factors are important in explaining the equality enhancing effect of the Great Depression. First, capital owners constitute a large part of the top incomes. During the Great Depression, many businesses were destroyed, and capital incomes (and thus top shares) were more severely affected than labor income. Second, the Roosevelt administration substantially increased the top rates of the income tax in this period, from 20 percent to 55 percent (Piketty & Saez, 2003). As a result, income inequality was reduced significantly during the Great Depression years.

Often comparisons are made between the Great Recession and its "Great" predecessor, the Great Depression. Yet interestingly, they differ in the direction of the link between banking crises and inequality: where the Great Depression had a decreasing effect on inequality, studies on the GFC so far find evidence supporting higher income inequality following this crisis. This partly reflects the inconclusiveness of the literature on the effects of banking crisis on income inequality. Freeman (2010) concluded that between 2007 and 2009, the bottom decile in the United States showed the smallest increase in hourly wages, compared to the top decile, which experienced the largest increase.

In line with Freeman's conclusions on the effect of inequality during the GFC, Piketty and Saez (2013), who based their inequality analysis on the World Top Incomes Database, found that the GFC did not reverse the long run trend of rising top incomes: with 46.3 percent, top decile shares were higher in 2010 compared to the pre-GFC period in the United States.

The increase in inequality that accompanied the GFC is partially the result of government interventions: after large drops in share prices following the onset of the GFC,

government bailouts and fiscal stimulus reversed this trend and led to an increase in the prices of shares from 2010 onwards. As a consequence, the incomes of the higher income groups were stabilized. In addition, adverse outcomes of the GFC, including increased debt to GDP ratios, unemployment and production losses, directly caused harm to the real economy. This burden of the GFC is predominantly born by the working class people, inducing increased levels of inequality following the most recent banking crisis (Freeman, 2010).

Atkinson and Morelli (2011) studied the distributional effects of banking crises by analyzing both historical and recent inequality trends. Of the 25 analyzed banking crises in the period 1911-2010, 9 crises had a decreasing effect on inequality, whereas 10 episodes of banking crises increased inequality compared to the pre-crisis inequality situation. For 6 cases, no change in inequality was observed. Due to this contradicting evidence, the authors were unable to find a clear pattern of the impact of systemic banking crises on income inequality. Honohan's (2005) cross-sectional study, on the other hand, did generate conclusive results. By comparing Gini coefficients shortly before and after the onset of a banking crisis, an average decline in the Gini coefficient was found. This evidence is illustrated by World Bank case studies on Indonesia, Mexico, Russia and Africa, who all experienced a drop in income inequality following the occurrence of banking crises.

These results were confirmed by a similar cross-country study from Lopez (2003), who used non-overlapping five-year averages to study 133 episodes of banking crises in the period 1960-2000. Lopez found that crises are associated with a decline in income inequality. He explains this by the negative effect that economic downturns have on the demand for tertiary workers, whereas the demand for the middle-income workers stays relative constant. It is important to note that as per capita income is likely to fall during crises episodes, it is very likely for the poorest to be worse off despite the observed distributional consequences that follow banking crises.

A more recent study on the impact of banking crises on the distribution of income was conducted by Roine, Vlachos and Waldenström (2009), who used data on banking crises in the 20th century to estimate its effect on top incomes. They observed a negative effect of banking crises on top incomes: a banking crises would permanently decrease the share of the top 1 percent by 0.2 percentage points for each year of the crisis. However, no significant effect was found for the incomes of the upper middle class, defined as the top 90 to 99 percent of incomes.

2.2: Currency crises

Compared to the ambiguous results that different studies on the effect of banking crises on income inequality produced, academic studies on the currency crises–inequality relationship appears to be more consistent in their conclusions. Galbraith and Jiaqing (1999) matched Kaminsky and Reinhart's (1996) dataset on currency crises with UTIP data on inequality of industrial earnings to analyze the effect of 34 currency crises in the period 1970-1995. Their results showed that the mean increase in inequality following a crisis was significantly higher compared to changes in inequality in non-crisis years.

Multiple studies were devoted to the currency crises that hit Latin America, and their effects on income inequality. Lustig (2000) analyzed this topic by comparing the Gini coefficient before, during and after the onset of a crisis in Latin American countries in the 1980s. A higher Gini coefficient was found for 5 out of 8 cases during the crisis, and 15 out of 20 episodes showed higher inequality measured after the occurrence of a currency crisis compared to the pre-crisis Gini coefficient. Interestingly, the study concluded that this deterioration in the distribution of income was mostly due to the middle incomes that were hit disproportionally, not the poorest quintile. This was accompanied by an (sometimes substantial) increase in the top 10 percent of incomes. Gasparini and Lustig (2011) covered the Latin American series of currency crises in both the 1980s and 1990s and concluded that for a majority of the countries, the increase in income inequality was associated with macroeconomic crises.

Fallon and Lucas (2002) not only focused on Latin America in the 1990s, but also included the East Asian crises in this period, which enabled them to compare the impact of two large waves of currency crises on income inequality. Whereas Latin America clearly showed substantial increases in inequality following the 1990s currency crises, East Asia appeared to have experienced only minor changes in its distribution of income. The authors attribute these different inequality effects to differences in the structure of lower-income and middle-income countries: the latter tends to be characterized by greater formal sector wage rigidity, leading to higher levels of unemployment during crises periods, which exacerbates inequality.

Baldacci, de Mello and Inchauste (2002) analyzed the link between currency crashes and income inequality using macro level data. A difference-in-difference panel regression analysis concluded that a currency crash was followed by an increase in income inequality, mainly due to the large income losses suffered by the second lowest income quintile. Their results are robust to the use of the Gini coefficient as an alternative inequality measure, which

was found to be increasing following currency crises. This effect on inequality was found to be stronger if currency crises are accompanied with a fall in average income. In addition, deteriorating terms of trade, tightening fiscal policy and rising levels of inflation strengthen the impact of currency crashes on inequality.

The impact of twin crises on income inequality has not yet been the topic of a research study. Since the abovementioned studies all focus on different episodes of crises, use different definitions of banking and currency crises, and base their results on various measures of inequality, it is difficult to achieve a common consensus on the relationship between financial crises and income inequality. Evidence is highly conflicting, especially for the link between banking crises and income inequality. However, for all three types of crises it is important to estimate an overall effect that covers as many historical episodes as possible, such that a general impact can be concluded. This paper aims to provide a consistent framework for previous inconsistent conclusions, and to develop a clear systemic relationship between banking crises, currency crises, twin crises and income inequality.

Chapter 3: Crises and mechanisms

In general, financial crises can be defined as episodes of financial-market volatility characterized by disturbing problems of illiquidity and insolvency, or when government intervention aimed to contain these illiquidity and insolvency problems is taking place. Both definitions can also occur simultaneously, and such an event also qualifies as a financial crisis (Bordo & Meissner, 2016). This paper distinguishes between 3 types of financial crises, which will be defined below: banking crises, currency crises and twin crises. Next to defining the 3 different financial crises under analysis, this section describes the main mechanisms through which banking crises, currency crises and twin crises influence income inequality. This paper will examine whether these proposed mechanisms hold empirically.

3.1: Banking crises

For an episode to be classified as banking crisis, significant signs of financial distress in the banking system should be present. This can take the form of bank runs, losses in the banking system or liquidations of banks (Laeven & Valencia, 2012). According to Laeven and Valencia (2008), episodes of banking crises are mostly triggered by the distress of systemically important financial institutions. The problems of individual institutions are easily spread to the whole banking system. In addition, the fragile nature of banks makes them

sensitive to runs of depositors (Claessens & Kose, 2013). Banking crises are often characterized by systemic panics, widespread failures and/or the exhaustion of the banking system capital. As restructuring and other intervention measures cannot be implemented immediately, banking crises usually last multiple years (Bordo & Meissner, 2012).

The study of Brown (2013) concluded that middle income households were hit disproportionally compared to high-income families during the most recent episode of a banking crisis (between 2008 and 2012), and identified two channels through which this increase in income inequality takes place. The first and primary channel through which banking crises affect the distribution of household income is the labor market. When the banking system is under large pressure, the availability of credit to the corporate sector is reduced significantly (also referred to as credit crunch). As a result, production and investment is reduced, leading to a decrease in both employment and the wage level (Brown, 2013). The combination of wage drop, which mostly hits the lower income households, with the maintenance of business incomes can lead to increasing inequality during periods characterized by banking crises, as this increases the gap between the lower and higher income households (Calvo, 2013).

The next proposed transmission mechanism of banking crises to income distribution is the financial market channel (Brown, 2013). The availability and price of financial services affects the abilities of individuals to smooth their consumption over time and to absorb adverse income shocks. During times of financial distress, banks are likely to reduce the volume and increase the price of household credit (Attansio & Weber, 2010). People with lower levels of initial wealth are less capable to insure themselves against the effects of banking crises, and are therefore expected to disproportionally bear the economic costs of these episodes. Thus, where empirical research found mixed evidence on the effect on banking crises on income inequality, theoretical literature suggests an increasing impact.

3.2: Currency crises

A speculative attack on the currency that results in devaluation or a sharp depreciation, or a situation where the threat of such a speculative attack has become so large that authorities are forced to defend their currency, can be classified as a currency crisis. Often, an inconsistency between the domestic fundamentals and the (pegged) currency is initiating the speculative attack.

The main channel through which currency crises can have an increasing effect on inequality is the product market. A large depreciation of the local currency increases the relative price of imported goods and domestic tradable goods. The increase in the price of imported goods mainly affects the middle-income households, as these imported goods comprise in particular durable consumption goods (Brown, 2013). As domestically produced tradable goods concern staple goods, their price increase is expected to impact the lower incomes as well (Fallon & Lucas, 2002). In short, the terms of trade effects caused by currency crises lower the real income of laborers, such that lower income classes are disproportionally affected by severe currency shocks. Supply side effects may account for an additional increase in income inequality due to currency crises. As resources are allocated toward the tradable sector, the non-tradable sector experiences a decreased demand for labor, causing unemployment and declining real wages (Agénor, 2002).

3.3: Twin crises

Twin crises occur when currency crises and banking crises overlap, which tends to happen quite frequently. Especially when countries have implemented a system of fixed exchange rates, financial crises often develop into twin crises. In this situation, currency depreciations intensify the problems that the banking sector is facing through the exposure of borrowers and banks to foreign currency (Laeven & Valencia, 2008). Thus, currency crises tend to trigger financial distress, resulting in a twin crisis. However, the causality often runs the other way as well, as banking crises can lead to capital flights by foreign depositors, which causes uncontrollable pressure on the currency (Bordo & Meissner, 2016). Kaminsky and Reinhart (1999) studied twin crises in the period 1970-1995, and found that problems in the banking sector often precede currency crises. Subsequently, the outbreak of a currency crisis intensifies the problems in the banking system, resulting in a vicious circle. Furthermore, twin crises are far more severe than the occurrence of banking and currency crises in isolation.

When banking and currency crises occur simultaneously, distributional consequences may result through a substantial increase in financial liabilities. A depreciation of the local currency in times where the banking system is under severe pressure results in an increase of the local currency equivalent of loans (Dvorksy, Scheiber & Stix, 2010). As a large fraction of household loans and deposits are denominated in foreign currency, individuals may experience a reduction in net wealth during twin crises periods. Inequality effects arise through this channel, as lower- and middle-income households are more likely to hold loans.

The lower income classes are thus confronted with a sharp increase in their liabilities, hence a decrease in their wealth (Brown, 2013).

Chapter 4: Data analysis

4.1: Data description

This section describes the main data sources and adjustments of the variables used in the empirical analysis. In order to identify systemic relationships between income inequality and financial crises, a cross-country dataset for 24 countries in the period 1880–2012 is used.[1] The data are transformed to five-year cumulative averages; this and other adjustments are discussed further in chapter 5. One of the main strengths of this research is the large period of time covered by this data set. However, due to the large time span over which data is used, the control variables are retrieved from different sources. This makes it impossible to run a regression over the entire period. Therefore, the dataset is divided into three subsets: the pre-World War 1 period (1880–1913); the Interwar period (1920–1939); and the post-World War 2 period (1950–2012). Both World Wars are excluded from the dataset as data for these periods can severely bias the results.

4.1.1: Income inequality

Two proxies are used to represent income inequality. For the Interwar and post-World War 2 period, the share of total income earned by the top 1 percent of individuals is utilized as a measure of income inequality. The data for the top 1 percent income shares are retrieved from the World Wealth and Income Database (before: World Top Incomes Database), which is the largest historical inequality dataset available. Long run top income share time series were calculated from income tax data combined with national accounts, where the latter represent aggregate incomes. Income is defined as labor, business and capital income. The advantage of exploiting this dataset is that the sources of computation are available for a long time period, on an annual basis and for a large number of countries. In addition, tax data tend to suffer less from sampling and self-reporting biases than household survey data (Piketty & Saez, 2013). As argued by Atkinson, Piketty and Saez (2011), Gini coefficients are very sensitive to changes in top incomes, because top incomes represent such a significant share of total income. Moreover, calculations of Gini coefficients differ across countries, as their measure can be either income or consumption based. However, using top incomes rather than Gini

[1]Some countries are only included for the period 1950-2012. A list of the countries and corresponding time and crises periods is included in the appendix.

coefficients as an inequality proxy comes with disadvantages as well, as this measure only focusses on one side of the income distribution. Due to its wide availability and reliable calculation, top incomes are nevertheless preferred as a dependent variable for this research. Data on top 10 and top 5 percent income shares, available from the same source as top 1 shares, are used for robustness checks.

The second measure of income inequality is based on the work of Williamson (2002), who makes use of changes in the ratio of unskilled wages to GDP per capita. This alternative income inequality indicator is used for all pre 1950 data, covering the periods 1919-1930 and 1880-1913. Unskilled wage to GDP ratios are favored to top incomes as a measure of inequality for this timeframe, as tax income data suffer from limited and reduced reliability in the pre-1950 period. Williamson (2002) compiled the data on unskilled wages; historical data on GDP per capita are available from The Maddison Project (2013). Because the wages were reported as nominal wage rates with 1913 as base year, the GDP per capita data were transformed to nominal values relative to 1913 as well. Based on these converted data, the unskilled wages to GDP per capita ratio was calculated. It should be noted that, contrary to the data on top incomes, the ratio of unskilled wages to GDP represents the lowest part of the income distribution.

4.1.2: Financial Crises

As the primary source on episodes of financial crises, this paper relies on the research of Bordo, Eichengreen, Klingebiel and Martinez-Peria (2001), whose dataset spans 120 years of financial history. They define banking crises as a situation of severe financial distress, which results in the deterioration of most or all of the banking system's capital. An episode qualifies as a currency crisis when either a forced change in parity, the abandonment of a pegged exchange rate or an international rescue occurs. In addition, when there is a substantial pressure on the exchange rate market, a currency crisis is indicated if this pressure exceeds a certain threshold. Lastly, twin crises are identified as periods where banking crises and currency crises occur simultaneously, or when currency crises precede or follow episodes of banking crises by a maximum of two years. The financial crises variables are dummy variables, which take the value of 1 when a crisis occurred that year.

In addition to the dataset from Bordo et. al. (2001) that this research is using, financial crises data constructed by Reinhart and Rogoff (2010) is a second widely used dataset on the

long run incidence of crises.[2] However, the definitions of banking crises, currency crises and twin crises differ substantially between the two publications. Reinhart and Rogoff (2010) use bank runs as determinant of banking crises episodes: they classify a period as a banking crisis when either bank runs occur that lead to the closure of one or more of the financial institutions or require significant interventions; or, in the absence of bank runs, when large-scale government assistance of an important financial institution takes place. As the failure of only one bank is required for the outbreak of a banking crisis according to Reinhart and Rogoff (2010), they are likely to overestimate the number of banking crises that have occurred. Currency crises are defined in the Reinhart and Rogoff's (2010) dataset as a nominal depreciation of 25 percent or more, which again differs from Bordo et. al. (2001), although the difference in banking crises definitions is expected to have larger consequences. Nevertheless, this research exploits the alternative crises dataset as a robustness check for the main results based on the data from Bordo et. al. (2001).

As this paper also covers the most recent episodes of crises, it complements the dataset of Bordo et. al. (2001) with research on the systemic financial crises of Laeven and Valencia (2012) for the years 2000-2012. It should be noted that this dataset has been criticized for ignoring some important historical episodes of currency crises; however, the recent nature of Laeven and Valencia's (2012) research proved beneficial for this paper.

4.1.3: Control variables

Apart from the main variables of interest – income inequality and the three types of financial crises: banking, currency and twin crises – the regression equation consists of multiple control variables. This paper bases the inclusion of control variables on the work of Roine et. al. (2009). Due to differences in relevance and availability of variables over time, the set of control variables differs for the three time periods under analysis. All variables and their sources are summarized in table 1. The correlation matrix, which is included in the appendix, demonstrates that the independent variables are suited for the regression.

For the most recent period (1950-2012), three control variables supplementing the standard regression equation are identified: GDP per capita, openness to trade and central government expenditure. According to evidence presented by Roine et. al. (2009), all control variables except openness are expected to be positively correlated to income inequality. Data on GDP per capita, one of the most obvious determinants of inequality, is retrieved from the

[2] Taylor (2015) published a database on systemic financial crises, but this is more focused on banking crises.

Total Economy Database. To quantify trade openness, the traditional measure of the sum of imports and exports as a percentage of GDP is used. Data on this metric is available from International Financial Statistics. Alternatively, data on tariffs could serve as an openness proxy, but since their measurement and interpretation is rather complex, this paper opts for the trade to GDP ratio instead. Lastly, central government expenditure accounts for the activity and growth of countries' governments, and is measured by the central government expenditure as a share of GDP. The source of data on this variable is The World Bank.

For the pre-1950 examination, only GDP per capita and openness are included as set of controls. Historical data on GDP per capita are obtained from The Maddison Project (2013). The Bilateral Trade Dataset has been an important source for retrieving both historical terms of trade and openness data. Openness was calculated by dividing the total trade values by GDP data retrieved from The Maddison Project (2013). As government expenditure only makes up a small amount of total output, this variable becomes highly irrelevant for the pre-World War 1 and Interwar periods.

4.1.4: Testing for mechanisms

This paper aims at examining the channels through which financial crises affect income inequality, based on theoretical predictions that are described in chapter 3. Unfortunately, it was not feasible to translate the proposed channel for twin crises into data. Therefore, it will be empirically analyzed whether the theory on the mechanisms through which banking and currency crises are expected to influence income inequality holds. To this end, three extra variables are added to the regression equation. First, when examining the distributional consequences of banking crises, domestic credit provided by the financial sector as percentage of GDP will serve as a proxy for the availability of corporate credit. This includes all credit to various sectors (excluding the central government) on a gross basis. Second, the mechanism of changes in the price of household credit will be captured by the lending interest rate. Data on domestic credit provided and the lending rate is available from The World Bank. Unfortunately, both proxies for the mechanisms of banking crises are only available from 1960 onwards; therefore, only the Post-World War 2 period will be analyzed for the empirical validity of these banking crisis channels.

As described in chapter 3, changes in the terms of trade constitute the major channel through which currency crises affect the income distribution. Therefore, this variable and its interaction term with currency crises will be added to the regression equation to test whether the proposed mechanism of currency crises to inequality is empirically valid. The variable

terms of trade is defined as the ratio of export prices to import prices. Because of the Bilateral Trade Dataset (Barbiery & Keshk, 2012), which is the source of terms of trade data for the pre-1950 years, this mechanism of currency crises to inequality can be examined for all three periods under analysis. For the Post-World War 2 period, data are retrieved from International Financial Statistics.

Table 1: Variable definitions

Variable	Definition	Source
Top 1 incomes (1919 – 2012)	Share of total income earned by those with the 1% highest incomes	World Wealth and Income Database
Wage to GDP ratio (pre 1950)	Ratio of unskilled wages to GDP per capita	Williamson; The Maddison Project
Banking Crisis	Deterioration of most or all of the banking system's capital	Bordo et. al.; Laeven & Valencia
Currency Crisis	Forced change parity; abandonment of pegged exchange rate or international rescue	Bordo et. al.; Laeven & Valencia
Twin Crisis	Simultaneous occurrence of banking and currency crises; maximum 2 years apart	Bordo et. al.; Laeven & Valencia
GDP per capita	GDP per capita	1950-2012: Total Economy Database Pre 1950: The Maddison Project
Openness	Imports plus exports as percentage of GDP	1950-2012: International Financial Statistics Pre 1950: Bilateral Trade Dataset; The Maddison Project
Government expenditure	Central government expenditure as percentage of GDP	The World Bank
Domestic credit	Domestic credit provided by the financial sector as percentage of GDP	The World Bank
Lending interest rate	Bank rate that meets the financing needs of households	The World Bank
Terms of Trade	Ratio of export to import prices	1950-2012: International Financial Statistics Pre 1950: Bilateral Trade Dataset

4.2: First look at the data

To develop a sense of the developments of the main independent variable, it is useful to analyze the graphical representation of income inequality before presenting empirical results, as some patterns in the evolution of income inequality might be visible. Graphs at the country level are presented, which support the main point of research of this paper.

4.2.1: Country-level comparison

Figure 1 shows the evolution of the unskilled wages to GDP ratio for the pre-World War 1 and Interwar periods (separated by the black line) for the major countries. The effects of the Great Depression on income inequality are clearly visible in this graph: for all countries, the share of unskilled wages as percentage of GDP has increased, which implies a decrease in income inequality for this period. This is in line with earlier findings on the relationship between the Great Depression and income inequality, as discussed in section 2. Another interesting observation is the strong common trend of income inequality: with some exceptions, all countries experience a similar development of inequality over time.

The same trend across countries can be found in figure 2, where top income shares are displayed for the period 1919-2012. Again, a decrease in inequality in the Great Depression years can be concluded for most countries. A striking feature of the top 1 incomes series is the general decreasing trend in top incomes (and thus in income inequality) that can be observed until 1980, after which it reverses and develops into an increasing tendency. From the data, it looks as if the GFC had an increasing effect on income inequality, which is in line with predictions of previous literature and theory. However, it is difficult to draw clear conclusions from the graph as some countries clearly experienced a decrease in top incomes for the first part of the GFC. Because of this notable cross-country variation, accurate links between crises episodes and income inequality can only be estimated through regression analysis.

Figure 1: Unskilled wages to GDP ratio. Source: See table 1

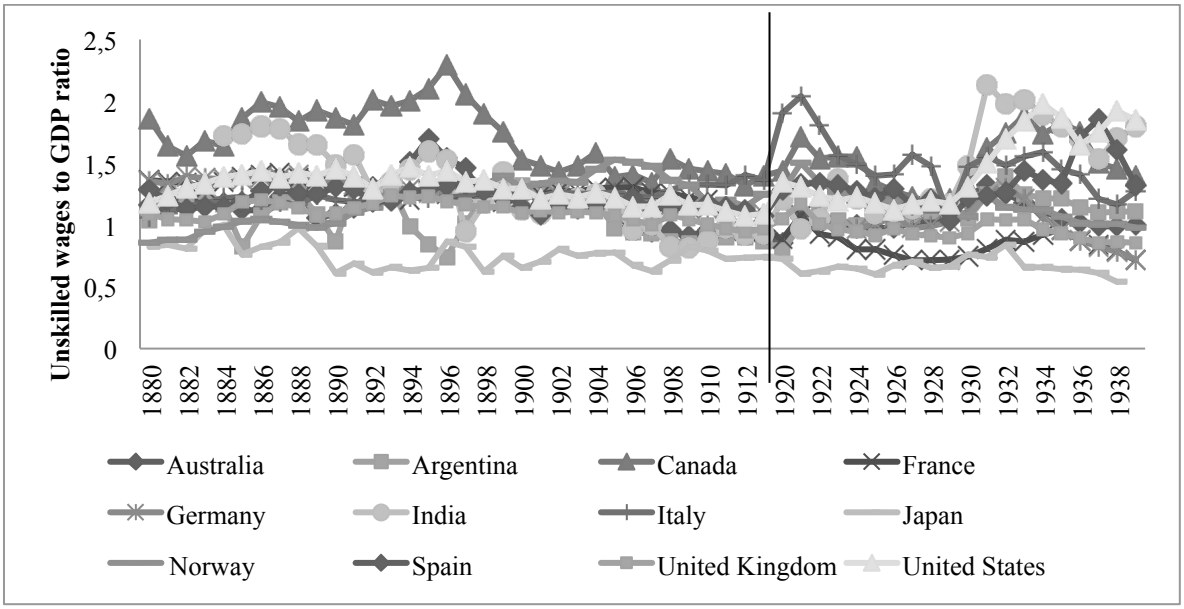
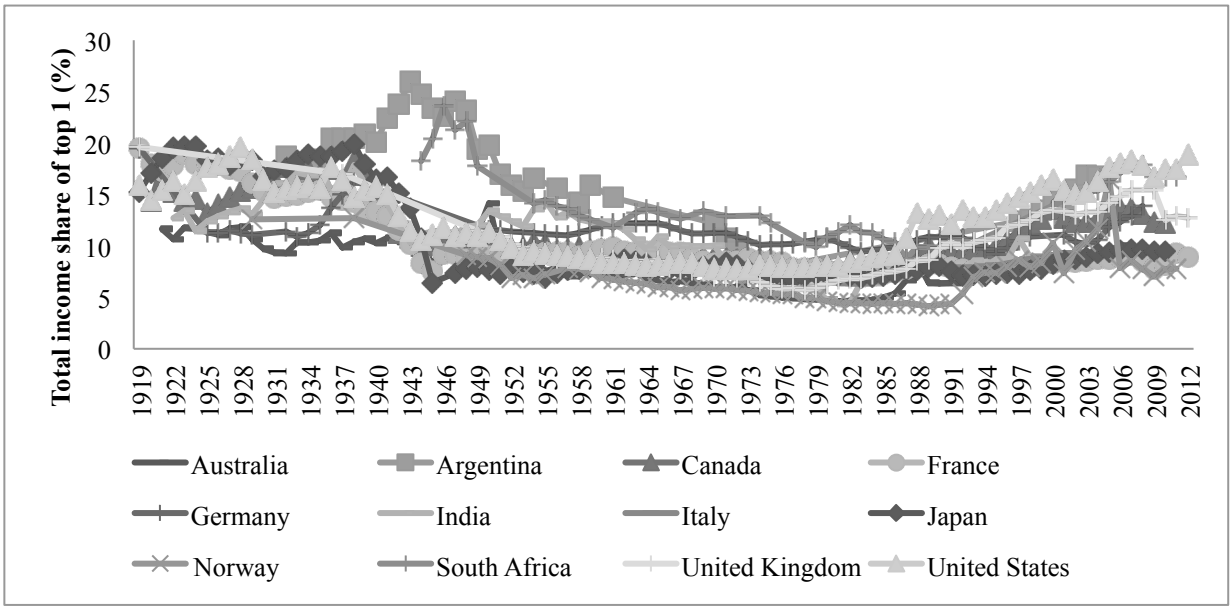


Figure 2: Top 1 percent of incomes. Source: See table 1



Chapter 5: Methodology

5.1: Regression specification

This paper adopts a panel regression approach for a panel of 24 countries, to examine the impact of financial crises on income inequality. With panel data, both unobservable time-invariant factors and common and country specific trends are accounted for (Roine, 2009). The independent variable and the control variables are calculated as the cumulative change over a five-year period. This has not only the advantage of preventing non-stationarity problems, but also accounts for the large amount of annual volatility in the data. This paper opts for changes in five-year periods rather than first differencing the variables, as annual data tends to be relatively noisy. The cumulative change in variable x is defined as: $\Delta x = x_t - x_{t-5}$. A linear relationship is assumed between the dependent and independent variable, such that the main regression equation is specified as follow:

$$\Delta inequality_{it} = \alpha(crisis)_{it} + \Delta X'_{it}\beta + \mu_i + \varepsilon_{it} \quad (1)$$

where the independent variable *inequality* is calculated differently for different time windows, as follows:

1. Interwar and Post-World War 2 periods: the five-year cumulative change in top 1 percent incomes,
2. Interwar and Pre-World War 1 periods: the change over a five-year period of the wage to GDP ratio

crisis is defined as the percentage of time that has been spent in a crisis for the previous five-year period, and is divided into banking, currency and twin crises. Furthermore, $\Delta X'$ is the vector of control variables, which is calculated as the change over a five-year period. The control variables are specified in chapter 4, but as this vector includes a different set of control for different types of crises and time periods, a summary is given in table 2. Both the dependent variable and the control variables were tested for the presence of a unit root, but no non-stationarity could be concluded. Graphs of the inequality proxies and control variables over time are included in the appendix, graph 1-7. Country specific trends are captured by a country specific effect μ_i. Finally, ε_{it} represents the standard idiosyncratic error term.

When testing for the mechanisms of financial crises, three more variables will be added to the vector $\Delta X'$: the domestic credit provided by the financial sector to GDP ratio and the lending interest rate when the crisis indicator is banking crisis in the post-World War 2

period, and terms of trade when examining the effect of currency crises on inequality for all three time periods under analysis.

Table 2: overview of included control variables

	Banking crises	**Currency crises**	**Twin crises**
Post World War 2	GDP per capita	GDP per capita	GDP per capita
Dependent variable:	Openness	Openness	Openness
Top 1 income share	Government expenditure	Government expenditure	Government expenditure
	Domestic credit provided*	Terms of Trade*	
	Lending interest rate*		
Interwar Period	GDP per capita	GDP per capita	GDP per capita
Dependent variable:	Openness	Openness	Openness
Top 1 income share and unskilled wage ratio		Terms of Trade*	
Pre World War 1	GDP per capita	GDP per capita	GDP per capita
Dependent variable:	Openness	Openness	Openness
unskilled wage ratio		Terms of Trade*	

*only included in the regression equation when testing for crisis mechanisms

5.2: Technical specification

The performed Hausman test indicated that fixed effects are preferred (see figure 1 in the Appendix). Therefore, the coefficients of the regression are estimated according to a fixed effects (FE) model. In addition, the standard errors of the regression will be transformed using a process that is described below.

As can be seen from figures 2 and 3 in the appendix, the data tested positive on heteroskedasticity and autocorrelation according to the LR and Woolridge tests. In addition, cross-sectional dependence is very likely to be present due to the large time frame used in the analysis. Unfortunately, the dataset was too unbalanced to perform any cross-sectional dependence tests, so standard errors correcting for cross-sectional dependence were compared to those of a standard regression. Since almost all standard errors were significantly lower when adjusting for cross-sectional dependence, this paper corrects for the presence of cross-

country dependence to ensure validity of the empirical results. Therefore, the standard errors of the coefficients of the FE regression will be adjusted to correct for all three problems: heteroskedasticity, autocorrelation and cross-sectional dependence. To this end, Driscoll and Kraay (1998) standard errors will be used, which are based on a nonparametric covariance estimator that produces heteroskedasticty- and autocorrelation-consistent standard errors that are at the same time robust to any form of spatial and temporal dependence. The Driscoll and Kraay (1998) standard errors are based on the heteroskedasticity- and autocorrelation consistent matrix estimator of Newey and West (1987); however, cross-sectional dependence is taken into account as well. See the appendix for a more detailed explanation of the implementation of fixed effects and the adjustments of the standard errors.

Thus, an FE regression model with Discroll and Kraay standard errors based on the FE estimator will be used to estimate the regression. The Driscoll and Kraay standard errors are implemented in stata through the xtscc command, which suits the dataset used in this paper as it can be applied to unbalanced panels and is most reliable for longer time periods. No time-fixed effects are allowed for the regression based on xtscc, as xtscc already accounts for time-invariant variables with time-invariant effects (Hoechle, 2007).

A limitation of this research that has to be addressed is the possibility of reverse causality. The income inequality measures that represent the dependent variable in this research might have an effect on the explanatory variables, both directly and indirectly. For example, an increase in the top income shares could have a direct impact on economic growth. Indirect reverse causality possibly results in endogeneity problems. The correct way to deal with these endogeneity issues would be to identify and include instruments for each independent variable. As this research aims to be the first to systematically examine the long-run relationship between financial crises and income inequality, it is not feasible to devote much time to IV regressions. Therefore, it cannot be claimed that causality is fully established in this paper, which should be born in mind when interpreting the results. Despite the limitations mentioned in this section, this paper is believed to make important contributions to the research on the crises-inequality relationship.

Chapter 6: Empirical results

This section presents the empirical results from the regression analyses specified in the previous chapter on the methodology. The tables summarize the results for banking crises, currency crises and twin crises, respectively, as the main independent variable. For the post-World War 2 and Interwar periods, the dependent variable is the share of top 1 percent of

incomes. For the years before 1950, the unskilled wages to GDP ratio is the attribute that represents income inequality. Results from the main regression are reported, and the mechanisms through which banking and currency crises affect income inequality are analyzed.

6.1: Financial crises and income inequality

6.1.1: Pre-World War 1 period

As no previous study covering this time period is available, the analysis below represents the first published results for the impact of financial crises on income inequality. Instead of top income data, the cumulative change in the wage to GDP ratio over a five-year period is used as dependent variable for this period due to sparse availability of the former inequality measure. Although the measures focus on different aspects of the income distribution, they both represent income inequality to such an extent that it is justified to compare interpretations of the three periods with different dependent variables. However, one should be careful to compare the magnitudes of the coefficients related to the two inequality proxies; the interpretation of the results will therefore be more focused on the signs of the crisis to inequality relationship.

The results of regression equation 1 (see chapter 5) are reported in table 3. The first two columns represent banking crises; the middle two columns refer to currency crises and the last columns assume twin crises as a crisis indicator. All three types of financial crises have a significant effect on the wage to GDP ratio, although for currency crises and twin crises this effect only becomes significant when the interaction term between crises and log GDP is added to the regression equation. Since the sign of the relationship between inequality and banking crises, currency crises and twin crises is negative, it can be concluded that during all three types of financial crises, the unskilled wage to GDP ratio decreased. Thus, the wages of unskilled workers decreased more than total GDP during banking crises and twin crises, and therefore the bottom part of the income distribution was hit relatively strong compared to the higher ranges of the income distribution. In conclusion, when an additional year in the five-year period was spent in a financial crisis, an increase in income inequality is present for the pre-World War 1 period.

For banking and twin crises, a positive and significant coefficient on the interaction term between crises and GDP per capita was found. This result shows that when banking and twin crises are accompanied by negative economic growth, their adverse effect on the wage to GDP ratio is even larger. As financial crises are often accompanied by recessions, this

scenario is realistic to consider. Interestingly, currency crises interacted with GDP growth is not significant for the pre-World War 1 period, whereas this is the only significant interaction term in the years 1950–2012. This could indicate that the effects of currency crises combined with an economic recession on income inequality became more important in the recent years, whereas the opposite happened for banking crises and currency crises associated with negative economic growth. Future research might investigate this observed phenomenon in more detail.

Table 3: Pre-World War 1 period

	Banking Crises		**Currency Crises**		**Twin Crises**	
Crisis indicator	-0.161*** (0.051)	-0.290*** (0.058)	-0.065 (0.057)	-0.115** (0.055)	-0.045 (0.066)	-0.113* (0.060)
ΔLog GDP	-1.051*** (0.120)	-1.166*** (0.150)	-1.030*** (0.122)	-1.066*** (0.124)	-1.021*** (0.125)	-1.074*** (0.119)
ΔOpenness	-0.114*** (0.026)	-0.121*** (0.024)	-0.103*** (0.026)	-0.104*** (0.026)	-0.103*** (0.026)	-0.105*** (0.025)
Crisis*ΔGDP		1.872* (1.071)		1.001 (0.606)		1.209* (0.698)
N	291	291	291	291	291	291
Within R^2	0.282	0.289	0.266	0.268	0.264	0.268

Notes: dependent variable is cumulative change over 5 years in the unskilled wage to GDP ratio for the period 1880-1913. Standard errors are reported in parentheses. FE-estimation by xtscc. * p<0.1; ** p<0.05; *** p<0.01

6.1.2: Interwar Period

The main crisis covered in the Interwar period is the Great Depression, whose effects on income inequality were previously found to differ from the preceding and following period under analysis. The results produced by this paper, as summarized in table 4 and 5, confirm these previous results: banking crises are found to have a negative effect on top incomes and a positive effect on the unskilled wage ratio in the period 1920-1939. This unskilled wage growth is especially remarkable when one keeps in mind the circumstances in which this took place: whereas the 5-year economic growth rate on average declined by 6 percentage points, the growth in the wage to GDP ratio increased by 12 percent. Overall, a decrease in income inequality following episodes of banking crises can be concluded in this period.

The finding that banking crisis have a decreasing effect on income inequality in the period 1920-1939 can be explained by the observation that primarily the relatively rich capital owners were hit by the Great Depression, as pointed out in chapter 2. At the same time, top income taxes increased, further diminishing the incomes of the rich. Whereas the top income shares were falling during the Great Depression, unskilled wages were rising (Williamson & Lindert, 1980). Bordo, Erceg and Evans (2001) contribute this phenomenon, which leads to countercyclical wages, to the presence of wage rigidity in the years 1920–1939. In contrast, the pre-World War 1 period was characterized by acyclical wages, and they became pro-cyclical post-World War 2 (Hanes, 1996).

The same conclusion about narrowing income inequality can be drawn for twin crises: whereas the unskilled wage to GDP ratio was not affected by twin crises in the Interwar period, top incomes are found to decrease when associated with twin crises. Surprisingly, currency crises are associated with increasing top incomes in the Interwar period, where they are found to have no effect on the unskilled wages. It follows that the impact of currency crises on the income distribution differs from the effects of banking and twin crises. This finding is highly important as it shows that the impact of crises on inequality is dynamic and depends on the economic environment and the nature of the crisis. For all three crises types, the interaction term with GDP growth was insignificant, hence there is no supporting evidence for a larger effect on inequality when crises coincide with economic recessions.

Table 4: Interwar period; dependent variable: unskilled wages to GDP ratio

	Banking Crises		**Currency Crises**		**Twin Crises**	
Crisis indicator	0.092*	0.061	-0.082	-0.047	0.030	0.002
	(0.048)	(0.041)	(0.066)	(0.071)	(0.081)	(0.091)
ΔLog GDP	-1.298***	-1.219***	-1.324***	-1.255***	-1.318***	-1.282***
	(0.111)	(0.105)	(0.112)	(0.175)	(0.106)	(0.114)
ΔOpenness	-0.013	-0.019*	-0.022*	-0.021*	-0.015	-0.019
	(0.010)	(0.010)	(0.012)	(0.011)	(0.011)	(0.013)
Crisis*ΔGDP		-0.633		-0.533		-0.389
		(0.406)		(0.616)		(0.380)
N	176	176	176	176	176	176
Within R^2	0.753	0.758	0.752	0.754	0.750	0.752

Notes: dependent variable is cumulative change over 5 years in the unskilled wage to GDP ratio for the period 1919-1939. Standard errors are reported in parentheses. FE-estimation by xtscc. * p<0.1; ** p<0.05; *** p<0.01

Table 5: Interwar period; dependent variable: top 1 incomes

	Banking Crises		Currency Crises		Twin Crises	
Crisis indicator	-4.531**	-4.419*	2.785**	2.908**	-5.317***	-4.197
	(1.625)	(2.206)	(1.099)	(1.218)	(1.530)	(2.722)
ΔLog GDP	1.232	1.071	3.373**	3.849	1.571	1.085
	(1.237)	(1.509)	(1.316)	(2.767)	(1.245)	(1.477)
ΔOpenness	0.075	0.091	-0.102	-0.115	0.048	0.119
	(0.140)	(0.206)	(0.088)	(0.112)	(0.165)	(0.222)
Crisis*ΔGDP		1.230		-2.994		5.935
		(7.298)		(11.019)		(7.254)
N	112	112	126	126	112	112
Within R^2	0.237	0.238	0.113	0.115	0.212	0.217

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for the period 1920-1939. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

6.1.3: Post-World War 2 period

The results for the regression between changes over 5 year of top incomes and the explanatory variables for the years 1950–2012 are presented in table 6. A number of interesting conclusions can be drawn from this overview. First, both banking crises and twin crises are associated with an increase in top 1 incomes, such that these two crisis types are found to widen income inequality. No significant effects can be concluded for the interaction term between banking crises, twin crises and GDP growth; hence, income inequality is not more affected when these types of financial crises occur simultaneously with negative economic growth. The conclusion with respect to banking crises contradicts results found by Honohan (2005) and Lopez (2003), who both concluded that banking crises have a decreasing effect on income inequality. An explanation for the different findings can be that the authors mentioned above use the Gini coefficient as the dependent variable, rather than the income share of the top 1 percent. The distinction between different time periods is a plausible explanation why this study finds an impact of banking crisis on top incomes that is opposite to the relation found by Roine et. al. (2009), who cover the period 1900-2000 in their analysis.

Next, the significant negative marginal effect of currency crises on top incomes leads to the conclusion that the distribution of income becomes more equal when currency crashes occur in the post-World War 2 period. This finding is surprising, as previous research found strong evidence in favor of an increasing relationship between currency crisis and inequality.

An explanation for the contrasting empirical evidence of this paper is the measure of inequality that is used. As this research only looks at the top incomes instead of the total income distribution, it might be the case that lower incomes are hit even harder during currency crises, which would lead to the conclusion of increasing income inequality. Interestingly, the negative sign of the interaction term between currency crises and GDP implies an increase in top incomes when currency crises are accompanied with an economic recession. Thus, the direct effect of currency crises is a decrease in top incomes, whereas currency crises combined with negative economic growth are found to widen inequality.

Table 6: Post-World War 2 period

	Banking Crises		**Currency Crises**		**Twin Crises**	
Crisis indicator	1.223*** (0.232)	1.173* (0.627)	-1.281** (0.504)	0.186 (0.612)	0.953*** (0.342)	0.834* (0.418)
ΔOpenness	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
ΔGovernment expenditure	-0.277*** (0.069)	-0.277*** (0.071)	-0.280*** (0.069)	-0.288*** (0.068)	-0.285*** (0.069)	-0.285*** (0.069)
ΔLog GDP	-0.197 (1.386)	-0.250 (1.430)	-1.907 (1.391)	-0.987 (1.454)	-1.243 (1.431)	-1.320 (1.451)
Crisis*ΔGDP		0.681 (7.979)		-14.229** (6.253)		2.002 (7.271)
N	648	648	648	648	641	641
Within R^2	0.194	0.194	0.169	0.182	0.170	0.170

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for the period 1950-2012. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

6.1.4: Control variables

For both the pre-World War 1 period and the Interwar period, the variable cumulative change in log GDP per capita enters significantly when the dependent variable is the unskilled wage to GDP ratio. The sign of the GDP growth is negative; hence, it can be concluded that the growth in GDP per capita is pro-cyclical. Thus, when the cumulative growth in GDP per capita increases, income inequality will increase as well. This result holds for all three crisis types in the periods specified above. In addition, GDP growth is found to have a positive sign when top 1 incomes is used as inequality proxy for currency crises in the Interwar period. The

phenomenon that high economic growth mainly benefits the rich is in line with top incomes being more responsive to growth, as their compensations are more strongly linked to profits (Roine et. al., 2009). For the post-World War 2 period, the 5-year cumulative change in the growth of GDP per capita is found to be insignificant. The data on GDP for this period come from a different source than the previous periods under analysis, which explains the differences in findings.

Openness to trade appears to only have an economic effect on the unskilled wage to GDP ratio, which is utilized as inequality proxy in the years 1880 – 1913 and 1920 – 1939. It is found to be insignificant in the Interwar period when top 1 incomes is specified as the dependent variable, and the coefficient for the post-World War 2 period is close to zero (although significant). The empirical evidence on the variable openness suggests that trade openness is important for the left end of the income distribution, but is of less to none significance when considering the top income shares. The sign on openness in the pre-World War 1 period is in line with the predictions in the literature: an increase in openness to trade leads to higher income inequality. The positive link between openness and income inequality can be explained by the Heckscher Ohlin theory, which states that the effects of trade depend on the relative factor abundance and productivity differences (Easterly, 2005). As the countries included in this paper's dataset are mostly relatively capital abundant, increased openness to trade would benefit the capital owners, which are assumed to represent the richer class in the society.

Lastly, government expenditure, which was only included for the time period 1950–2012, was found to have a decreasing effect on top incomes. The equalizing forces of central government expenditure can be traced back to the objectives of many governments to protect and help the poorest of the society. This finding is in line with what one might expect, as governments aim to narrow income inequality.

6.2: Mechanisms

One of the main objectives of this paper is to empirically examine the mechanisms through which financial crises affect income inequality, as predicted by theory. Table 7 reports the results for the channels behind the relation between banking crises and inequality, defined by the availability of credit to the corporate sector and the price of household credit (captured by the lending interest rate), respectively. The coefficient of the interaction term between credit availability and banking crises is not statistically significant, although the negative sign is in

line with theory, which predicted that declined availability of credit to the corporate sector during an episode of banking crisis widens inequality.

Next, the cumulative change in the lending interest rate interacted with the variable banking crises is associated with increasing income inequality. The positive sign of the coefficient of this interaction term indicates that an increase in the price of household credit during a banking crisis results in higher top income shares. This increase in income inequality through a higher price of credit household is indeed in line with theoretical predictions.

Table 7: mechanisms of banking crises

	Credit availability	**Lending interest rate**
Banking crisis	1.677***	1.428***
	(0.158)	(0.333)
ΔOpenness	0.000**	0.000***
	(0.000)	(0.000)
ΔGovernment expenditure	-0.296***	-0.231***
	(0.072)	(0.074)
ΔLog GDP	-0.181	0.855
	(0.990)	(1.185)
ΔCredit availability	0.015***	
	(0.004)	
ΔLending interest rate		-0.036
		(0.022)
Crisis*mechanism	-0.015	0.154*
	(0.026)	(0.085)
N	622	489
Within R^2	0.262	0.214

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for the period 1950-2012. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 8 summarizes the results for the regression equation of currency crises, with the terms of trade and the interaction term between terms of trade and currency crises added to the set of control variables. The deterioration of the terms of trade following currency crashes was expected to be an important channel through which currency crises affect the distribution of income. Theory proposed that the terms of trade effects caused by currency crises lower the

real income of laborers, such that lower income classes are disproportionally affected by severe currency shocks, resulting in increased inequality. For all three time periods under analysis, the empirical results confirm terms of trade to be important in explaining the impact of currency crises on the distribution of income. In both the pre-World War 1 and Interwar period, the interaction term between terms of trade and currency crises is negative for the unskilled wage ratio specified as dependent variable, which stems from the fact that the coefficient of the currency crisis variable enters negatively. However, when the link between currency crises and unskilled wages would have been positive, it could be concluded that a decline in the terms of trade during a currency crisis results in higher income inequality, as described by theory. Evidence on the channel of terms of trade in the post-World War 2 period is in line with theory as well: the negative coefficient of the interaction term between currency crises and terms of trade indicates that income inequality increases when the terms of trade deteriorate.

Table 8: mechanisms of currency crises

	Post-World War 2	**Interwar**		**Pre-World War 1**
		Wage ratio	Top 1 incomes	
Currency crisis	-1.313*** (0.445)	-0.044 (0.065)	2.900* (1.506)	0.153 (0.118)
ΔOpenness	0.059*** (0.007)	-0.006 (0.012)	-0.250 (0.222)	-0.150** (0.059)
ΔGovernment expenditure	-0.191*** (0.062)			
ΔLog GDP	-1.972 (1.309)	-1.410*** (0.094)	4.224*** (1.227)	-1.088*** (0.101)
ΔTerms of trade	1.524*** (0.416)	0.127** (0.051)	-2.197** (0.794)	0.153 (0.118)
Crisis*Δtrade	-5.727* (3.087)	-0.329* (0.175)	4.814 (4.317)	-2.071*** (0.661)
N	575	111	79	193
Within R^2	0.214	0.857	0.213	0.417

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for column 1 and 3; cumulative change over 5 years in the unskilled wage to GDP ratio for columns 2 and 4. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

6.3: Robustness checks

A few robustness tests were conducted by using alternative measures of income inequality and alternative definitions of crises. The results are reported in the appendix, table 3–8. First, the 5-year cumulative change in top 5 incomes and top 10 incomes represented the dependent variable for the post-World War 2 period. From the results, it can be concluded that banking and twin crises significantly increase the incomes of both the top 5 and top 10 percent of earners. This is consistent with the findings on the effect of financial crises on top 1 incomes. For both alternative dependent variables, the results of banking and twin crises become insignificant when an interaction term between the crisis indicator and GDP per capita is included. Hence, although the effect of banking crises and twin crises for top 5 and 10 incomes is similar to the impact on the top 1 percent of incomes, the relation between these types of financial crises and the alternative top incomes appears to be less strong. This indeed confirms the conclusion that income inequality increased because the effects on top 1 incomes occur to be more robust than on top 5 and top 10 earners. The exception to this finding are currency crises; whereas all three top income measures display a negative coefficient, this decreasing effect on income inequality is larger for top 10 income shares compared to top 1 incomes. Thus, the positive relation between banking and twin crises is found to weaken when a larger percentage of the incomes are taken into account, whereas the opposite happens for the negative effects of currency crises.

Next, the definition of financial crises by Reinhart and Rogoff (2010) is used as alternative for the crisis indicator variable. The sign of the relationship between banking crises and income inequality is identical to the signs for Bordo et. al.'s definition of crises for all three periods. In the pre-World War 1 period, no significant effect of currency and twin crises on income inequality was found. The empirical evidence of currency and twin crises in the Interwar period when using Reinhart and Rogoff's (2010) data specification is ambiguous: whereas the unskilled wage ratio decrease, top 1 incomes are found to increase following both crises types. This differs from the results extracted from Bordo et. al.'s data, which did generate conclusive results for the Interwar period. Lastly, twin crises are associated with increasing income inequality in the years 1950 – 2012, which is similar to the results reported in section 6.1. No significant results were found for currency crises in this period.

Conclusion

The study on the developments of income inequality by Piketty (2014) combined with the recent Global Financial Crisis revived the relevance of the link between crises and income inequality. This paper aimed to empirically analyze the long-term relationship between financial crises and income inequality. Whereas previous studies on the crises-inequality relationship often have focused on specific crises episodes, the main novelty of this research is the long time period covered. In addition, three crises types are distinguished and analyzed separately. One of the main objectives of this paper is to empirically examine the mechanisms through which banking and currency crises affect the income distribution, as proposed by theoretical models.

The empirical results of this paper provide evidence that banking crises and twin crises are associated with higher income inequality in the pre-World War 1 and post- World War 2 period. As predicted by previous research, this paper indeed found evidence for a decline in income inequality after the outbreak of banking crises and twin crises in the Interwar period. This decreasing effect in the Interwar period can be explained by nominal wage rigidities, leading to acyclical wages, combined with increased top income taxes in this period. Currency crises are concluded to widen income inequality in the years 1880–1913 and 1920–1939. For the most recent post-World War 2 period, a narrowing effect of currency crises on inequality is found, which differs from previous results. However, for this period, the interaction term between currency crises and GDP growth suggests that currency crises tend to increase top incomes when accompanied by an economic recession. This interacted term between financial crises and economic growth was, next to the result just mentioned, only significant for banking and twin crises in the pre-World War 1 period. The evidence on these two significant interacted variables in the years 1880–1913 is in favor of a larger adverse effect of banking and twin crises on the unskilled wage to GDP ratio when accompanied by negative economic growth.

This paper also conducted an empirical analysis of the channels through which banking and currency crises affect income inequality. The mechanisms of banking crises could only be examined in the Post-World War 2 period due to limited data availability. Whereas the coefficient of the interaction term between credit availability and banking crises is not statistically significant, the higher lending interest rate during episodes of banking crises are significantly associated with increasing inequality, confirming the theoretical predictions. For all three time periods under analysis, the regression results confirm terms of

trade to be important for explaining the impact of currency crises on the distribution of income.

When using top 5 and top 10 income shares as alternative inequality measures in the post-World War 2 period, the positive relation between banking and twin crises is found to weaken when a larger percentage of the incomes are taken into account, whereas the opposite happens for the negative effects on top incomes of currency crises. The results of this paper are robust to relying on Reinhart and Rogoff's definition of crises, although more insignificant relationships between financial crises and the distribution of income were concluded with this alternative crisis definition.

When interpreting this paper's results, one should bear in mind the limitations inherent in this research. The regression specification did not correct for possible endogeneity problems, and different inequality measures were used across the time periods. Nevertheless, the conclusions achieved by this paper are valid and highly relevant for today's political consequences. As it is the poor who suffer disproportionally from banking crises and twin crises, the government could take responsibility to limit the adverse effects on income inequality during crisis times. Where this paper is the first to empirically examine the distributional consequences of financial crises over the long-term, much is still left to do for future studies. First, it is important to get an even better understanding of the channels through which inequality is affected. When the drivers of income inequality are examined more thoroughly, the next step should be to design appropriate policy responses to deal with the inequality-increasing effects of financial crises.

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APPENDIX

Table 1: Overview countries and crises episodes

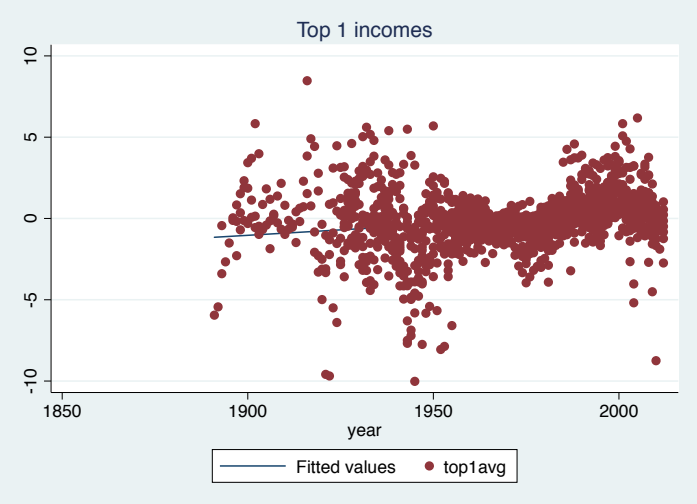
Country	Time period	Region	Crises years		
			Banking crises	Currency crises	Twin crises
Argentina	1880 - 2012	Latin America	1890-91; 1914; 1931; 1934; 1980 - 82; 1989-90; 1995-96; 2001-03	1885; 1889 - 91; 1908; 1914; 1928 - 31; 1950; 1959; 1962; 1967; 1970; 1975; 1982; 1984; 1987; 1989; 1991; 1995; 2002	1890 - 91; 1914; 1929 - 31; 1980 - 82; 1989 - 91; 1995 - 96; 2002
Australia	1870 - 2012	Oceania	1893; 1989-92	1915; 1932 -33; 1949; 1971; 1976; 1983; 1985	
Canada	1870 - 2012	North America	1923; 1983-1985	1891; 1893; 1908; 1921; 1929; 1931; 1950; 1962; 1981; 1986	
China	1900 - 2012	Asia	1998	1980; 1986; 1989; 1992	
Denmark	1870 - 2012	Europe	1885; 1907-08; 1914; 1921; 1931; 1963	1914; 1921-22; 1931-1932; 1961; 1969; 1971; 1990; 2002	1914; 1921-22; 1931-32
Finland	1900 - 2012	Europe	1910-1912; 1921; 1931; 1939; 1991-1994	1908; 1913; 1921; 1931; 1949; 1971; 1986; 1991; 1993	1921; 1931; 1991-1994
France	1870 - 2012	Europe	1882; 1889; 1907; 1930-1932; 1994-95; 2008-2012	1888; 1914; 1923; 1926; 1936-1937; 1948; 1957; 1968; 1992	1888-1889
Germany	1870 - 2012	Europe	1901; 1931; 2008-2012	1893; 1907; 1914; 1931; 1934; 1949	1931
India	1880 - 2012	Asia	1993-1994	1993	1993
Indonesia	1900 - 2012	Asia	1997-2001	1975; 1978; 1983; 1986; 1992; 1997-1998	1997-1998
Ireland	1900 - 2012	Europe	2008-2012	1976; 1986; 1992	
Italy	1870 - 2012	Europe	1891; 1893; 1907; 1921; 1930-1931; 1935; 1990-1995; 2008-2012	1894; 1908; 1935-1936; 1964; 1976; 1992; 1995	1893-1894; 1907-1908; 1935-1936; 1990-1995
Japan	1870 - 2012	Asia	1901; 1907; 1917; 1927; 1992-2000	1900-1901; 1904; 1908; 1917; 1921; 1931-1932; 1979	1900-1901; 1907-1908
Netherlands	1870 - 2012	Europe	1897; 1914; 1921; 1939; 2008-2012	1914; 1921; 1923; 1935; 1949; 1971	1914; 1921
New Zealand	1900 - 2012	Oceania	1987	1975; 1978; 1980; 1984; 1988	
Norway	1870 - 2012	Europe	1921-23; 1931; 1987-1993	1914; 1931; 1949; 1971; 1986	1931; 1986-1993
Portugal	1880 - 2012	Europe	1891; 1920; 1923; 1931-1932; 2008-2012	1891; 1931; 1971; 1976; 1978; 1983	1891; 1931-1932

Singapore	1974 - 2012	Asia	1982	1998	
South Africa	1900 - 2012	Africa	1977; 1985	1975; 1978; 1981-1982; 1984; 1986; 1988; 1992; 1995	
Spain	1870 - 2012	Europe	1920; 1924-1925; 1931; 1977-1984; 2008-2012	1931; 1958; 1967; 1971; 1976; 1982; 1992; 1995	1931; 1976-1984
Sweden	1870 - 2012	Europe	1897; 1907; 1931-1932; 1991-1994; 2008-2012	1914; 1931-1932; 1949; 1971; 1992	1931-1932; 1991-1994
Switserland	1870 - 2012	Europe	1931; 1933; 2008-2012	1914; 1936; 1939; 1971; 1977	
UK	1870 - 2012	Europe	1890; 1974-1976; 2008-2012	1914; 1931; 1947; 1949; 1961; 1964-1967; 1976; 1992;	1974-1976
US	1870 - 2012	North America	1884; 1893; 1907; 1914; 1930-1933; 1984-1991; 2008-2012	1890-1893; 1933; 1960; 1971	1891-1893; 1930-1933

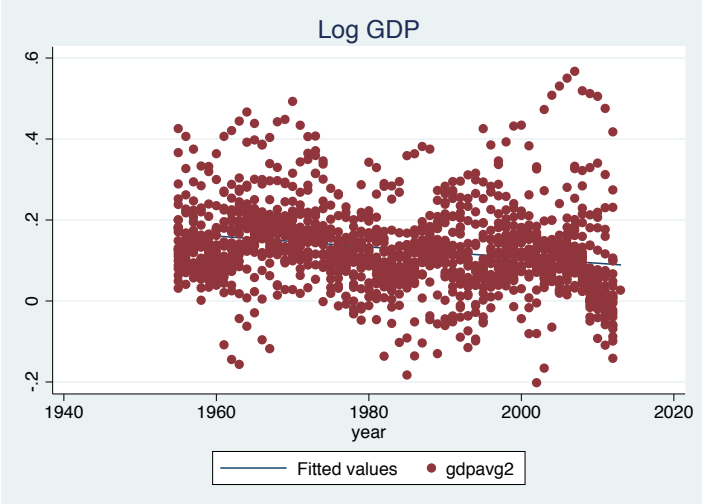
Table 2: Correlation matrix

	Top 1 incomes	**Openness**	**Government expenditure**	**Log GDP**
Top 1 incomes	1.0000			
Openness	0.0879	1.0000		
Government expenditure	-0.3239	-0.2979	1.0000	
Log GDP	0.1442	0.2913	-0.4487	1.0000

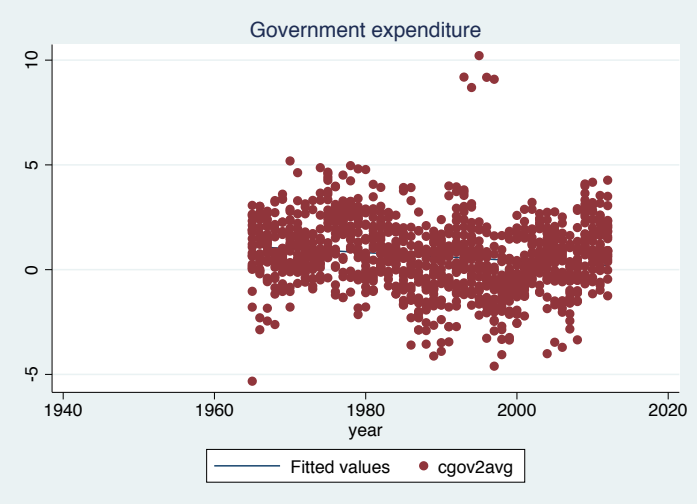
Graphs 1-7: plots of dependent and control variables over time; cumulative change over a five-year period



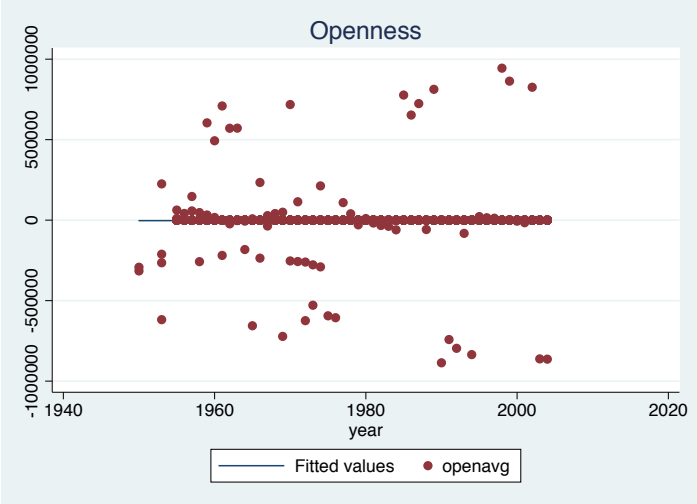
Graph 1: top 1 incomes 1900–2012



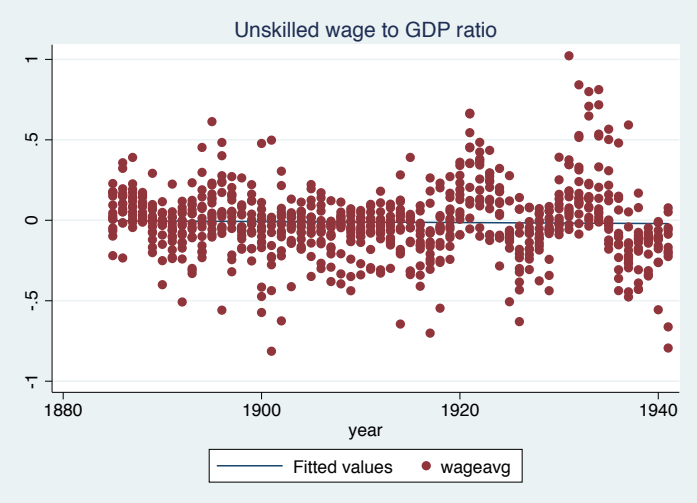
Graph 2: Log GDP 1950-2012



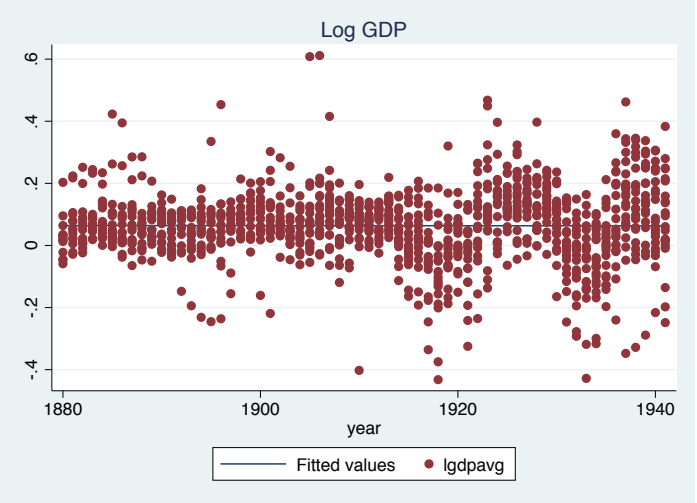
Graph 3: Government expenditure 1950-2012



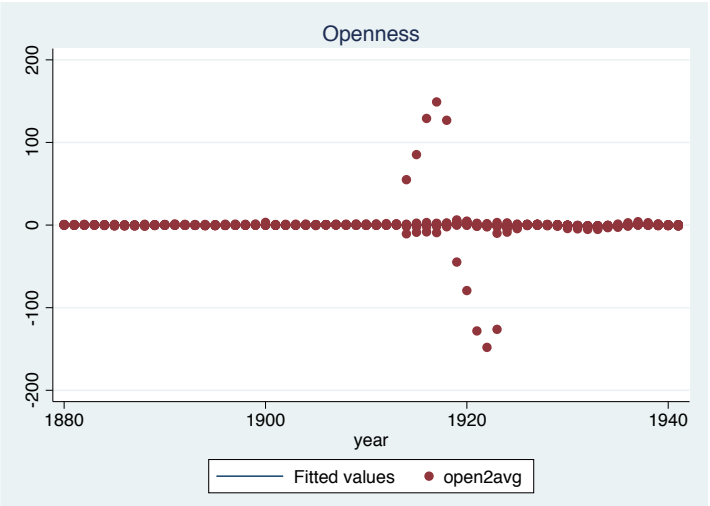
Graph 4: Openness 1950-2012



Graph 5: Unskilled wage ratio 1880-1940



Graph 6: Log GDP 1880-1940



Graph 7: Openness 1880-1940

Figure 1: Hausmann test for fixed effects

```
hausman fixed random, sigmamore
----------------------------------------------------------------------------
          b = consistent under Ho and Ha; obtained from xtreg
          B = inconsistent under Ha, efficient under Ho; obtained from xtreg

   Test:  Ho:  difference in coefficients not systematic

                chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =       27.81
              Prob>chi2 =      0.0000
```

Figure 2: LR test for heteroskedasticity

```
. estimates store homosk

. local df = e(N_g) - 1

. lrtest hetero homosk , df(16)

Likelihood-ratio test                           LR chi2(16) =    150.43
(Assumption: homosk nested in hetero)           Prob > chi2 =    0.0000
```

Figure 3: Woolridge test for serial correlation

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
   F(  1,      21) =     79.592
         Prob > F =      0.0000
```

Table 3: Robustness check; dependent variable: top 5 income shares

	Banking Crises		Currency Crises		Twin Crises	
Crisis	1.091***	-0.116	-2.981***	-2.318***	0.935*	-0.022
Indicator	(0.257)	(0.523)	(0.623)	(0.653)	(0.500)	(0.581)
ΔOpenness	0.089***	0.096***	0.101***	0.100***	0.092***	0.095***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
ΔGovernment	-0.381***	-0.368***	-0.351***	-0.357***	-0.385***	-0.379***
expenditure	(0.073)	(0.079)	(0.073)	(0.071)	(0.074)	(0.076)
ΔLog GDP	-4.094**	-5.362***	-6.284***	-5.822***	-5.011***	-5.639***
	(1.635)	(1.698)	(1.396)	(1.537)	(1.536)	(1.511)
Crisis*ΔGDP		16.094***		-6.558		15.806***
		(5.589)		(6.926)		(4.717)
N	543	543	543	543	536	536
Within R^2	0.233	0.246	0.253	0.254	0.221	0.230

Notes: dependent variable is cumulative change over 5 year in top 5 percent incomes for the period 1950-2012. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 4: Robustness check; dependent variable: top 10 income shares

	Banking Crises		Currency Crises		Twin Crises	
Crisis	1.458***	0.594	-4.031***	-4.291***	1.209*	-0.091
indicator	(0.340)	(0.577)	(0.781)	(1.184)	(0.697)	(0.783)
ΔOpenness	0.055***	0.060***	0.069***	0.069***	0.062***	0.066***
	(0.018)	(0.019)	(0.023)	(0.022)	(0.017)	(0.017)
ΔGovernment	-0.292**	-0.282**	-0.263**	-0.261**	-0.293**	-0.282**
expenditure	(0.114)	(0.120)	(0.114)	(0.110)	(0.115)	(0.118)
ΔLog GDP	-4.705**	-5.559**	-7.890***	-8.023***	-5.863**	-6.629***
	(2.296)	(2.223)	(2.127)	(2.518)	(2.277)	(2.310)
Crisis*ΔGDP		11.323*		2.423		20.889***
		(6.241)		(11.393)		(7.398)
N	538	538	538	538	531	531
Within R^2	0.142	0.148	0.172	0.172	0.126	0.139

Notes: dependent variable is cumulative change over 5 year in top 10 percent incomes for the period 1950-2012. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 5: Robustness check; Reinhart and Rogoff crises variable pre-World War 1 period

	Banking Crises		Currency Crises		Twin Crises	
Crisis indicator	-0.183*** (0.033)	-0.331*** (0.061)	-0.098 (0.122)	0.013 (0.176)	-0.044 (0.098)	-0.004 (0.102)
ΔLog GDP	-0.122*** (0.026)	-0.130*** (0.026)	-0.101*** (0.028)	-0.102*** (0.027)	-0.101*** (0.028)	-0.101*** (0.028)
ΔOpenness	-1.053*** (0.121)	-1.193*** (0.138)	-1.021*** (0.115)	-1.028*** (0.116)	-1.012*** (0.119)	-1.009*** (0.121)
Crisis*ΔGDP		1.900** (0.738)		-1.483 (1.175)		-1.598* (0.879)
N	291	291	291	291	291	291
Within R^2	0.282	0.289	0.266	0.268	0.264	0.268

Notes: dependent variable is cumulative change over 5 year unskilled wage to GDP ratio for the period 1880-1913. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 6: Robustness check; Reinhart and Rogoff crises variable Interwar period (dependent variable: unskilled wage to GDP ratio)

	Banking Crises		Currency Crises		Twin Crises	
Crisis Indicator	0.053 (0.056)	0.052 (0.054)	-0.164* (0.078)	-0.174** (0.079)	-0.086 (0.053)	-0.158** (0.069)
Openness	-0.013 (0.011)	-0.016 (0.012)	-0.018 (0.010)*	-0.011 (0.009)	-0.017 (0.011)	-0.019* (0.010)
Log GDP	-1.305*** (0.121)	-1.188*** (0.141)	-1.355*** (0.092)	-1.519*** (0.102)	-1.352*** (0.115)	-1.311*** (0.112)
Crisis*GDP		-0.508 (0.399)		0.641 (0.435)		-0.576 (0.453)
N	176	176	176	176	176	176
Within R^2	0.751	0.756	0.762	0.771	0.751	0/754

Notes: dependent variable is cumulative change over 5 year unskilled wage to GDP ratio for the period 1920-1939. Standard errors are reported in parentheses. Estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 7: Robustness check; Reinhart and Rogoff crises variable Interwar period (dependent variable: top 1 incomes)

	Banking Crises		Currency Crises		Twin Crises	
Crisis Indicator	-3.074**	-2.779**	-1.398*	-1.776*	-5.626***	-3.662**
	(1.091)	(1.200)	(0.669)	(0.903)	(1.126)	(1.279)
Openness	-0.113	-0.074	-0.172*	0.008	-0.125	-0.036
	(0.091)	(0.105)	(0.089)	(0.089)	(0.078)	(0.090)
Log GDP	0.988	0.273	3.280**	-0.221	1.261	0.133
	(1.674)	(1.788)	(1.292)	(1.317)	(1.341)	(1.272)
Crisis*GDP		3.965		15.189***		13.766***
		(2.992)		(2.290)		(3.081)
N	126	126	126	126	126	126
Within R^2	0.141	0.222	0.085	0.185	0.191	0.227

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for the period 1920-2039. Standard errors are reported in parentheses. FE-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 8: Robustness check; Reinhart and Rogoff crises variable post-World War 2 period

	Banking Crises		Currency Crises		Twin Crises	
Crisis Indicator	1.362***	1.624***	-0.113	0.437	1.688	3.492**
	(0.166)	(0.311)	(0.546)	(1.065)	(1.281)	(1.394)
ΔOpenness	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔGovernment expenditure	-0.268***	-0.269***	-0.285***	-0.288***	-0.285***	-0.287***
	(0.071)	(0.070)	(0.071)	(0.073)	(0.071)	(0.070)
ΔLog GDP	0.223	0.651	-1.324	-0.895	-1.122	-0.563
	(1.235)	(1.334)	(1.402)	(1.512)	(1.374)	(1.440)
Crisis*ΔGDP		-2.833		-5.407		-23.616*
		(3.708)		(7.124)		(13.982)
N	659	659	659	659	659	659
Within R^2	0.219	0.221	0.153	0.155	0.157	0.170

Notes: dependent variable is cumulative change over 5 year in top 1 percent incomes for the period 1950-2012. Standard errors are reported in parentheses. Fe-estimation by xtscc. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Technical specification: Driscoll and Kraay standard errors

The Driscoll and Kraay (1998) standard errors are based on the heteroskedasticity- and autocorrelation consistent matrix estimator of Newey and West (1987); however, cross-sectional dependence is taken into account as well. As the regression will be based on a fixed effect regression model with Driscoll and Kraay standard errors, the data are transformed in two steps. First, all model variables are within-transformed as follows:

$$\tilde{z}_{it} = z_{it} - \bar{z}_i + \bar{\bar{z}}, \quad \text{where } z_{it} = T_i^{-1} \sum_{t=t_{i1}}^{T_i} z_{it} \quad \text{and } \bar{\bar{z}} = (\sum T_i)^{-1} \sum_i \sum_t z_{it}$$

This corresponds to the OLS estimator of:

$$\tilde{y}_{it} = \tilde{x}'_{it}\theta + \tilde{\varepsilon}_{it}$$

for which it is assumed that the regressors x_{it} are uncorrelated with ε_{it}, implying strong exogeneity. However, the error terms ε_{it} themselves are allowed to be heteroskedastic, autocorrelated and cross-sectionally dependent.

The next step is to estimate the FE transformed regression model above with Driscoll-Kraay standard error. The coefficient θ can consistently be estimated by OLS regression, yielding:

$$\hat{\theta} = (X'X)^{-1}X'y$$

Discroll and Kraay standard errors for the coefficient estimates are then obtained as the square root of the diagonal elements of the asymptotic covariance matrix:

$$V(\hat{\theta}) = (X'X)^{-1}\hat{S}_T(X'X)^{-1}$$

where $\hat{S}_T$ is defined by Newey and West (1987) as:

$$\hat{S}_T = \hat{\Omega}_0 + \sum_{j=1}^{m(T)} \omega(j,m)[\hat{\Omega}_j + \hat{\Omega}'_j]$$

with m(T) denoting the lag length of autocorrelation and $\omega(j,m)$ representing the modified Bartlett weights. The matrix $\hat{\Omega}_j$ is defined as:

$$\hat{\Omega}_j = \sum_{t=j+1}^{T} h_t(\hat{\theta}) h_{t-j}(\hat{\theta})' \text{ with } h_t(\hat{\theta}) = \sum_{i=1}^{N(t)} h_{it}(\hat{\theta})$$

To make the Discroll and Kraay (1998) estimator suited for unbalanced panels in the xtscc command, in the summation above, the N in N(t) is allowed to vary with t. In short, Driscoll and Kraay's covariance estimator is equal to the heteroskedasticity- and autocorrelation consistent covariance matrix estimator of Newey and West (1987) applied to the time series of cross-sectional averages of the $h_{it}(\hat{\theta})$.