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Essays on Growth, Finance and Inequality

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ABSTRACT

This dissertation consists of three chapters.

The first chapter examines the frequency of banking crisis is statistically significantly correlated to growth for the time windows of 1 decade and 2 decades, this negative relationship becoming increasingly more statistically insignificant overall for time windows from 3 decades to 10 decades before finally becoming positive, though statistically insignificant, for the time windows of 13 decades and longer for our sample. The frequency of currency crisis is statistically significantly negatively associated with growth overall for the time windows of 1 decade to 10 decades, before becoming insignificantly positive for time windows of 13 decades and longer for our sample.

The second chapter examines the effect of capital account openness on growth using two measurements of capital account openness, i.e., CAPITAL (1955-2004) and The Chinn-Ito Index (1970-2014). I find that capital account openness had a positive effect on 5-year average growth, 10-year average growth and 20-year average growth based on panel analyses, but an insignificant even negative effect on growth in the long run based on cross-sectional regressions. The results are robust to controlling country dummy and time dummy.

The third chapter uses data of Gini coefficient, GDP per capita, ratio of fixed capital to GDP and ratio of labor to GDP from China for period 1978-2013, this paper attempts to explore long run and short run causality relationship between income inequality and growth. My findings show there exist neither long run nor short run causality link between Gini coefficient and log of GDP per capita.

DEDICATION

To my parents and families, who have been there for me from day one. Thank you for all of the endless love, support, encouragement and dedication.

To all friends of mine, who has been supporting me studying abroad, Thank you for all of your love, support, help, encouragement and dedication.

This is a tribute to all of you.

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CHAPTER ONE

Banking Crisis, Currency Crisis and Growth

This paper examines the effect of banking and currency crises on long-run growth. Our data cover 130 economies from 1800 to 2010, some dating from 1800 with the rest beginning in later years. The data include banking crises, currency crises, output per worker, growth rate of population and regional dummies.

We found that both the frequency of banking crises and the frequency of currency crises have a negative and statistically significant effect on growth in the short run and a positive effect on growth, though statistically insignificant, in the longer run. While the frequency of currency crisis has a more negative impact on growth in the short to medium run (10 decades) than does the frequency of banking crisis, the effects of both become insignificantly positive in the longer run.

More specifically, we show that the frequency of banking crisis is statistically significantly correlated to growth for the time windows of 1 decade and 2 decades, this negative relationship becoming increasingly more statistically insignificant overall for time windows from 3 decades to 10 decades before finally becoming positive, though statistically insignificant, for the time windows of 13 decades and longer for our sample. The frequency of currency crisis is statistically significantly negatively associated with growth overall for the time windows of 1 decade to 10 decades, before becoming insignificantly positive for time windows of 13 decades and longer for our sample.

1. Introduction

Financial crisis, which has attracted people's attention since the Great Depression, is one of the dominant economic features of our age, with one of the resulting questions becoming*: How does financial crisis affect economic growth?* This paper limits financial crisis to banking crisis and currency crisis only. To answer this question, we attempt to explore further the relationship between banking crises, currency crises and growth from short-run to long-run based on the existing literature.

The first and perhaps the deepest impression about a financial crisis is its strong destructive power and contagious effect. Indeed, a large body of literature discusses the output loss caused by banking and currency crises, most exploring recessions and their subsequent recoveries after banking and currency crises, showing how disruptive these financial crises are and how long it takes for economies to recover. For example, Bordo *et al*. (2001) concluded that banking and currency crises were more frequent but less costly in the 1980s and 1990s based on data for 23 countries from the nineteenth century until today, and Claessens et al. (2012) show that recessions accompanied with episodes of financial disruption, notably house and equity price busts, tend to be longer and deeper, while recoveries combined with rapid growth in credit and house prices tend to be stronger.

Bordo and Haubrich (2012) examine the strength of recoveries after banking crises, finding that deeper recessions associated with them are also associated with faster recoveries. Similar results were found by Dwyer et al. (2013), who concluded that cross-country evidence is consistent with Zarnowitz's Law, i.e., if there is a contraction in economic activity as measured by real GDP per capita after a banking crisis, a larger fall

is associated with recovery at a faster rate; however, they also found a substantial diversity in the effect of banking crises on real GDP per capita.

More recently, Devereux and Dwyer (2016) examined the output costs associated with 150 banking crises using cross-country data after 1970, finding many banking crises do not lead to contractions and most do not lead to large contractions, a result that holds for both developed and developing economies. In addition, they found that output losses are positively related to prior economic conditions such as credit growth for developed economies. For low-income economies, they found that other factors such as having a stock market and deposit insurance are more important.

Another stream of the literature addresses the relationship between banking crisis, currency crisis and growth, an area closer to the question posed earlier, with Milesi-Ferretti and Razin (2000) finding that growth tends to decline in the year when the crisis occurred and to recover thereafter; in addition, countries more open to trade tend to grow faster after currency crises. Barro (2001) conducted a panel analysis of 67 industrialized and emerging countries, finding that a twin crisis typically reduces economic growth over a five-year period by 2% per year. In addition, he found that the financial crises had no persistent effects on growth beyond a five-year period. Reinhart and Rogoff (2009), who examined the fifteen worst financial crises of the second half of 20th century, found that 10 years after these crises, the median level of GDP per capita was still 15 percent below the trend level prior to crisis, although GDP was unaffected once enough time passed.

Hong and Tornell (2005) investigated data from 100 developing countries, finding that even if the growth rate of GDP recovered to its pre-trend level two to three years after

a recession resulting from a currency crisis, it falls permanently below the original growth path that it would have achieved without the crisis. Gupta et al.'s (2007) study of 195 episodes of currency crises in developing countries from 1970 to 2000 found that approximately 60% of them were accompanied by output contraction, while the rest were accompanied by output expansion. They concluded that crises are 1.5 times more likely to be contractionary in emerging markets than in developing economies. Cecchetti et al. (2009) used 40 systemic crises with information on the policies implemented found in Laeven and Valencia (2008), complementing the data for these 40 crises with more detailed information on initial conditions and outcomes. They found most systemic banking crises led to a decrease in growth, taking the economies several years to recover to their prior peak level. Bordo et al. (2010) investigated the impact of foreign currency debt on currency and debt crises and their indirect effects on short-term growth and long-term output based on data from 45 countries from 1880-1913 and 1973-2003, finding that the financial crisis driven by foreign currency exposure led to significant permanent output losses, and Reinhart and Rogoff (2015) investigated 66 countries over an extensive period, finding that crises are typically associated with lower medium-term (five to ten years) growth.

This research introduced above provides evidence for a negative impact of banking and currency crises on economic growth. Based on their earlier work (Rancière et al, 2006), Rancière et al. (2008), found results contradicting these studies that long-run growth (from 10 to 40 years) and banking crises are positively related. They showed that over the last four decades, countries that have experienced financial crises have, on average, grown faster than countries with stable financial conditions. To explain this finding, they present

a model in which contract enforceability problems generate borrowing constraints and impede growth. The key of to this mechanism is that government bailout guarantees encouraged individuals to take more risks than would otherwise be the case, and this behavior increases investment rate, further enhancing growth although this strategy incurs systemic crisis occasionally, a well-known moral hazard combined with institutional factors and policies at work. Similarly, Houston et al. (2010) also found a higher likelihood of financial crisis could be associated positively with higher growth by initiating stronger creditor rights to encourage both risk-taking and enhanced growth. Jarrow (2014) proposed a model to explain this bilateral relationship between financial development and economic growth.

Contrasting findings give us different perspectives, the overall reasoning being that if the prosperity of the financial industry inherently contributes to economic growth, there must exist some underlying risk factors accompanying the development of this industry. A financial crisis will break out at some point when that these risks evolve out of control. Therefore, the development of financial markets is a two-edged sword. In this sense, the negative short-run correlation between financial crisis and growth may be positive or negligible in the long run.

Consider an extreme case such as North Korea, which has a repressed financial system run by the government. There is no possibility of a financial crisis in North Korea even if the country experiences a lack of economic growth. Beyond that extreme, though, the countries with stable financial conditions (a safe path) might not grow faster than the countries with risk-taking tendencies (a risky path).

There is another possible role that financial crisis plays, that is, reform catalyst. Government, institutions and even the public can learn lessons from financial crisis, this will increase institutional quality, which is beneficial to growth in the long run.

If a country can learn from the financial crisis and subsequently takes institutional reform, then this country will possibly get stronger and make financial crisis less costly. In turn, this makes it utilize the positive effect of financial system on growth to the utmost extent, and then financial crisis might actually regenerate a vibrant economy. The literature introduced above, which is not extensive, finds mixed results on the effect of crises on an economic growth in the long run. Theoretically, either relationship is possible. Then it is just the mixed evidence in the literature trigger us to examine the relationship between banking, currency crises and long-term growth.

Based on the existing literature, we construct a broader dataset covering 130 countries from 1800 to 2010, a period much longer than that found in most of the literature. Our data on banking crises and currency crises combine 4 sources, i.e., Bordo et al. (2001), Reinhart and Rogoff (2011) and Laeven and Valencia (2013), and our data of the output per worker and population growth come from Tamura et al. (2016).

Some countries in our consolidated dataset cover the entire period from 1800 to 2010, with the remainder encompassing later time spans as explained in detail in Section Two. As our results show, the frequency of banking crises is significantly negatively associated with growth for time windows of one and 2 decades, a negative relationship that becomes increasingly more insignificant overall for time windows from three to 10 decades, and finally becoming a positive though insignificant for longer time window of 13, 16, and

19 decades. While the frequency of a currency crisis is significantly negatively associated with growth overall for time windows from one to 10 decades, it becomes insignificantly positive for time windows of 13, 16, and 19 decades. In the short to medium run, the frequency of currency crisis is more negatively related to growth than the frequency of banking crisis. These results are more comprehensive than those found in previous works, for they incorporate short-term, medium-term and long-term analyses, thereby actually capturing the evolution of the relationship between banking crises, currency crises and economic growth.

This paper is structured as follows: Section 2 introduces the definitions of banking crisis and currency crisis, providing an historical review of the theories associated with them. Section 3 presents the empirical analysis, and Sections 4 offers conclusions and implications of this work.

2. Definitions and Duration of Banking Crises and Currency Crises

2.1. Definitions of Banking Crisis

The fact that definitions and dating of banking crises differ across studies has been discussed in previous work before (see Frydl, 1999; Boyd et al. 2009; Babecký et al., 2012). Table 1.1 gives the definitions for dating the various types of crises for the three sources of our dataset: Bordo et al. (BEKM); Laeven and Valencia (LV); Reinhart and Rogoff (RR). As this table shows, these vary across these three datasets. In particular, for banking crises, researchers disagree about how many banks must be closed or what percentage of the financial system's capital must be impaired for a crisis to be classified as systemic.

Table 1.1. Definitions of Banking Crisis and Currency Crisis

Authors	Sample	Banking Crisis Definition	Currency Crisis Definition
Bordo et al(2001)	1880-1939 21 Advanced Countries 1945-1997 21 Advanced Countries + 34 Less Developed Countries and Emerging Market Economies	Financial distress resulting in the erosion of most or all of aggregate banking system capital as in Caprio and Klingebiel (1996)	Forced change in parity, abandonment of a pegged exchange rate, or an international rescue. OR: an exchange market pressure (EMP) above a critical threshold (calculated as a weighted average of exchange rate change, short-term interest rate change, and reserve change relative to the same for the center country, the UK before 1913 and the US after). A currency crisis is said to occur when this index exceeds a critical threshold. We score an episode as a currency crisis when it shows up according to either or both of these indicators
Reinhart and Rogoff (2009)	1800-2011 70 Countries	A banking crisis occurs when there are **one of two types of events**: **(1)** bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions; **OR** **(2)** if there are no runs, the closure, merging, takeover, or **large-scale government assistance** of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions.	Reinhart and Rogoff(2009) An annual depreciation versus the US dollar (or the relevant reserve currency currency—historically the UK pound, the French franc, or the German DM and presently the euro) of 15 percent or more.

Laeven and Valencia (2012)	1970-2011 162 Countries	Two conditions 1. Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations) 2. Significant banking policy intervention measures in response to significant losses in the banking system.	Nominal depreciation of the currency against the dollar of at least 30% that is also 10 percentage points higher than the rate of depreciation in the year before.

The dating of banking crises has traditionally relied primarily on the identification of "events" or subjective criteria to determine when one occurs (for example, Caprio and Klingebiel, 1996; Caprio, Klingebiel, Laeven, and Noguera, 2005; and Reinhart and Rogoff, 2009). While the advantage of such an approach is its flexiblility, the disadvantage is that it may be seen as arbitrary. The definition of banking crisis provided by Laeven and Valencia (2013) is more clear and easy to quantify, hence, less subject to such criticism.

To compare the accuracy of various databases of banking crises, Chaudron et al. (2014) have compiled data to reconstruct the most important aspects of a systemic banking crisis based on their definition that a significant number or proportion of the banks must fail and/or that a significant proportion of the banking's sector equity must have faced losses. Using these data, Chaudron et al. (2014) compared the dating of banking crises for the three leading databases (Caprio et al, 2005; Reinhart and Rogoff, 2009; Laeven and Valencia, 2013) for the four crises with the most different time periods across these databases– the United States savings and loan crisis during the 1980s, the Japanese banking crisis of the 1990s, Norway's banking crisis during the early 1990s and Turkey's crisis

around the turn of the century. Their evidence suggests the database of banking crises compiled by Laeven and Valencia is the most accurate. The standard adopted by Charudron et al. (2014) does not take into account the possible interventions of the government that could reduce bank failures while both RR's and LV's definitions of a banking crisis consider large-scale of government intervention, meaning the latter would consider an event not accompanied with substantial capital loss due to the intervention by government as a banking crisis while Charudron et al.(2014) would not.

Unsatisfied with the prevalent definitions of banking crisis, Von Hagen and Ho (2007) propose an index based on money market pressure to identify banking crises for 47 countries from 1980 to 2001. They measure the money market pressure by the change in the short-term interest rate divided by its standard deviation plus the change in the volume of central bank reserves divided by its standard deviation. Based on Von Hagen and Ho (2007), Jing, Zhongbo, et al (2015) modify the market pressure index and identify banking crises for 109 countries from 1970 to 2009. Boyd et al. (2009) developed systemic bank shock indicators based on a theoretical model.

2.2. Definitions of Currency Crisis

Currency crisis is a situation in which a country with a fixed or pegged exchange rate faces a financial situation such as a deterioration of economic fundamentals or a speculative attack on the foreign exchange market, resulting in it needing to move to a floating exchange rate regime. Since the exchange rate determined by market is much higher than pegged level, the central bank of the country does not have sufficient foreign

exchange reserves to maintain the pegged fixed exchange rate, subsequently leading to a chronic balance of payments deficit and finally, the currency depreciating dramatically. This currency crisis is also referred to as a balance of payments crisis.

The definitions of currency crisis are not as different as the definitions of banking crisis, for it is much easier to quantify by the change in the exchange rate. A currency crisis is usually identified by a threshold decline (e.g., 15% or 30%) in the nominal exchange rate. Both Laeven and Valencia (2013) and Reinhart and Rogoff (2009) adopt the definition proposed by Frankel and Rose (1996).

2.3. History and theory overview of banking crises

Banking crises have been around for a long history, were referred to as bank panics or liquidity crises before the appearance of deposit insurance or other forms of government guarantees and the creation of the lender of last resort (see Bordo et al., 2016). During a bank panic many depositors rush to convert their deposits into cash almost simultaneously, leading to bank failure since these institutions do not have enough reserves to meet the demand. Bank panics were typical in the nineteenth century for the developed countries where the central bank functioned as the lender of last resort. After WWII, with the widespread adoption of deposit insurance and the intervention by the lender of last resort, banking panics become rare. Instead, now banking issues largely involve the insolvency of significant parts of the banking system, referred to as banking crises.

According to Bordo et al. (2016), there are three traditional approaches for theorizing about banking crises: the monetarist approach; the financial fragility approach

and the business cycles approach, with the contemporary literature based on rational expectations and game theory being based on these. The first approach, the monetarist approach developed by Friedman and Schwartz (1963), identifies financial crises with banking panics. According to them, banking panics occur because the public loses confidence in the ability of banks to convert deposits into currency. This loss of confidence is typically associated with the failure of important financial institutions as happened in 1873, 1893, and 1907.

The business cycles approach views banking panics as more likely during a recession because the returns on bank assets are likely to fall as borrowers become less likely to repay their loans (Mitchell, 1941). Depositors anticipating an increase in non-performing loans try to protect their wealth by withdrawing their deposits, precipitating a bank run (Allen and Gale, 2007).

Government guarantees created a direct link between the banking system and the government's balance sheet. Once this precedent was set, a costly bailout had the potential to create significant fiscal imbalance and even lead to default. Moreover, guarantees could also lead to moral hazard problems.

The third approach, the financial fragility approach, regards financial crises as an essential part of the upper turning point of the business cycle and as a necessary consequence of the excesses of the previous boom. Its well-known twentieth century proponents are Hyman Minsky (1977) and Henry Kaufman (1986). This approach has seen increased interest since the financial crisis of 2007-2009.

2.4. History and theory overview of currency crises

Advanced countries under the pre-1914 gold standard generally avoided currency crises, speculative attacks on a pegged exchange rate reflecting an inconsistency between domestic fundamentals and the peg; however, they became a larger concern in the interwar and under the Bretton Woods system (Bordo et. al., 2001). Many currency crises, for example those in the early 1970s during the breakdown of the Bretton Woods global system, were due to the conflict between the goal of maintaining a fixed exchange-rate regime with other policy goals.

In the first-generation model of currency crises, Krugman (1979) argued that the conflict of domestic fiscal and monetary fundamentals with the pegging exchange rate would incur speculative attacks. The second-generation models (Obstfeld, 1995) suggest that self-fulfilling prophecies potentially occur: if investors expect other investors to attack the currency, then they attack the currency rationally. The Asian crisis led to the creation of third- generation speculative attack models. Both the financial institutions and the exchange-rate regimes collapsed in this crisis, indicating the links between governments and financial institutions can expose the system to further fragility. The third-generation models explore how problems in the banking and financial system interact with currency crises and how these crises impact the rest of the economy (McKinnon & Pill (1996), Krugman (1998), Corsetti, Pesenti, & Roubini (1998), Radelet & Sachs (1998), Chang and Velasco (2000), Burnside, Eichenbaum, and Rebelo (2001 and 2004), Krugman(1999)).

2.5. Relationship between banking crisis and currency crisis

According to Bordo and Meissner (2015), during the post-World War II period and especially since the 1970s, banking, currency, and debt crises have become closely linked because governments realized the disastrous consequence of banking panics, becoming more willing to guarantee significant percentages of the liabilities of the banking system; because of this decision, banking panics have evolved into sovereign debt crises. Frequently, currency crises have occurred simultaneously with banking crises, a situation referred to as twin crises (Kaminsky and Reinhart, 1999). Glick and Hutchison (2000) found that these twin crises occurred frequently in financially liberalized emerging markets, with banking crisis frequently preceding the currency crisis in emerging markets but the converse not holding true.

Causality between these two can begin with either the crisis: a banking crisis can lead to capital flight and consequently currency devaluation, while a currency crisis can, in turn, lead to insolvency for banks holding a large number of foreign currency denominated liabilities and domestic currency denominated assets. In addition, there may be joint causality, i. e., some underlying common factors that cause the twin crisis, meaning there might not be a causality relationship between banking and currency crises (see Chang and Velasco (1999), McKinnon and Pill (1996, 1998), Kaminsky and Reinhart (1999)).

2.6. Duration of banking crises and currency crises

While the researchers listed in Table 1.1 define duration as the time it takes for an economy to recover from the downturn after financial crises, they differ in the standards used to measure the recovery. Even though it is more accurately phrases as "*duration of*

recession after crisis," for simplicity, we will refer to it as the "duration of crisis." Below are the definitions for duration of crisis for these three researchers:

- According to Bordo et al. (2001, p. 55), *"To quantify the depth and duration of crises, we calculate the trend rate of growth of GDP for five years preceding the event. Recovery time, that is, crisis duration, is calculated as the number of years before GDP growth returns to the trend."*
- According to Reinhart and Rogoff (2014, pp. 51) "*duration measure is the number of years it takes to reach the prior peak in real per capita income."*
- And Leaven and Valencia (2013, pp. 245) define it as *"the end of a crisis as the year before both real GDP growth and real credit growth are positive for at least two consecutive years. In case the first two years record growth in real GDP and real credit, the crisis end date equals the starting date of the crisis. In computing end dates, we use bank credit to the private sector (in national currency) from IFS (line 22d). . . . We truncate the duration of crises at five years, starting with the first crisis year. . . We also report the duration of the crisis, computed as the difference between the end and start years of the crisis, measured in years."*

As all three definitions of the duration of a crisis is measured in years, for this research, the minimum duration of a crisis is required to be at least one year. The duration of all banking crises and currency crises in our sample are shown in detail in Table A1 in Appendix.

3. Data description

We use three data sources from the banking crises and currency crises listed in Table 1.1, i.e., from Bordo et al. (2001), Reinhart and Rogoff (2011) and Laeven and Valencia (2013), and one source of output per worker and growth rate of population from Tamura et al. (2016). We combined these datasets of financial crisis following the procedure of Dwyer et al. (2013), using the dataset from Bordo et al.(2001) before 1970 and Laeven and Valencia (2013) for 1970 on, and then Reinhart and Rogoff (2011) when these two datasets are not available. More specifically, Bordo et al. (2001) provide data for a 21-country sample from 1880 to1939 and 21 advanced countries plus 34 less developed countries and emerging markets. The crises dataset from Laeven and Valencia (2013) covers 161 countries from 1970 to 2011 during which they identify 147 banking crises. The variables we used are listed in Table 1.2.

The communistic countries during this time period adopted a planned economy regime, which did not have a banking system nor did it experience financial crises. In addition, these countries adopted a Material Product Balance System (MPS), while capitalist countries adopted the System of National Accounts (NAS), the former is based on a planned economy while the latter is based on a market economy. Most of the communist countries switched to market-oriented countries after the dissolution of Soviet Union in 1991. While the data of the countries ever adopted communist regime are poorly estimated even decades after their transition. Given these differences, the data are not comparable between these two economies for our sample. In addition, our dataset is divided into 1 decade, 2 decades, …, 10 decades, while there are only 2 decades from 1990s to 2010, which is not long enough to cover the length of time windows longer than 3 decades.

Henceforth we just delete the data of the countries ever adopted communist regime.

As a result, we deleted the data from the countries under a communist regime, meaning our combined dataset included 130 countries from 1800 to 2010. The initial years in our sample differ across countries, focusing on 1800, 1820 and 1970 with all end dates being the year 2010. Figure 1.1 shows the beginning years of the different countries in the sample.

Figure 1.1 shows the beginning years of different countries in the sample.

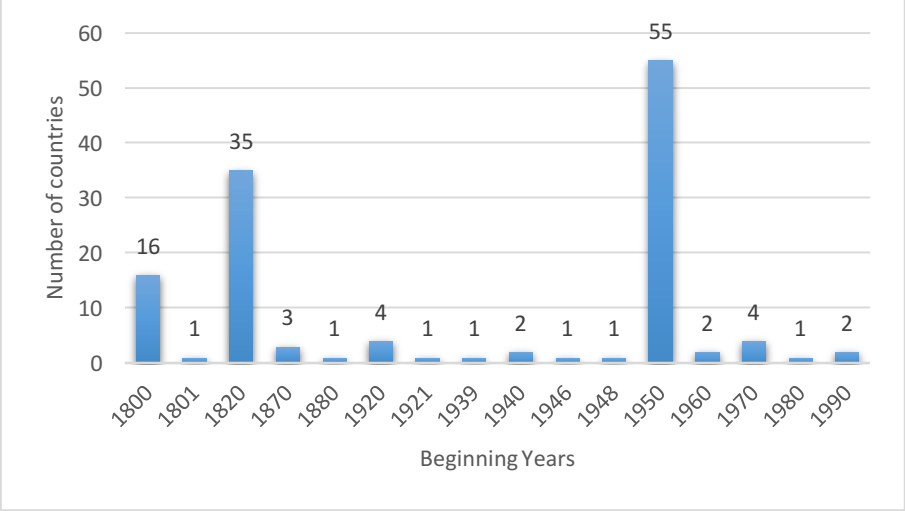


Figure 1.1 Beginning Years of Different Countries

Figure 1.2 shows the number of countries in the each beginning year for our sample.

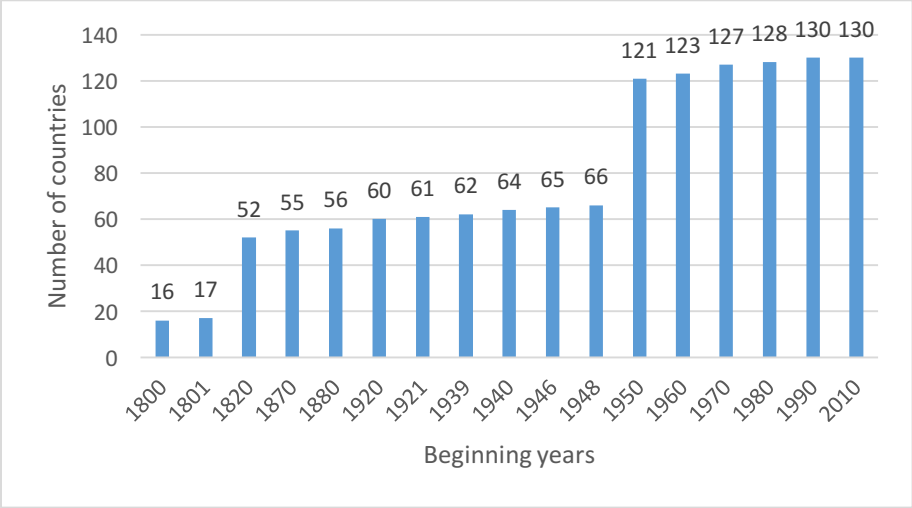


Figure 1.2. Number of Countries in Beginning Years

Table 1.2. Definitions and Sources of Variables Used in the Regression Analysis

Variable	Definition and construction	Source
Output per Worker	Output per worker in 2000 constant US$	Tamura *et al.*(2016)
Growth Rate of Output per Worker	Log difference of Output per worker	Tamura *et al.*(2016)
Growth Rate of Population	Log difference of Population	Tamura *et al.*(2016)
Frequency of Banking Crises	The number of banking crises a country experienced during a given period	Bordo *et al.*(2001), Reinhart and Rogoff (2011), Laeven and Valencia (2013)
Frequency of Currency Crises	The number of currency crises a country experienced during a given period	Bordo et al.(2001), Reinhart and Rogoff (2011), Laeven and Valencia (2013)
Region Dummy	Western Countries: 1 Southern Europe: 2 Central and Eastern Europe: 3 Newly Industrialized Countries: 4	Tamura *et al.*(2016)

	Asia: 5
	Sub-Saharan Africa: 6
	Latin America: 7
	Middle East: 8
	North Africa: 9

It should be noted that as will be shown in Section 3, the dataset is divided into decadal intervals, which are of multiple decades, the value in end years of each decade, 1800, 1810, …, 2010 are used for calculating the average annual growth rate of output per worker and population , while the frequency of data provided by Tamura et al. (2016) is only approximately but not exactly decadal. The missing data from Tamura et al. (2016) in the end years of each decade 1800, 1810, 1820, 1830... 2000 and 2010 were interpolated. After comparing various methods, we chose the geometrically interpolation method in which the values for the missing years are interpolated by adjacent available values. One limitation of this method is that the value in the interpolated year may be substantially different from the surrounding values for such reasons as financial crises, political crises or natural disasters. This issue, however, will be addressed in the long-run analysis.

The regional dummy variable comes from Tamura et al. (2016), who followed the convention of Lucas (1988) in region composition, with the only exceptions being the placement of Israel and Turkey in the Southern Europe region.

Table 1.3. Summary Statistics 1

Statistics	Formula	Value

Total Number of Banking Crises	$TB = \sum_{i=1}^{N} TB_i$	248
Total Number of Currency Crises	$TB = \sum_{i=1}^{N} TC_i$	458
Average Number of Banking Crises per Country per Year	$AB = \sum_{i=1}^{N} \frac{TB_i}{T_i} \Big/ N$	0.0153
Average Number of Currency Crises per Country per Year	$AC = \sum_{i=1}^{N} \frac{TC_i}{T_i} \Big/ N$	0.0284
Average Annual Growth Rate of Output Per Worker	$AG\_Y = \sum_{i=1}^{N} \frac{G\_Y_i}{T_i} \Big/ N$	0.0136
Average Annual Growth Rate of Population	$AG\_P = \sum_{i=1}^{N} \frac{G\_P_i}{T_i} \Big/ N$	0.0168

Note: TB_i, Total number of banking crises for country i over its sample period.

TB, Total number of banking crises over our sample.

TC_i, Total number of currency crises for country i over its sample period.

TC, Total number of currency crises over our sample.

AG_Y, Average annual growth rate of output per worker over our sample.

AG_P, Average annual growth rate of output per worker over our sample.

G_Y_i, Average annual growth rate of output per worker for country i over its sample period.

G_P_i, Average annual growth rate of population for country i over its sample period.

T_i, The length of sample period of country i.

Table 1.3 shows that the total number of banking crises is 248 and the total number of currency crises is 458 in our sample, the average number of banking crises per country per year is 0.015, and the average number of banking crises per country per year is 0.028. These two average values could be taken as the probability of the occurrence of banking crisis or currency crisis for a country in any given year for our sample. Moreover, average

annual growth rate of output per worker over our sample is 0.014 and average annual growth rate of population over our sample is 0.017.

Table 1.4. Summary Statistics 2

Statistics	Mean	Median	Min	Max	Std Deviation
Duration of Banking Crises	2.3	1	1	11	1.7
Duration of Currency Crises	1.2	1	1	8	0.6
Duration between Banking Crises	26.7	13.5	2	152	28.8
Duration between Currency Crises	13.4	9	2	100	14.4

Based on the definitions of duration of banking crisis and currency crisis introduced in sub-section 2.6, Table 1.4 shows the summary statistics of the duration of banking crises, the duration of currency crises, the duration between banking crises and the duration between currency crises, shown in Figure 1.3, Figure 1.4, Figure 1.5 and Figure 1.6, respectively.

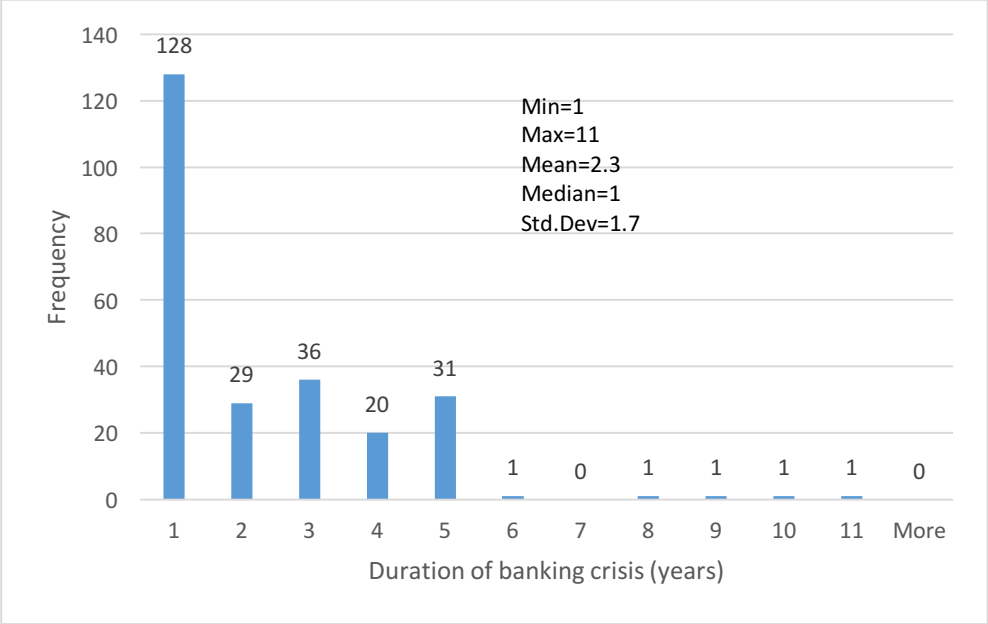


Figure 1.3. Histogram of the Duration of Banking Crises

More specifically, Figure 1.3 shows the histogram of the duration banking crises in our sample. We can see the minimum duration of a banking crisis is one year, as defined in Section 2.7, while the longest banking crisis lasts 11 years; the average duration of a banking crisis is 2.3 years, the median of which is 1 year, meaning that more than half of the banking crises last no more than 1 year. Of the 248 banking crises total in our sample, 128 last for 1 year, 29 for 2 years, 36 for 3 years, 20 for four years and 31 for 5 years.

Figure 1.4 below shows the histogram of currency banking crises in our sample.

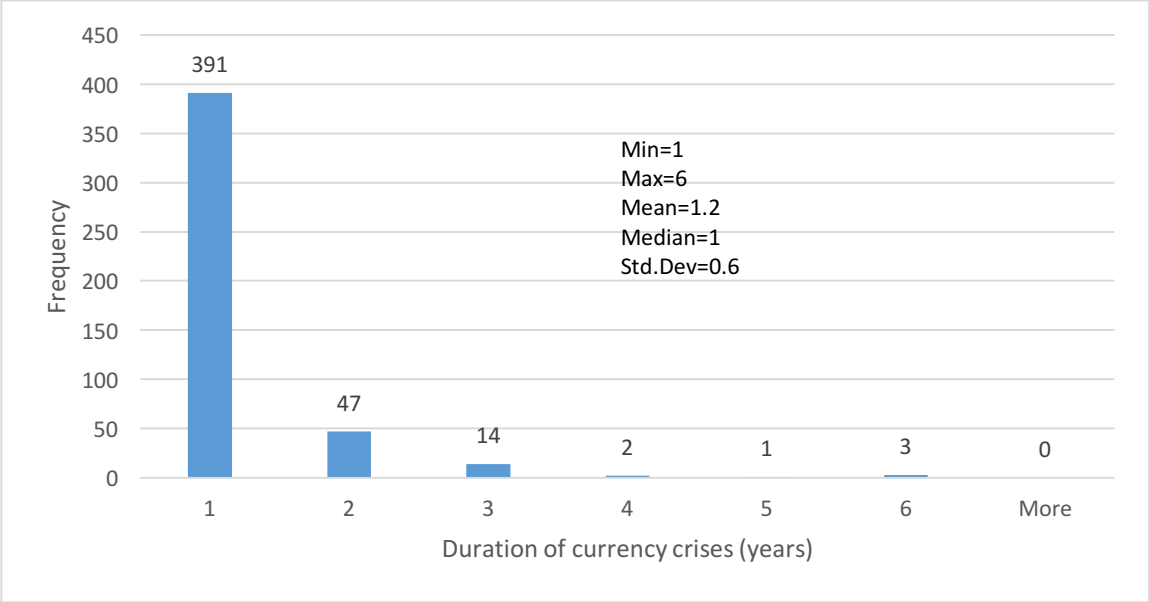


Figure 1.4. Histogram of the Duration of Currency Crises

We can see the minimum duration of currency crises is 1 year as defined in Section 2.7, with the longest currency crisis lasting 6 years; the average duration of the currency crises is 1.2 years, with a median of 1 year, meaning that more than half of currency crises

last no more than 1 year. Of the 458 total currency crises in our sample, 391 last for 1 year, 47 for 2 years, 14 for 3 years, 2 for 4 years, 1 for 5 years, and 3 for 6 years.

Figure 1.5 below shows the histogram of duration between banking crises in our sample.

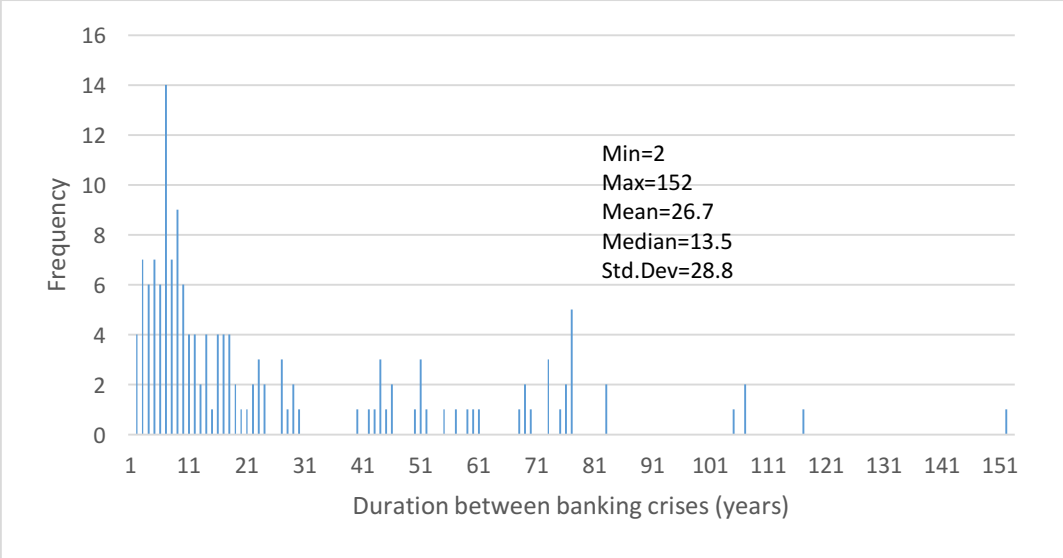


Figure 1.5. Histogram of Duration Between Banking Crises

We can see from this histogram that the shortest duration between banking crises is only 2 years, while the longest is 152 years, meaning that for 152 years, no banking crisis as defined in Section 2 occurred. The average duration between banking crises is 26.7 years, with a median of 13.5 years.

Figure 1.6 below shows the histogram between currency crises in our sample.

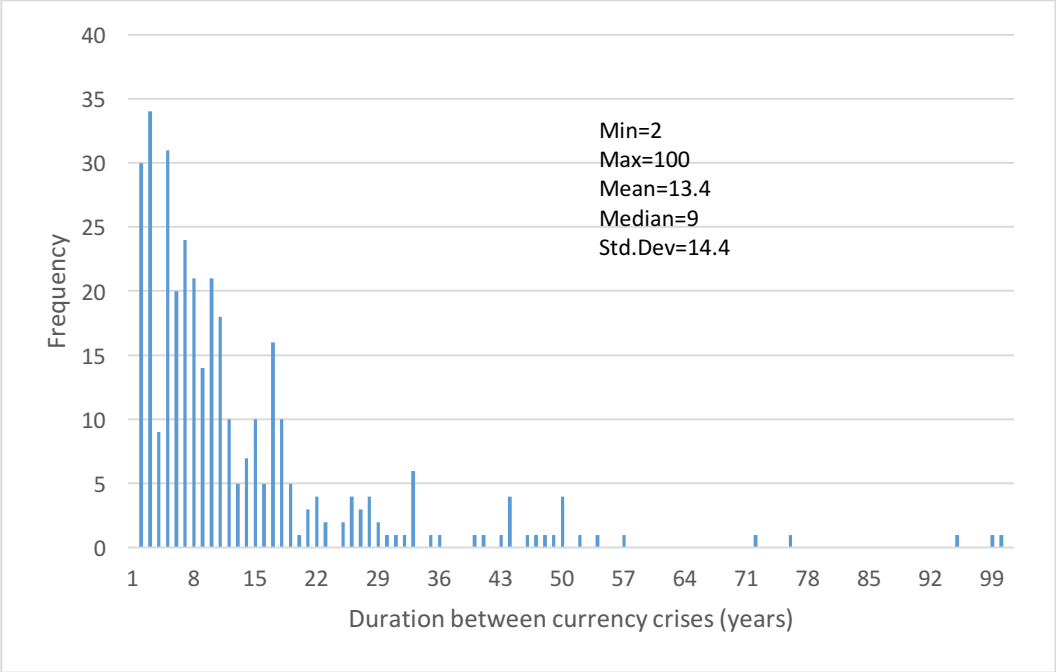
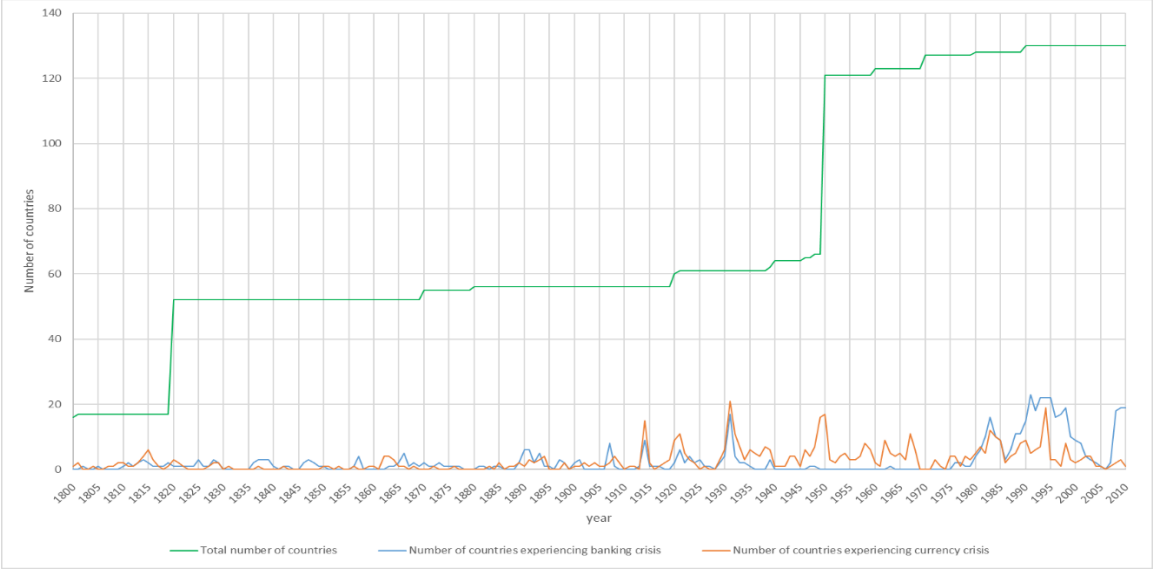


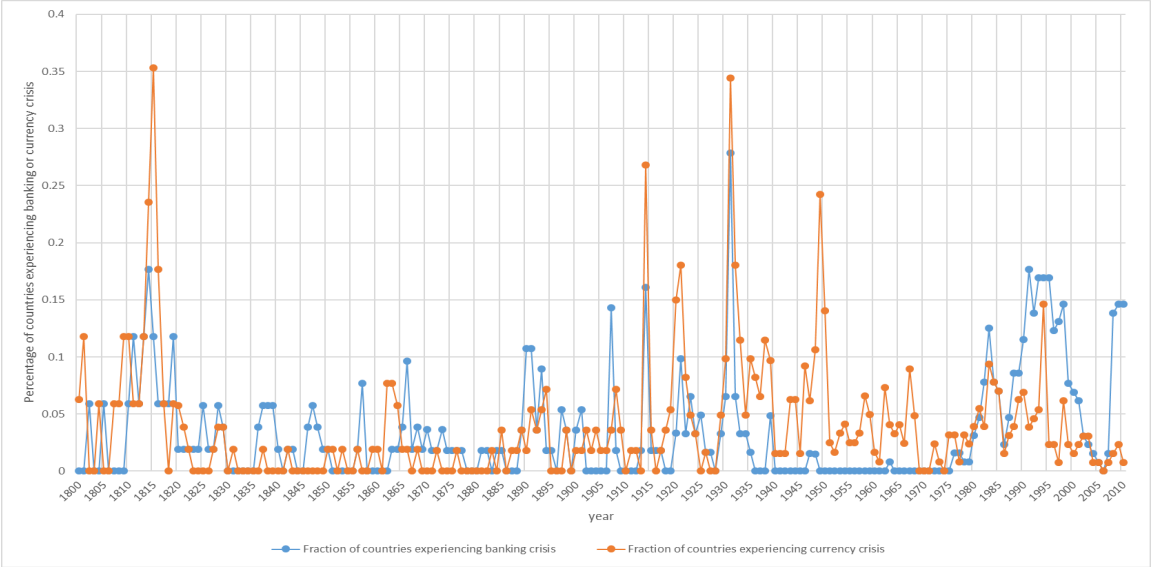
Figure 1.6. Histogram of Duration Between Currency Crises

We can see from this histogram that the shortest duration between currency crises is only 2 years, while the longest duration lasts 100 years, meaning that for a period of 100 years, no currency crisis as defined in Section 2 occurred. The average duration between currency crises is 13.4 years, with a median of 9 years.

Figure 1.7 below shows the number and percentage of countries experiencing banking and currency crisis from 1800 to 2010.



PANEL A



PANEL B

Figure 1.7. Number and Percentage of Countries Experiencing Banking and Currency Crisis from 1800 to 2010

This figure consists of two panels. Panel A shows the number of countries in financial crisis from 1800 to 2010, with the blue line representing the number experiencing a banking crisis during that period and the orange line, the number experiencing a currency

crisis. Similar to the curve in figure 1.2, the green curve represents the total number of countries included in our sample from 1800 to 2010.

Panel B shows the percentage of countries experiencing crises from 1800 to 2010, with the red line representing the percentage experiencing banking crises during that period and the green line the percentage experiencing a currency crisis. We can see clearly from PANEL B that, banking crises occurred highly simultaneously with currency crises. The percentage of countries experiencing currency crisis peaks significantly in 1815 at 0.35, 1914 at 0.27, 1931 at 0.34 and 1949 at 0.24. Overall, the percentage of countries experiencing banking crisis is lower than that of countries experiencing currency crisis from during 1800-2010 period, with only one peak exceeds 0.20 in 1931, and three peaks exceeds 0.15 in 1814, 1915, and 1993-1995.

Figure 1.8 shows the log of output per worker from 1800 to 2010.

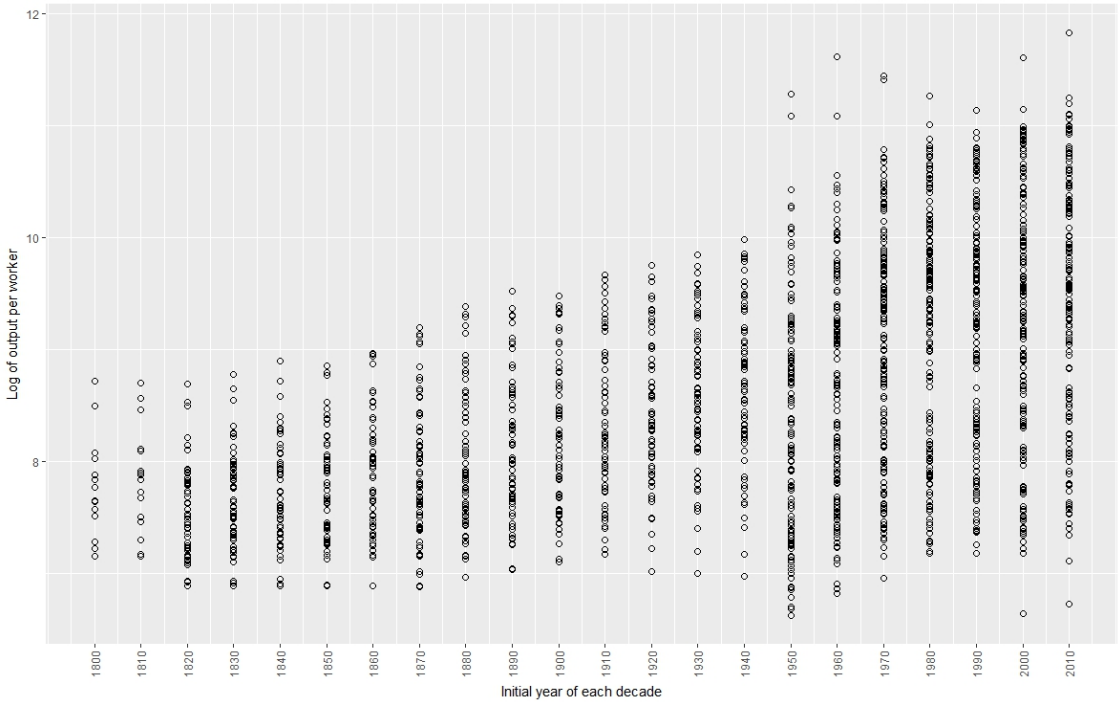


Figure 1.8. Log of Output per Worker for the Initial Years of Each Decade from 1800 to 2010

This figure clearly shows that the output per worker grew slowly but steadily during this period. The range of the log of output per worker increases over the years, with some being scattered far from the majority beginning in 1950. Part of the reason for this trend is that the number of countries increases from 66 in 1950 to 121 in 1950 as is shown in Figure 1.1. While most of the countries included after 1950 are low and middle-income countries, some of these economies expanded after 1950, and the gap between rich countries and poor countries became increasingly larger.

Figure 1.9 depicts the average growth rate of population of the countries for each decade from 1800 to 2010.

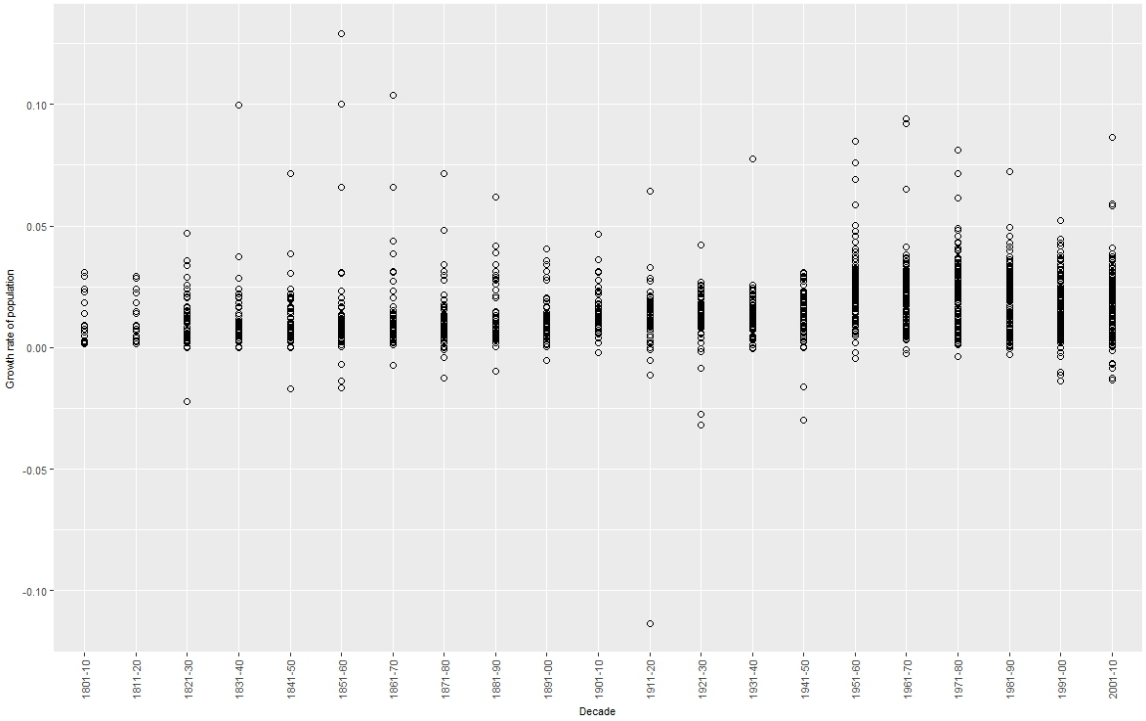


Figure 1.9. Average Growth Rate of Population of Countries from 1800 to 2010

As this figure shows, the growth rate of population remains very stable from 1800 to 2010, and most of the countries in our sample have an average growth rate of population of 0 to 0.05. The positive outlier in decade of 1851-1860 is in New Zealand, which has average annual growth rate of population of 12.91% during the decade. And the especially low outlier in decade of 1911-1920 is in Austria, which has average annual growth rate of population of -11.46% during the decade.

Figure 1.10 incorporates three parts into one graph, i.e., growth rate of output per worker per country for each decade, average number of banking crises and currency crises per country for each decade from 1800 to 2010.

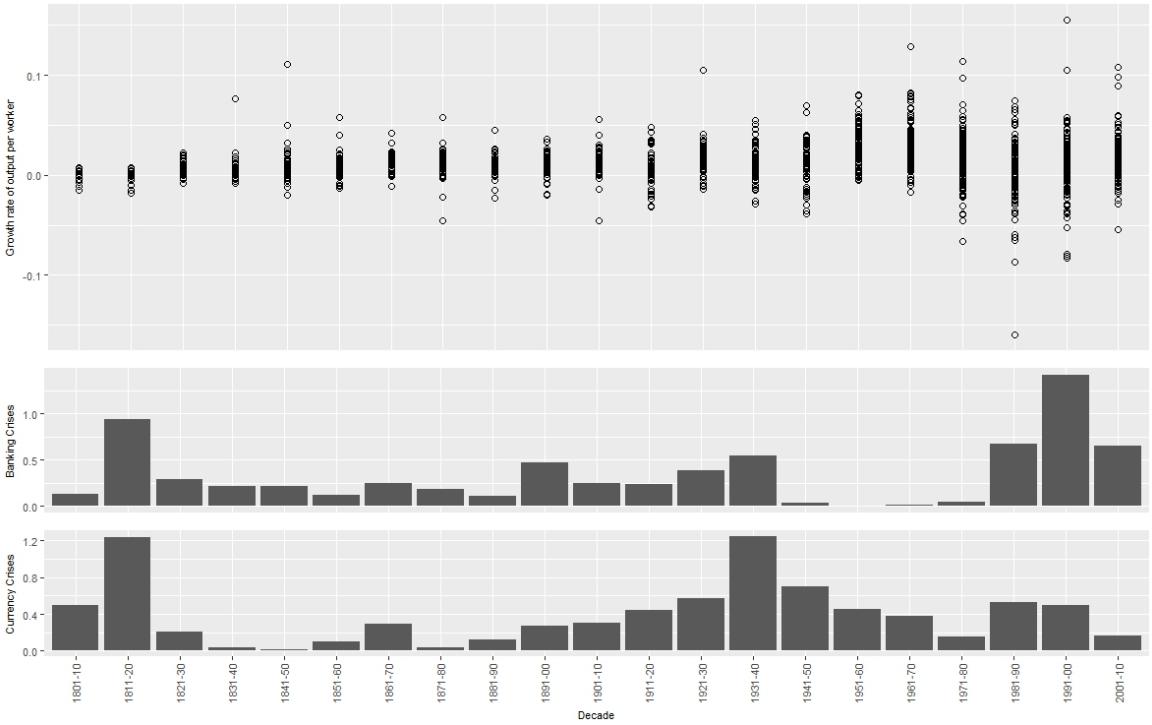


Figure 1.10. Growth Rate of Output per Worker per Country for Each Decade, Average Number of Banking Crises and Currency Crises per Country for Each Decade (1800-2010)

The average number of crises equals the number of crises divided by the number of countries in the sample for each sub-period. The data in the second panel and the third panel in Figure 1.10, which are similar to that in Panel B in Figure 1.7, show the average number of banking crises and currency crises per country from 1800 to 2010. As this figure shows, it is evident that often banking crises and currency crises occur simultaneously, both lines peaking in the 1811-1810 period, the 1931-1940 period and the 1991-2000 period. At first glance, the growth rate of output per worker for each decade in a period of more than an average number of banking crises and currency crises tends to be lower than during other periods, indicating that these crises have an adverse impact on growth in the

short run, i. e. for about a decade. There are some apparent outliers in figure 1.10, i.e., experienced high annual growth rate of output per worker of 11.09% in decade of 1841-1850, Venezuela experienced a high annual growth rate of output per worker of 10.53% in decade of 1921-1930, and Equatorial Guinea experienced a high annual growth rate of output per worker of 15.54% in decade of 1991-2000. The negative outlier is in Qatar, which has annual growth rate of output per worker of -15.96% in decade of 1981-1990.

4. Estimation

In this section, we investigate the relationship between banking crises, currency crises and growth, showing that our results are robust to the inclusion of variables controlling for population growth, country effect, time effect and regional dummy variables. In situations when the presence of unobservable, country-specific characteristics might affect the dependent variable and might be correlated with the independent variables, fixed effects models are particularly suitable. Moreover, they are generally appropriate when the data come not from a random sample but instead are the universe of data available, as is the situation here (For a discussion, see Hsiao, 1986.). In addition, our dataset covers 211 years, long enough to see the time effects on economic growth. Thus, we control for both country effect and time effect in the panel analysis.

4.1 Baseline models

Equation (4.1.1) below represents the baseline model for panel regressions:

$$\Delta y_{it} = \beta_1 FB_{it} + \beta_2 FC_{it} + \mu_i + \theta_t + \gamma' X_{it} + \varepsilon_{it} \qquad (4.1.1)$$

$$\Delta y_i = \beta_0 + \beta_1 FB_i + \beta_2 FC_i + \gamma' X_i + \varepsilon_i \quad (4.1.2)$$

where $\boldsymbol{\Delta y_{it}}$: is the average annual growth rate of output per worker for country i during period t(a specific time window), a value which equals the log difference of output per worker; $\boldsymbol{FB_{it}}$ is the frequency of banking crisis, i.e., the average number of banking crises country i experienced per decade during period t; $\boldsymbol{FC_{it}}$ is the frequency of Currency Crisis, i.e., the average number of currency crises country i experienced per decade during period t. While there are times when a banking or currency crisis spans across the adjacent two periods, if we count this banking crisis only in the first period, then its effect on growth in the second period is not controlled for. To address this situation, we prorate this bridging crisis over two periods. For example, a banking crisis begins in period $t-1$ and ends in period t, with a duration of L years; L_1 years of it fall in period $t-1$ and $L-L_1$ years of it fall in period t, then period $t-1$ has L_1/L of a banking crisis, and period t has $(L-L_1)/L$ of a banking crisis, meaning the number of banking or currency crises can be a percentage. The variable μ_i represents the country dummy and θ_t the period dummy. In addition, X_{it} is the set of control variables: the log of output per worker in the initial year for country i during period t and the average growth rate of population for country i during period t, and $\boldsymbol{\varepsilon_{it}}$ is the error term.

The coefficient β_1 in the equation measures how much the average growth rate of output per worker changes if the average number of banking crises a country experienced per decade increases by one, and similarly, coefficient β_2 measures by how much the average growth rate of output per worker changes if the average number of currency crises per decade increases by one;

Equation (4.1.2) represents the baseline model for cross-sectional regressions, where $\Delta \boldsymbol{y_i}$ is the average annual growth rate of output per worker for country i during the sample period, which equals the log difference of output per worker; $\boldsymbol{FB_i}$ represents the frequency of banking crisis, i.e., the average number of banking crises country i experienced per decade during the sample period; $\boldsymbol{FC_i}$ is the frequency of currency crisis, i.e., the average number of currency crises country i experienced per decade during the sample period; X_i represents the set of control variables for cross-sectional regressions, which includes the log of output per worker in the initial year of the sample period, the average growth rate of population during the sample period and regional dummies.

4.2. Endogeneity concern

In the absence of a theoretical growth model related to banking and currency crises that offers a clear explanation of these determinants, panel analysis offers the advantage of controlling for omitted (unobserved or mismeasured) variables. For example, the countries that experienced banking and currency crises might have other factors that boost their economy while those experiencing fewer such crises might not have, for example, a high real income level, a developed capital market, or a strong institution and legal system. The omission of such variables leads to an endogeneity problem. Because this research controls for county and time effects, panel analyses are appropriate as they allow for controlling for omitted variables without observing them.

The potential endogeneity problem caused by the reverse causality between the average annual growth rate of output per worker and the number of banking and currency

crises requires the former to affect the latter, a situation that may occur over ten years but not over thirty or more years. Even if this reverse causality exists, it only leads the correlation between growth rate of output per worker and the number of financial crises toward negative direction, but our findings show that their relationship evolves from negative to be positive. Hence, take one step back, the potential reverse causality is not strong enough to dominate over the underlying positive relationship between long-term growth rate of output per worker and the number of financial crises, which is one of our most important findings in our research.

Hence, there is supposed to be no serious concern about endogeneity problem in this research.

4.3. Multicollinearity Test

As mentioned in Section 2.5, the occurrence of banking crises and currency crises is often interconnected. Table 1.5 provides the correlation coefficients between their frequencies. Based on the "rule of thumb" test suggested by Anderson et al. (1990), any correlation coefficient exceeding 0.7 indicates a potential problem. As seen in Table 1.5, there are fairly low correlation coefficients between the frequency of banking crises and the frequency of currency crises, with the largest being 0.564 for the time window of the 16 decades from 1850 to 2010. Thus, there is no significant multicollinearity between the frequency of banking crises and the frequency of currency crises.

Table 1.5. Correlation Coefficients Between Frequency of Banking Crisis and Frequency of Currency Crisis for Various Time Windows

Time window	Correlation	Time window	Correlation
1 decade	0.286	9 decades	0.472
2 decades	0.318	10 decades	0.474
3 decades	0.394	13 decades(1820-1950)	0.565
4 decades	0.376	13 decades(1880-2010)	0.537
5 decades	0.431	16 decades(1820-1980)	0.535
6 decades	0.516	16 decades(1850-2010)	0.564
7 decades	0.519	19 decades(1820-2010)	0.524
8 decades	0.481		

The report of Variance Inflation Factor (VIF) for the four independent variables is shown in Table 1.6. None of the values in parenthesis is greater than 2.00, meaning there is no significant multicollinearity among the four independent variables.

Table 1.6. Variance Inflation Factor

	Frequency of Banking Crisis	Frequency of Currency Crisis	Log of Initial Output per Worker	Average Annual Growth Rate of Population
1 decade	1.075	1.0180	1.060	1.006
2 decades	1.082	1.093	1.054	1.027
3 decades	1.142	1.095	1.045	1.017
4 decades	1.080	1.048	1.024	1.026
5 decades	1.111	1.067	1.022	1.023
6 decades	1.191	1.153	1.028	1.020
7 decades	1.243	1.235	1.024	1.092
8 decades	1.210	1.163	1.081	1.075
9 decades	1.216	1.165	1.189	1.074

10 decades	1.208	1.039	1.166	1.273
13 decades(1820-1950)	1.467	1.204	1.299	1.056
13 decades(1880-2010)	1.601	1.272	1.277	1.431
16 decades(1820-1980)	1.432	1.152	1.293	1.111
16 decades(1850-2010)	1.651	1.270	1.196	1.222
19 decades(1820-2010)	1.550	1.172	1.336	1.178

4.4 Estimation Results

4.4.1. Panel regressions with fixed effects for both country and time

This section provides the panel analysis with fixed effects for both country and time from the time window of 1 decade to 10 decades based on the baseline model in Equation (4.1.1). Table 1.7 shows the panel regressions for the time windows of 1 decade and 2 decades, while Table 1.8 shows the panel regressions for time windows of 3 and 4 decades, Table 1.9 for time windows of 5 and 6 decades, Table 1.10 for time windows of 7 and 8 decades and Table 1.11 for time windows of 9 and 10 decades.

The variables in these panel regressions include the dependent variable of average annual growth rate of output per worker and the explanatory variables of frequency of banking crisis, i.e., the average number of banking crises per decade; frequency of currency crisis during each period, i.e., the average number of currency crises per decade; the log of the output per worker in the initial year of each period; the average growth rate of population during each period; and the country dummies and time dummies.

Table 1.7. Panel Analyses of 1 and 2 Decades Controlling for Country and Time Effects

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**1 decade**			**2 decades**		
Frequency of Banking Crisis	-0.0040 ***	-0.0042 ***	-0.0044 ***	-0.0032	-0.0035 *	-0.0037 *
	(0.0014)	(0.0014)	(0.0014)	(0.0024)	(0.0022)	(0.0021)
Frequency of Currency Crisis	-0.0030 **	-0.0037 ***	-0.0038 ***	-0.0024	-0.0038 **	-0.0041 **
	(0.0013)	(0.0010)	(0.0013)	(0.0019)	(0.0016)	(0.0021)
Log of Initial Output per Worker		-0.0155 ***	-0.0149 ***		-0.0187 ***	-0.0181 ***
		(0.0015)	(0.0019)		(0.0020)	(0.0020)
Growth Rate of Population			0.2200 ***			0.1648 **
			(0.0638)			(0.0726)
Number of Countries	130			130		
Number of Periods	20			10		
Number of Observations	1516			726		
R-squared	0.0145	0.0837	0.0987	0.0089	0.1760	0.1873
F statistics/ P value	10.0415/ 4.68e-05	41.5093/ < 2.22e-16	37.2854 / < 2.22e-16	2.7354/ 0.0657	42.2316/ < 2.22e-16	34.1589/ < 2.22e-16

* p<0.01 ** p < 0.05. *** p < 0.01.

The coefficients of the dummies of country and time are not reported

We divide the sample period for the time window of 1 decade into the 21 periods of 1801-1810, 1811-1820, …, 2001-2010. Table 1.7 lists the six columns representing the six regressions, each panel including three regressions. The R-squared, F-statistics/ P value show the regression listed in the first column is outperformed by that listed in the second and the third column. In addition, we can see that the coefficients of each variable remains stable in terms of sign, magnitude and significance across the second column and the third column. So we mainly look at the third column contains four variables of the coefficient. For panel analysis of a time window of 1 decade, the coefficient on frequency of banking

crisis is -0.0044 significant at a level of 1%, meaning that when the average number of banking crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.44%. The coefficient on frequency of currency crisis is -0.0038 significant at a level of 1%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.38%.

We divide sample period for the time window of 2 decades into the 10 periods of 1811-1830, 1831-1850, …, 1991-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. The coefficient on frequency of banking crisis is -0.0037, significant at a level of 1%, meaning that when the average number of banking crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.37%. The coefficient on the frequency of currency crisis is -0.0041, significant at a level of 1%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.41%.

Table 1.8. Panel Analyses of 3 and 4 Decades Controlling Country and Time Effects

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**3 decades**			**4 decades**		
Frequency of Banking Crisis	0.0013	-0.0006	-0.0012	0.0019	-0.0001	-0.0004
	(0.0026)	(0.0022)	(0.0022)	(0.0031)	(0.0023)	(0.0023)
Frequency of Currency Crisis	-0.0021	-0.0040 **	-0.0042 **	-0.0032	-0.0049 **	-0.0051 **
	(0.0022)	(0.0017)	(0.0017)	(0.0032)	(0.0021)	(0.0020)
Log of Initial Output per Worker		-0.0191 ***	-0.0183 ***		-0.0198 ***	-0.0192 ***

		(0.0021)	(0.0020)		(0.0022)	(0.0022)
Growth rate of Population			0.1408 *			0.0893
			(0.0807)			(0.0787)
Number of Countries	128			127		
Number of Periods	7			5		
Number of Observations	485			313		
R-squared	0.0039	0.2490	0.2571	0.0119	0.3276	0.3320
F statistics/	0.6838/	38.4725/	30.0331/	1.0861/	29.0645/	22.17/
P value	0.50538	< 2.22e-16	< 2.22e-16	0.33975	2.3326e-15	7.2424e-15

* p<0.01 ** p < 0.05. *** p < 0.01.

The coefficients on the dummies of country and time are not reported

We divide the sample period for the time window of 3 decades into the 7 periods of 1801-1830, 1831-1860, …, 1981-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For the panel analysis of this time window, the coefficient of frequency of banking crisis is statistically significant at -0.0012, meaning that when the average number of banking crises increases by one per decade, the average annual growth rate of output per worker per decade decreases by 0.12%. The coefficient of frequency of currency crisis is -0.0042, significant at a level of 5%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.42%.

We divide the sample period for the time window of 4 decade into the 5 periods of 1811-1850, 1851-1891, …, 1971-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. The coefficient of frequency of banking crisis is negative but close to zero and statistically insignificant, meaning that an increase in the average number of banking crises does not have a statistically significant effect on the average annual growth rate of output per worker for

the time window of 4 decades. The coefficient of frequency of currency crisis is -0.0051, significant at a level of 5%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.51%.

Table 1.9. Panel Analyses of 5 and 6 decades Controlling Country and Time Effects

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**5 decades**			**6 decades**		
Frequency of Banking Crisis	-0.0012	-0.0009	-0.0011	0.0013	-0.0008	-0.0005
	(0.0035)	(0.003)	(0.0026)	(0.0035)	(0.0019)	(0.0019)
Frequency of Currency Crisis	-0.0032	-0.0044 **	-0.0039 **	-0.0030	-0.0038 *	-0.0036 *
	(0.0036)	(0.0022)	(0.0022)	(0.0034)	(0.0022)	(0.0021)
Log of Initial Output per Worker		-0.0202 ***	-0.0200 ***		-0.0187 ***	-0.0197 ***
		(0.0018)	(0.0018)		(0.0014)	(0.0016)
Growth rate of Population			0.0350			-0.0863
			(0.1042)			(0.0882)
Number of Countries	123			121		
Number of Periods	4			3		
Number of Observations	248			229		
R-squared	0.0143	0.3942	0.3950	0.0088	0.5315	0.5359
F statistics/	0.8676/	25.816/	18.6196/	0.4631/	38.9418/	24.7223/
P value	0.4226	6.2024e-13	6.9124e-12	0.63059	< 2.22e-16	1.5685e-12

* p<0.01 ** p < 0.05. *** p < 0.01.

The coefficients of dummies of country and time are not reported

We divide the sample period for the time window of 5 decades into the 4 periods of 1811-1860, 1861-1910, …, 1961-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For this panel analysis, the coefficient of frequency of banking crisis is statistically insignificant at -0.0011,

meaning that when the average number of banking crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.11%. The coefficient of the frequency of currency crisis is -0.0039, significant at a level of 5%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.39%.

We divide the sample period for the time window of 6 decades into the 3 periods of 1831-1890, 1891-1950, and 1951-2010. We mainly look at the third column contains which contains four variables of the coefficient. For this panel analysis, the coefficient of frequency of banking crisis is negative but close to zero and statistically insignificant, meaning that an increase in the average number of banking crises does not have a statistically significant effect on the average annual growth rate of output per worker for this time window. The coefficient of the frequency of currency crisis is -0.0036, significant at a level of 10%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.36%.

Table 1.10. Panel Analyses of 7 and 8 Decades Controlling Country and Time Effects

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**7 decades**			**8 decades**		
Frequency of Banking Crisis	-0.0033 (0.0041)	-0.0021 (0.0028)	-0.0022 (0.0029)	-0.0076 (0.0061)	-0.0008 (0.0029)	-0.0006 (0.0030)
Frequency of Currency Crisis	0.0007 (0.0036)	-0.0021 (0.0027)	-0.0021 (0.0027)	-0.0020 (0.0034)	-0.0045 * (0.0025)	-0.0045 * (0.0026)
Log of Initial Output per Worker		-0.0170 *** (0.0020)	-0.0169 *** (0.0020)		-0.0182 *** (0.0025)	-0.0187 *** (0.0026)

Growth rate of Population			0.0220 (0.1209)			-0.0336 (0.0785)
Number of Countries	64			61		
Number of Periods	3			2		
Number of Observations	135			113		
R-squared	0.0064	0.4186	0.4191	0.0069	0.5013	0.5026
F statistics/ P value	0.2145/ 0.8075	15.8442/ 7.2801e-08	11.7215/ 3.1578e-07	0.1705/ 0.84371	16.0848/ 2.2667e-07	11.8735/ 9.5479e-07

* p<0.01 ** p < 0.05. *** p < 0.01.

The coefficients of dummies of country and time are not reported.

We divide the sample period for the time window of 7 decades into the 3 periods of 1801-1870, 1871-1940, and 1941-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For panel analysis of this time window, the coefficient of frequency of banking crisis is insignificant at -0.0022, meaning that when the average number of banking crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.22%. The coefficient of frequency of currency crisis is also -0.0021 and statistically insignificant, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.21%.

We divide the sample period for the time window of 8 decades into the 2 periods of 8 decades of 1851-1930 and 1931-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For the panel analysis, the coefficient of frequency of banking crisis is negative but close to zero and statistically insignificant, meaning that an increase in the average number of banking crises does not have a statistically significant effect on the average annual growth rate of output

per worker for the time window of 8 decades. The coefficient of frequency of currency crisis is -0.0045, significant at a level of 10%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.45%.

Table 1.11. Panel Analyses of 9 and 10 Decades Controlling Country and Time Effects

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**9 decades**			**10 decades**		
Frequency of Banking Crisis	0.0050 (0.0071)	-0.0002 (0.0032)	0.0001 (0.0033)	-0.0022 (0.0063)	0.0015 (0.0016)	-0.0001 (0.0011)
Frequency of Currency Crisis	-0.0010 (0.0037)	-0.0048 * (0.0028)	-0.0048 * (0.0018)	-0.0071 (0.0051)	-0.0065 ** (0.0025)	-0.0066 ** (0.0030)
Log of initial Output per Worker		-0.0146 *** (0.0014)	-0.0150 *** (0.0020)		-0.0168 *** (0.0015)	-0.0134 *** (0.0018)
Growth rate of Population			-0.0240 (0.1029)			0.2488 *** (0.0788)
Number of Countries	60			56		
Number of Periods	2			2		
Number of Observations	112			73		
R-squared	0.0107	0.5855	0.5859	0.1305	0.8195	0.8730
F statistics/ P value	0.2670/ 0.76675	22.5999/ 2.8831e-09	16.6268/ 1.4812e-08	1.0504/ 0.3758	19.6808/ 4.0936e-05	20.6203/ 2.6185e-05

* p<0.01 ** p < 0.05. *** p < 0.01.

The coefficients of dummies of country and time are not reported

We divide the sample period for the time window of 9 decades into the 2 periods of 10 decades of 1831-1920, 1921-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For the panel analysis of this time window, the coefficient of frequency of banking crisis is negative but close to zero and statistically insignificant, meaning that an average increase in the number of banking crises does not have a statistically significant effect on the average annual growth rate of output per worker for the time window of 9 decades. The coefficient of frequency of currency crisis is -0.0048, significant at a level of 10%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.48%.

We divide the sample period for the time window of 10 decades into the 2 periods of 10 decades of 1811-1910, 1911-2010. For the same reason, we mainly look at the third column contains which contains four variables of the coefficient. For the panel analysis of this time window, the coefficient of frequency of banking crisis is negative but close to zero and statistically insignificant, meaning that an increase in the average number of banking crises does not have a statistically significant effect on the average annual growth rate of output per worker for time window of 10 decades. The coefficient of frequency of currency crisis is -0.0068, significant at a level of 5%, meaning that when the average number of currency crises increases by one per decade, the average annual growth rate of output per worker decreases by 0.68%.

4.4.2. Cross-sectional Regression

Since the longest time window for panel analyses is 10 decades, to investigate the relationship between banking crises, currency crises and growth in the long run, we extend the time windows by conducting cross-sectional regressions for time windows of 13 decades, 16 decades and 19 decades. The variables in cross-sectional regressions include the dependent variable of average annual growth rate of output per worker and the explanatory variables of frequency of banking crisis, the average number of banking crises a country experienced during the sample period; frequency of currency crisis, the average number of currency crises a country experienced during the sample period; the log of initial output per worker, the log of the output per worker in the beginning of the year during the sample period; the average growth rate of population during the sample period; and the regional dummy introduced in Table 1.2.

Table 1.12 presents cross-sectional regressions for the 2 time windows of 13 decades based on the baseline model in Equation (4.1.2), with the first regression being from 1820 to 1950 and the second regression from 1880 to 2010.

Table 1.12. Crises and Growth: Cross-sectional Regressions for Time Window of 130 Years

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Explanatory Variables	**1820-1950 (130 years)**		**1880-2010 (130 years)**	
Intercept	0.0010 (0.0147)	0.0390 *** (0.0095)	0.0370 *** (0.0094)	0.0421 *** (0.0083)
Frequency of Banking Crisis	0.0072 ** (0.0032)	0.0032 (0.0023)	0.0039 (0.0043)	0.0030 * (0.0021)
Frequency of Currency Crisis	0.0026 (0.0030)	-0.0015 (0.0032)	-0.0020 (0.0029)	0.0015 (0.0022)

Log of Initial Output per Worker	-0.0006 (0.0019)	-0.0051 *** (0.0012)	-0.0024 * (0.0011)	-0.0039 *** (0.0009)
Growth Rate of Population	0.2270 *** (0.0762)	0.1715 *** (0.0442)		0.0227 (0.0690)
Region: Western Countries		0.0128 (0.0016)		0.0074 *** (0.0017)
Region: Southern Europe		0.0061 (0.0015)		0.0066 *** (0.0016)
Region: Newly Industrialized Countries		0.0044 (0.0016)		0.0128 *** (0.0018)
Region: Sub-Saharan Africa		0.0074 (0.0013)		-0.0014 (0.0026)
Region: Latin America		0.0097 (0.0026)		0.0016 (0.0018)
Region: Middle East		0.0086 (0.0018)		0.00240 (0.0026)
Region: North Africa		0.0049 (0.0015)		0.0017 (0.0017)
Number of countries	52		56	
Adjusted R-squared	0.1822	0.7005	0.0240	0.6374
F statistics/ P value	3.841/ 0.008818	11.85/ 2.029e-09	1.337/ 0.2688	9.79/ 1.232e-08

* p<0.01 ** p < 0.05. *** p < 0.01.

For the cross-sectional regression of period 1820-1950, the first column represents the regression without regional dummies, in which the coefficient of the frequency of the banking crisis is statistically significant 0.0072 and that of the frequency of currency crisis is statistically insignificant 0.0026. The second column under regression of period 1820-1950 represents the regression with regional dummies, in which both of coefficients of the

frequency of banking crisis and the frequency of currency crisis are statistically insignificant are 0.0032 and -0.0015 respectively.

Figure 1.11 plots the regression line between frequency of banking crisis and frequency of currency crisis and average annual growth rate of output per worker for cross-sectional regression of period 1820-1950. Figure 1.12 and figure 1.13 plot the regression lines between frequency of banking crisis, frequency of currency crisis and average growth rate of output per worker of each region for cross-regression of period 1820-1950 with regional dummies.

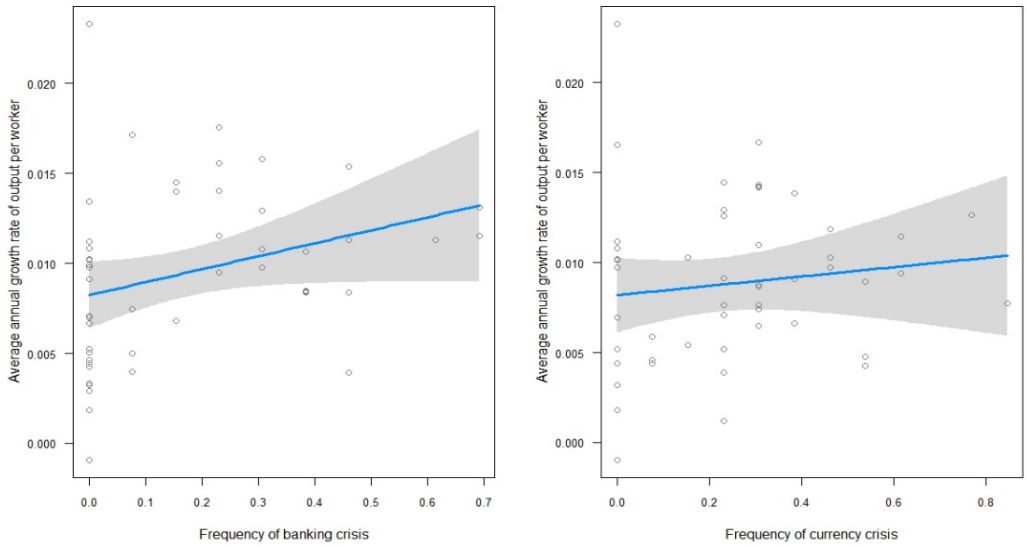


Figure 1.11 Regression Line Between Frequency of Banking Crisis and Frequency of Currency Crisis and Average Growth Rate of Output Per Worker for Cross- sectional Regression of 1820-1950 Without Regional Dummies.

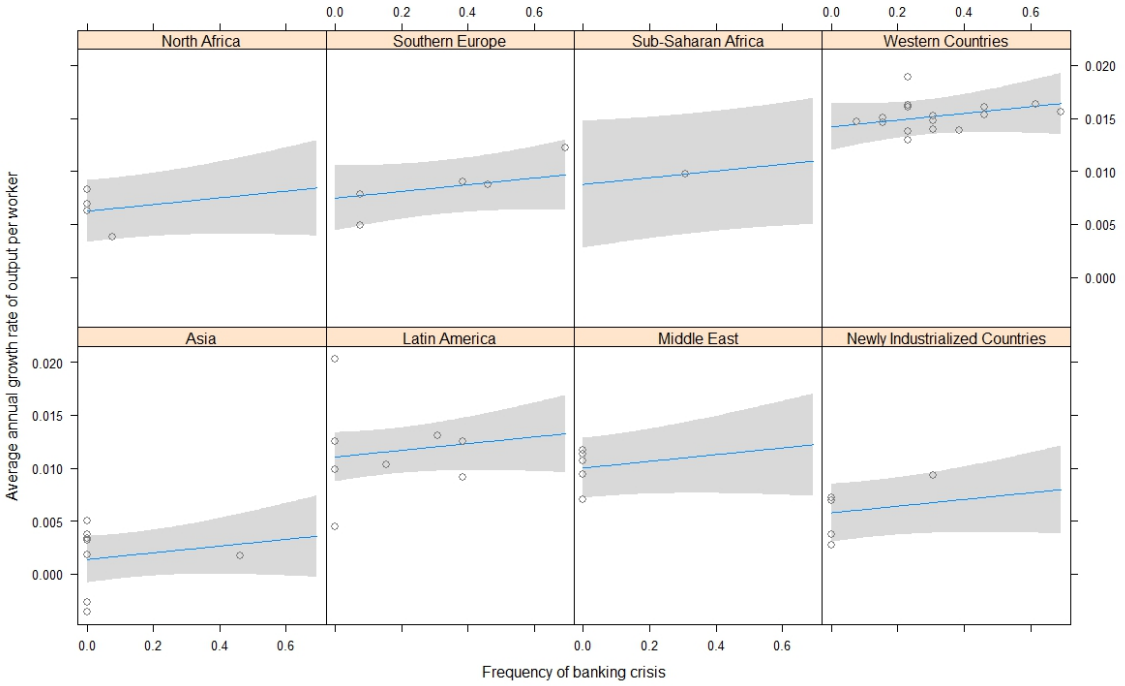


Figure 1.12 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross- sectional Regression of Period 1820-1950 with Regional Dummies.

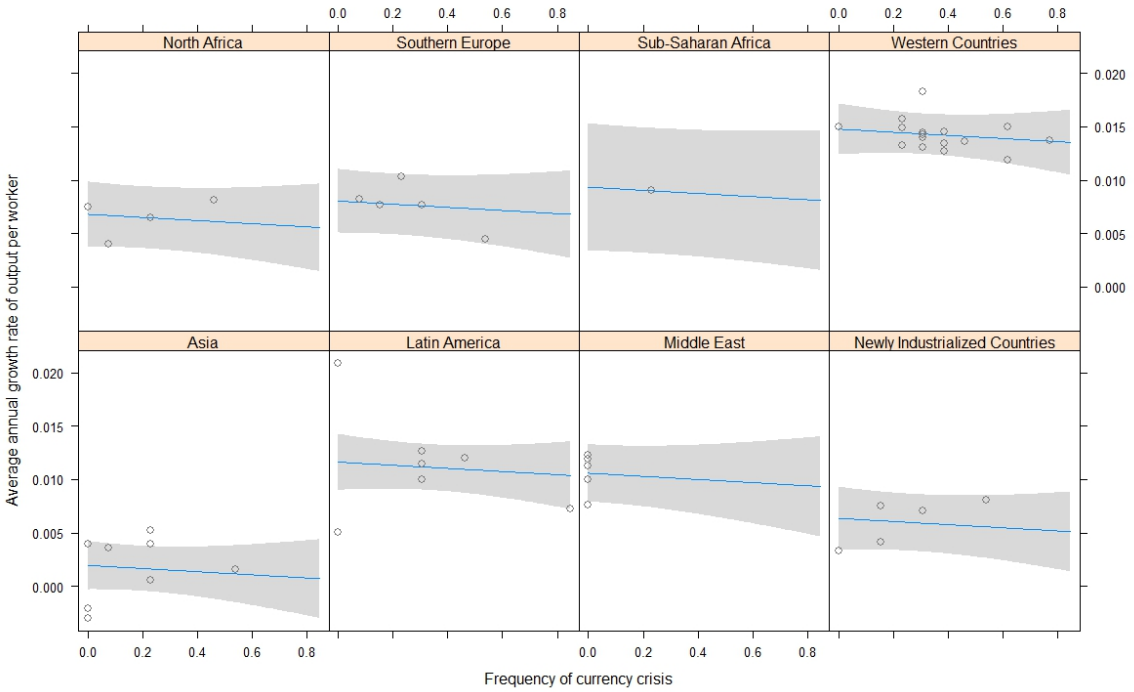


Figure 1.13 Regression Lines Between Frequency of Currency Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross- sectional Regression of Period 1820-1950 With Regional Dummies.

For the regression of period 1880-2010, the first column represents the regression without regional dummies, in which the coefficients of the frequency of the banking crisis and the frequency of currency crisis are statistically insignificant 0.0039 and -0.0020 respectively. The second column represents the regression with regional dummies, in which the coefficient of the frequency of banking crisis is statistically significant 0.0030 and the frequency of currency crisis is statistically insignificant -0.0015 respectively.

Figure 1.14 plots regression lines between frequency of banking crisis and average growth rate of output per worker of each region for cross-regression of period 1880-2010 with regional dummies. Figure 1.15 and figure 1.16 plot the regression lines between frequency of banking crisis, frequency of currency crisis and average growth rate of output per worker of each region for cross-regression of period 1880-2010 with regional dummies.

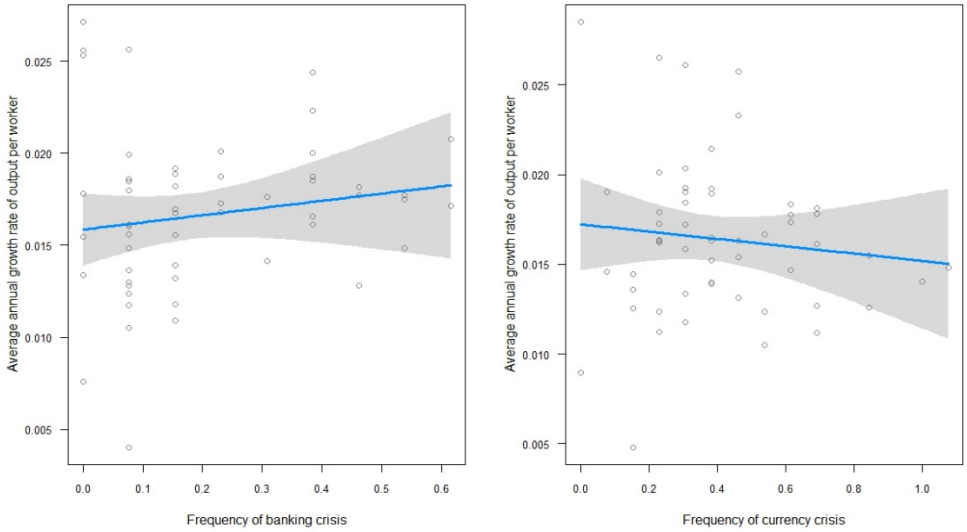


Figure 1.14 Regression Line Between Frequency of Banking Crisis and Frequency of Currency Crisis and Average Growth Rate of Output Per Worker for Cross-sectional Regression of 1880-2010 Without Regional Dummies.

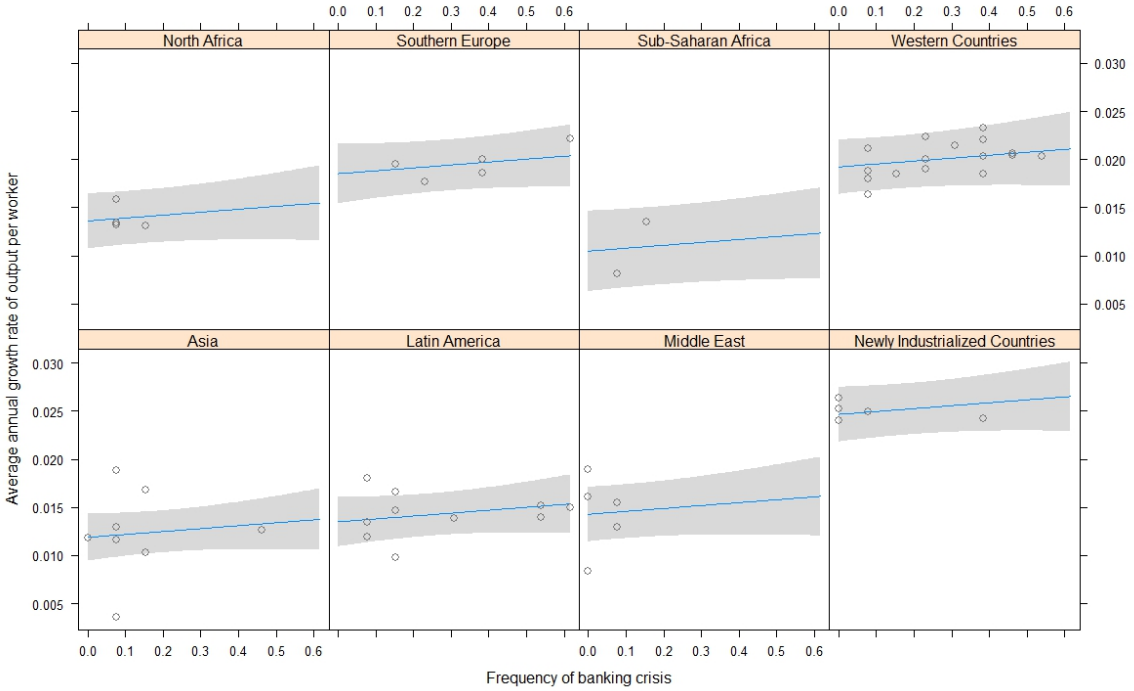


Figure 1.15 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1880-2010 With Regional Dummies.

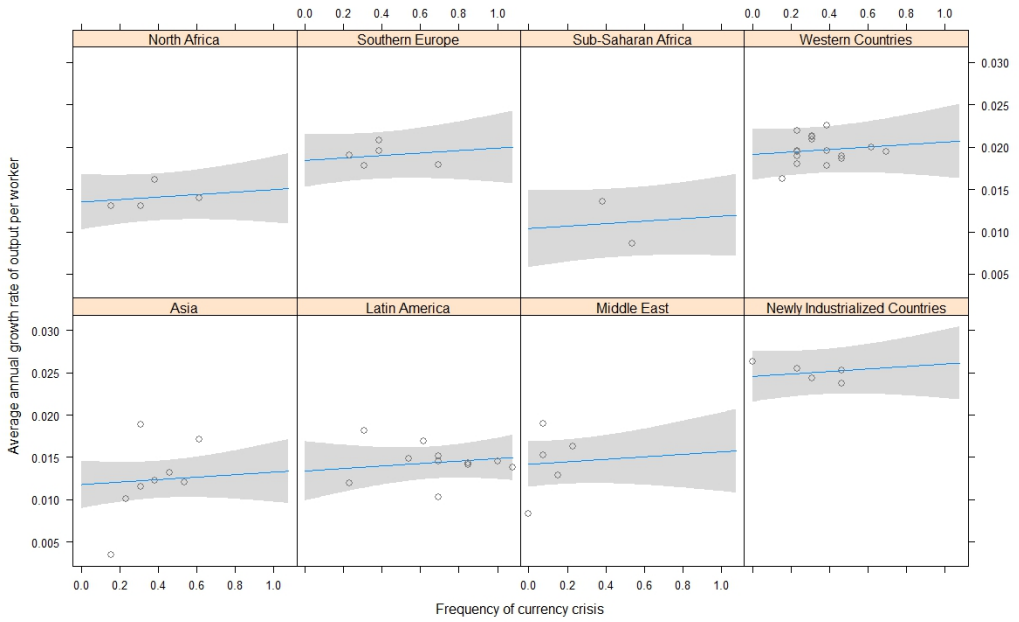


Figure 1.16 Regression Lines Between Frequency of Currency Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1880-2010 With Regional Dummies.

Table 1.13 presents the cross-sectional regressions for the 2 time windows of 16 decades based on the baseline model in Equation (4.1.2), with the first regression being from 1820 to 1980 and the second from 1850 to 2010.

Table 1.13. Crises and Growth: Cross-Sectional Regressions for the Time Window of 160 Years

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Explanatory Variables	**1820-1980 (160 years)**		**1850-2010 (160 years)**	
Intercept	0.0139 (0.0171)	0.0342 *** (0.0088)	0.0244 ** (0.0196)	0.0342 *** (0.0088)

Frequency of Banking Crisis	0.0084 * (0.0042)	0.0022 (0.0030)	0.0037 (0.0032)	0.0022 (0.0030)
Frequency of Currency Crisis	-0.0004 (0.0026)	-0.0006 (0.0027)	-0.0000 (0.0029)	-0.0006 (0.0027)
Log of Initial Output per Worker	-0.0003 (0.0021)	-0.0039 *** (0.0011)	-0.0012 (0.0014)	-0.0039 *** (0.0011)
Growth Rate of Population	0.1137 (0.0780)	0.0955 ** (0.0400)	-0.0140 (0.0858)	0.0955 ** (0.0400)
Region: Western Countries		0.0121 *** (0.0015)		0.0121 *** (0.0015)
Region: Southern Europe		0.0098 *** (0.0020)		0.0098 *** (0.0020)
Region: Newly Industrialized Countries		0.0093 *** (0.0017)		0.0093 *** (0.0017)
Region: Sub-Saharan Africa		0.0065 *** (0.0016)		0.0065 *** (0.0016)
Region: Latin America		0.0086 *** (0.0020)		0.0086 *** (0.0020)
Region: Middle East		0.0089 *** (0.0019)		0.0089 *** (0.0019)
Region: North Africa		0.0055 *** (0.0017)		0.0055 (0.0017)
Number of countries	52		52	
Adjusted R-squared	0.03747	0.6823	-0.04646	0.6613

F statistics/ **P value**	1.496/ 0.2185	10.96/ 6.106e-09	0.4339/ 0.7834	10.05/ 2.005e-08

* p<0.01 ** p < 0.05. *** p < 0.01.

For the cross-sectional regression of period 1820-1980, the first column represents the regression without regional dummies, in which the coefficient of the frequency of the banking crisis is statistically significant 0.0084 and that of the frequency of currency crisis is statistically insignificant -0.0004. The second column under regression of period 1820-1980 represents the regression with regional dummies, in which both of coefficients of the frequency of banking crisis and the frequency of currency crisis are statistically insignificant are 0.0022 and -0.0006 respectively.

Figure 1.17 plots the regression line between frequency of banking crisis and frequency of currency crisis and average annual growth rate of output per worker for cross-sectional regression of period 1820-1980. Figure 1.18 and figure 1.19 plots the regression lines between frequency of banking crisis and average growth rate of output per worker of each region for cross-regression of period 1820-1980 with regional dummies.

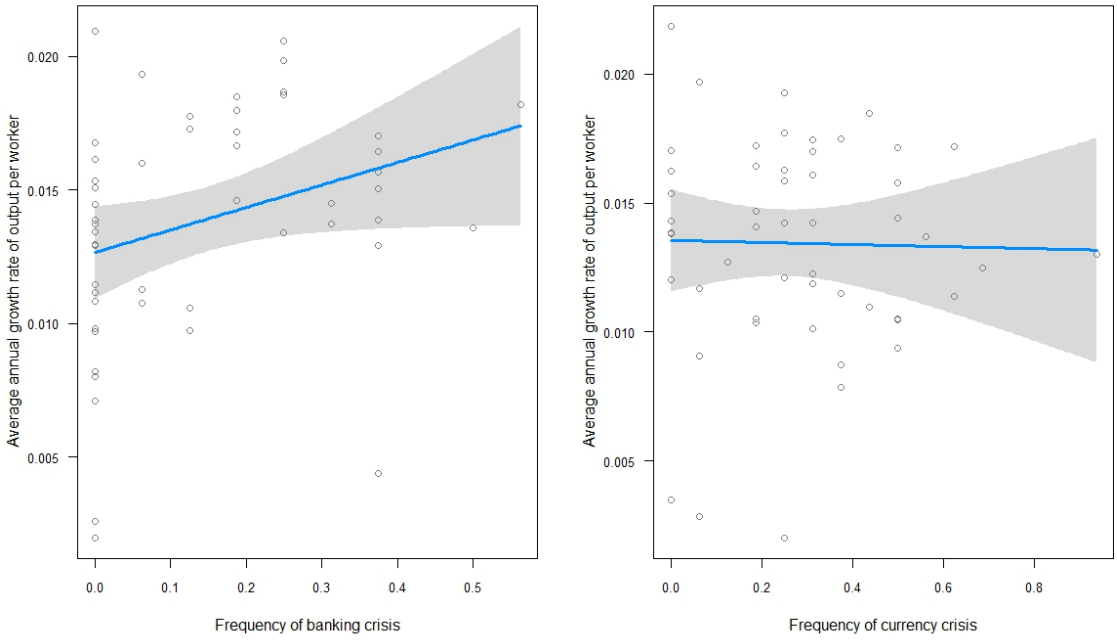


Figure 1.17 Regression Line Between Frequency of Banking Crisis and Frequency of Currency Crisis and Average Growth Rate of Output Per Worker for Cross-sectional Regression of Period 1820-1980 Without Regional Dummies.

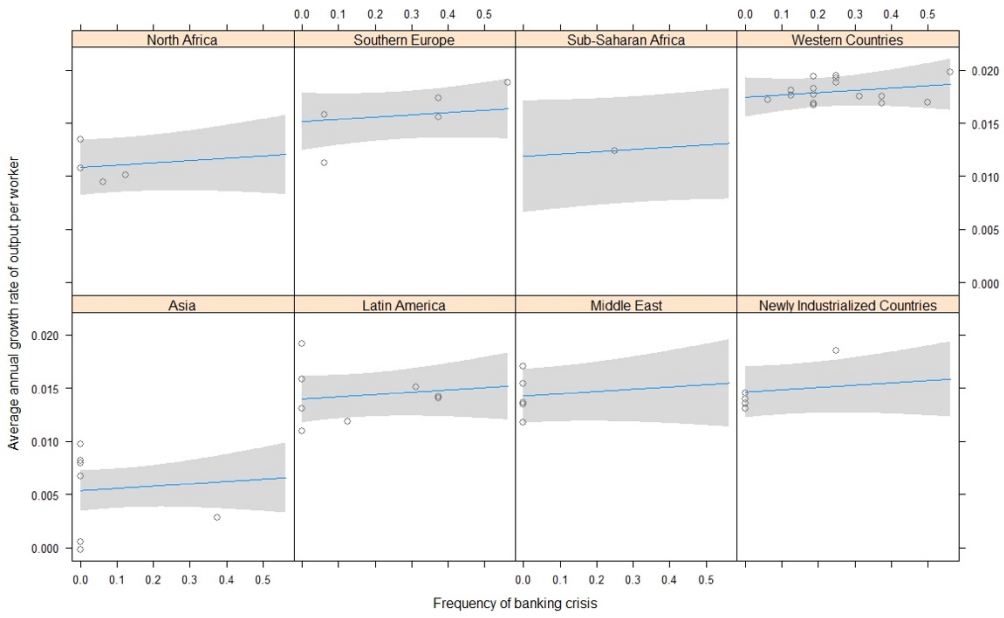


Figure 1.18 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1820-1980 With Regional Dummies.

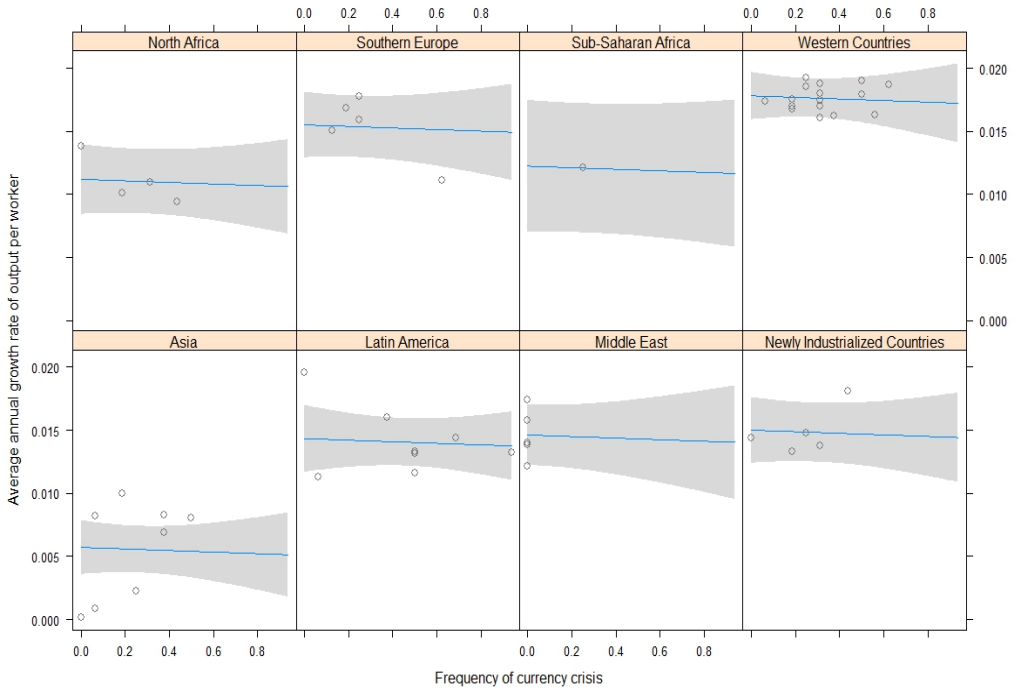


Figure 1.19 Regression Lines Between Frequency of Currency Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1820-1980 With Regional Dummies.

For the regression of period 1880-2010, the first column represents the regression without regional dummies, in which the coefficients of the frequency of the banking crisis is statistically insignificant 0.0037 and that of the frequency of currency crisis is almost close to zero respectively. The second column represents the regression with regional dummies, in which the coefficient of the frequency of banking crisis is statistically significant 0.0022 and the frequency of currency crisis is statistically insignificant -0.0006 respectively.

Figure 1.20 plots regression lines between frequency of banking crisis and average growth rate of output per worker of each region for cross-regression of period 1880-2010 with regional dummies. Figure 1.21 and figure 1.22 plot the regression lines between frequency of banking crisis, frequency of currency crisis and average growth rate of output per worker of each region for cross-regression of period 1880-2010 with regional dummies.

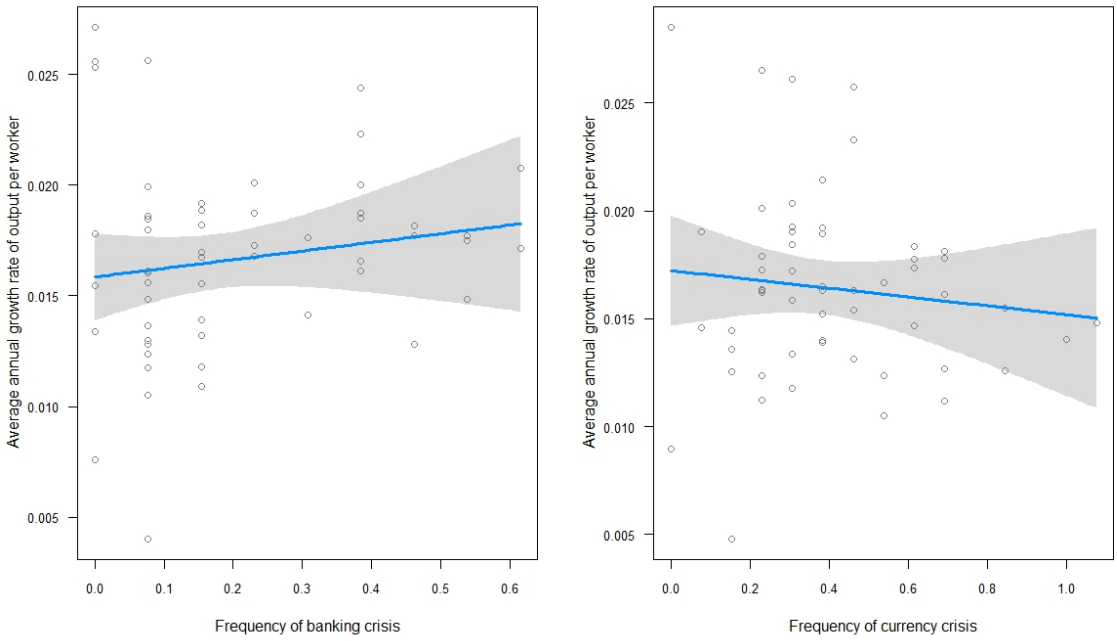


Figure 1.20 Regression line Between Frequency of Banking Crisis and Frequency of Currency Crisis and Average Growth Rate of Output Per Worker for Cross-sectional Regression of 1880-2010 without regional Dummies.

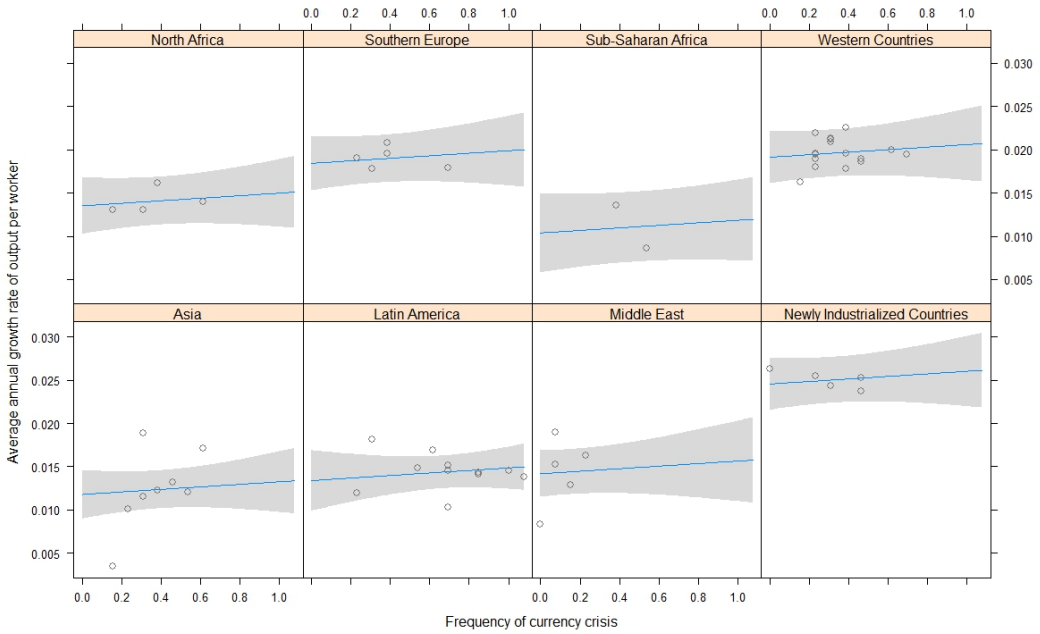


Figure 1.21 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of period 1880-2010 With Regional Dummies.

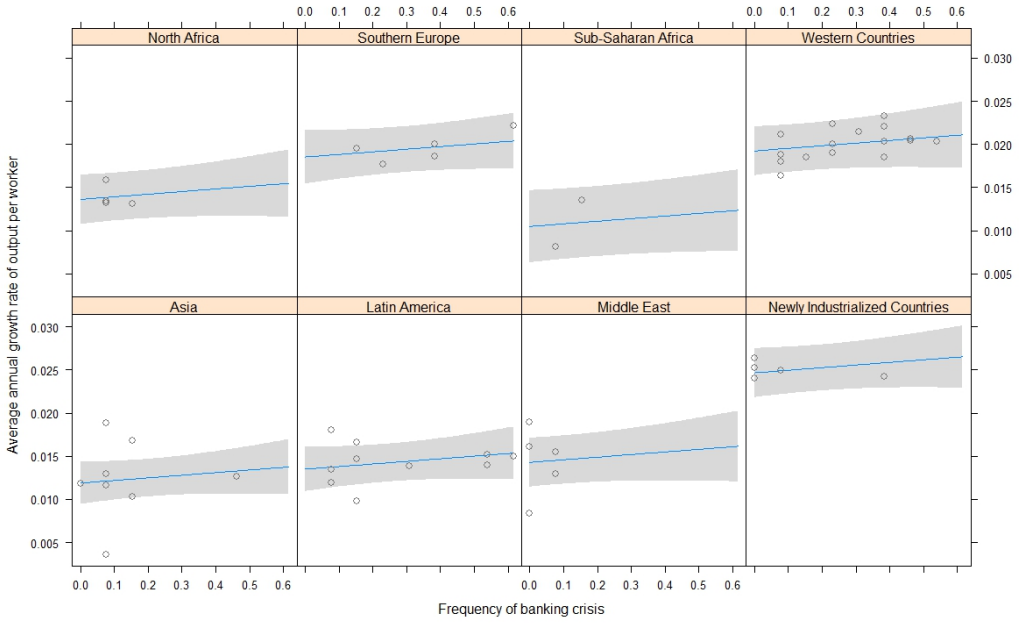


Figure 1.22 Regression Lines Between Frequency of Currency Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1880-2010 With Regional Dummies.

Table 1.14 presents the cross-sectional regressions for the time windows of 16 decades from 1820-1980 based on the baseline model in Equation (4.1.2).

Table 1.14. Crises and Growth: Cross-sectional Regressions for Time Window of 190 Years

Dependent variable: Average annual growth rate of output per worker

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Explanatory Variables	**1820-2010 (190 years)**	
Intercept	0.0299 **	0.0345 ***
	(0.0131)	(0.0082)
Frequency of Banking Crisis	0.0073 **	0.0021
	(0.0033)	(0.0018)
Frequency of Currency Crisis	-0.0012	0.0014
	(0.0025)	(0.0022)
Log of Initial Output per Worker	-0.0023	-0.0035 ***
	(0.0016)	(0.0010)
Growth Rate of Population	0.0381	0.0720 *
	(0.0829)	(0.0401)
Region: Western Countries		0.0074 ***
		(0.0011)
Region: Southern Europe		0.0056
		(0.0012)
Region: Central and Eastern Europe		
Region: Newly Industrialized Countries		0.0088 ***
		(0.0012)
Region: Sub-Saharan Africa		0.0017
		(0.0012)
Region: Latin America		0.0022

		(0.0014)
Region: Middle East		0.0025 (0.0019)
Region: North Africa		0.0020 (0.0013)
Number of countries	52	
Adjusted R-squared	0.0114	0.7008
F statistics/ **P value**	1.147/ 0.346	11.86/ 1.999e-09

* p<0.01 ** p < 0.05. *** p < 0.01.

For the cross-sectional regression of period 1820-2010, the first column represents the regression without regional dummies, in which the coefficient of the frequency of the banking crisis is statistically significant 0.0073 and that of the frequency of currency crisis is statistically insignificant -0.0012. The second column under regression of period 1820-2010 represents the regression with regional dummies, in which both of coefficients of the frequency of banking crisis and the frequency of currency crisis are statistically insignificant are 0.0021 and 0.0014 respectively.

Figure 1.23 plots the regression line between frequency of banking crisis and frequency of currency crisis and average annual growth rate of output per worker for cross-sectional regression of period 1820-2010. Figure 1.24 and figure 1.25 plot the regression lines between frequency of banking crisis and average growth rate of output per worker of each region for cross-regression of period 1820-2010 with regional dummies.

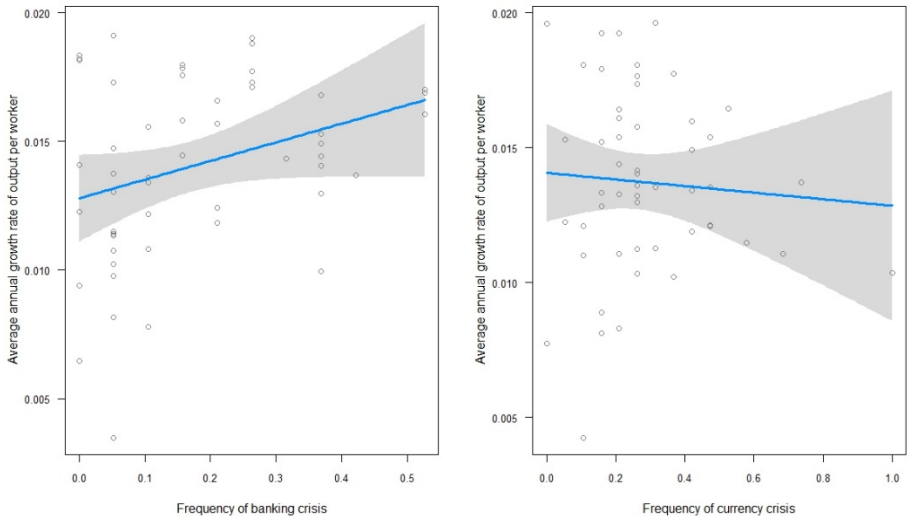


Figure 1.23 Regression Line Between Frequency of Banking Crisis and Frequency of Currency Crisis and Average Growth Rate of Output Per Worker for Cross-sectional Regression of 1820-2010 Without Regional Dummies.

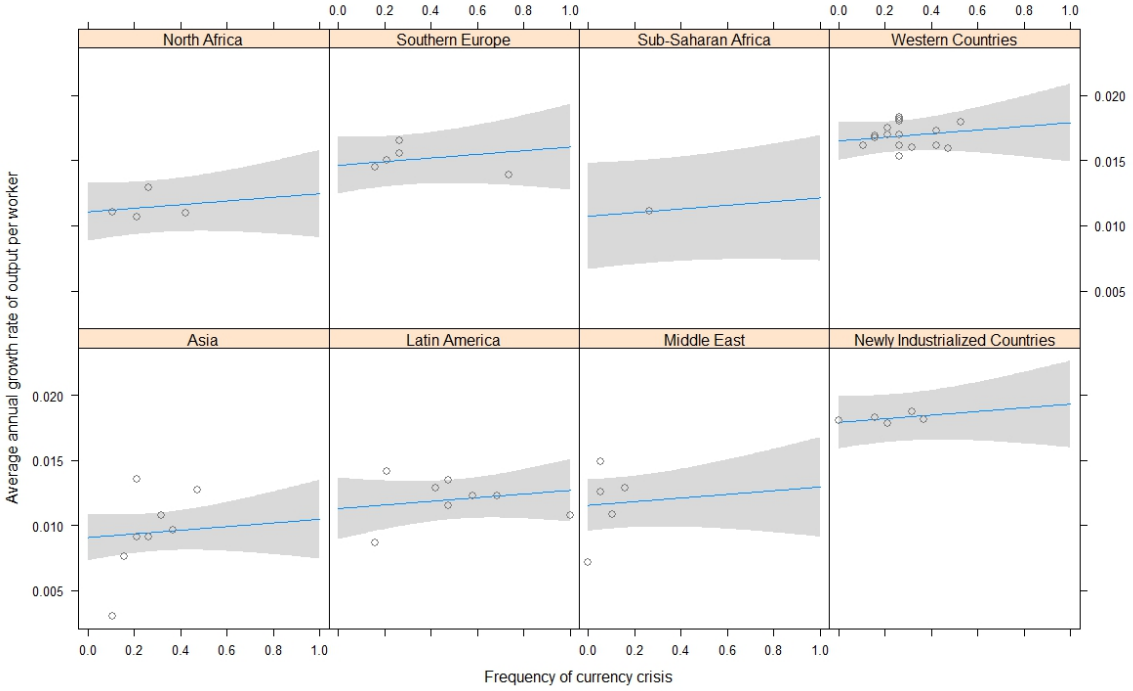


Figure 1.24 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1820-2010 With Regional Dummies.

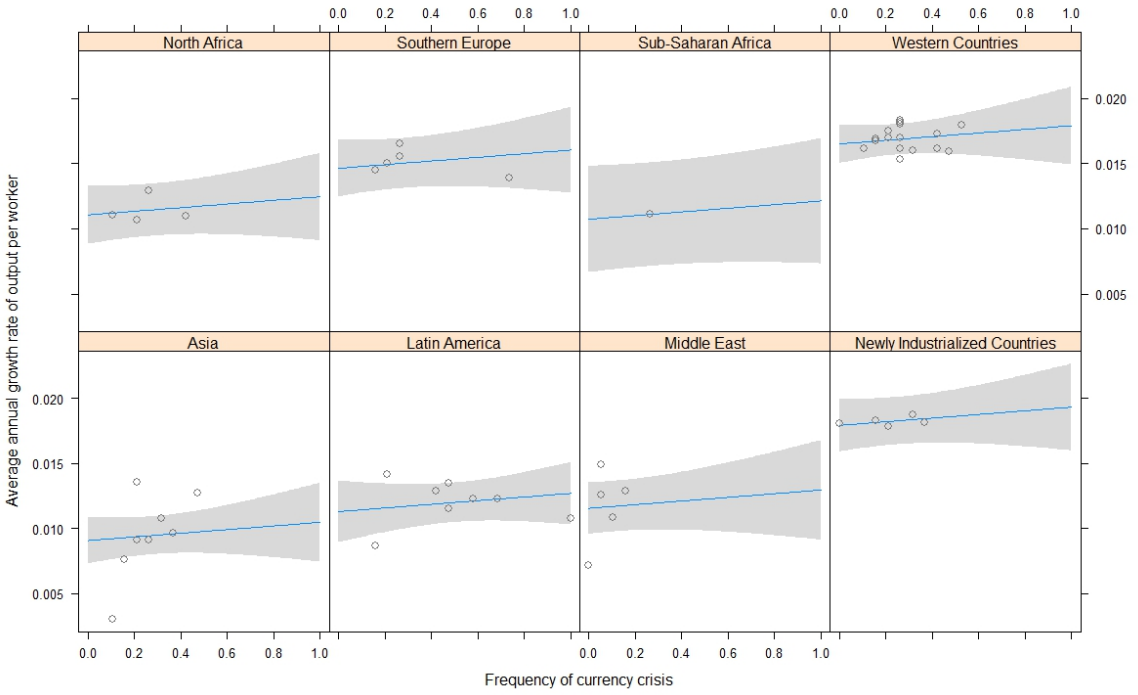


Figure 1.25 Regression Lines Between Frequency of Banking Crisis and Average Growth Rate of Output Per Worker of Each Region for Cross-sectional Regression of Period 1820-2010 With Regional Dummies.

4.4.3. Estimation Summary

Table 1.15 shows the summary of the coefficients of frequency of banking crisis and frequency of currency crisis for the regression with all of the four independent variables, i.e., frequency of banking crisis, frequency of currency crisis, log of initial GDP per capita and average growth rate of Population. The P values are reported in the parentheses below the estimates.

Table 1.15. Summary of Coefficients of Banking Crisis and Currency Crisis

(P values are presented below the corresponding coefficient)

Time window	Model	Coefficient on Frequency of Banking Crisis	Coefficient on Frequency of Currency Crisis	Number of Countries	Number of Observations
1 decade	Panel	-0.004 *** (0.001)	-0.004 *** (0.001)	130	1516
2 decades	Panel	-0.004 * (0.075)	-0.004 ** (0.010)	130	726
3 decades	Panel	-0.001 (0.602)	-0.004 ** (0.016)	128	485
4 decades	Panel	-0.000 (0.869)	-0.005 ** (0.015)	127	313
5 decades	Panel	-0.001 (0.695)	-0.004 *** (0.045)	123	248
6 decades	Panel	-0.000 (0.813)	-0.004 * (0.097)	121	229
7 decades	Panel	-0.002 (0.452)	-0.002 (0.439)	64	135
8 decades	Panel	-0.001 (0.852)	-0.005 * (0.087)	64	113
9 decades	Panel	0.000 (0.986)	-0.005 * (0.093)	61	112
10 decades	Panel	-0.000 (0.957)	-0.007 * (0.014)	56	73
13 decades	Cross section	0.003 (0.116)	-0.000 (0.573)	52 for 1820-1950	52 for 1820-1950

				56 for 1880-2010	56 for 1880-2010
16 decades	Cross section	0.002 (0.394)	0.001 (0.544)	52 for 1820-1980 52 for 1850-2010	52 for 1820-1980 52 for 1850-2010
19 decades	Cross section	0.002 (0.248)	0.001 (0.521)	52	52

* p<0.01 ** p < 0.05. *** p < 0.01.

Note: 1) The coefficients and corresponding P value for cross sectional regressions of time windows of 13 decades are average values over regressions of time windows 1820-1950 and 1880-2010.

2) The coefficients and corresponding P value for cross sectional regressions of time windows of 16 decades are average values over regressions of time windows 1820-1880 and 1850-2010.

Figure 1.26 shows graphically the tabular information in Table 1.15. The one small difference between the two is that Table 1.15 rounds the coefficients to the fourth decimal place while Figure 1.26 rounds them to the seventh decimal place.

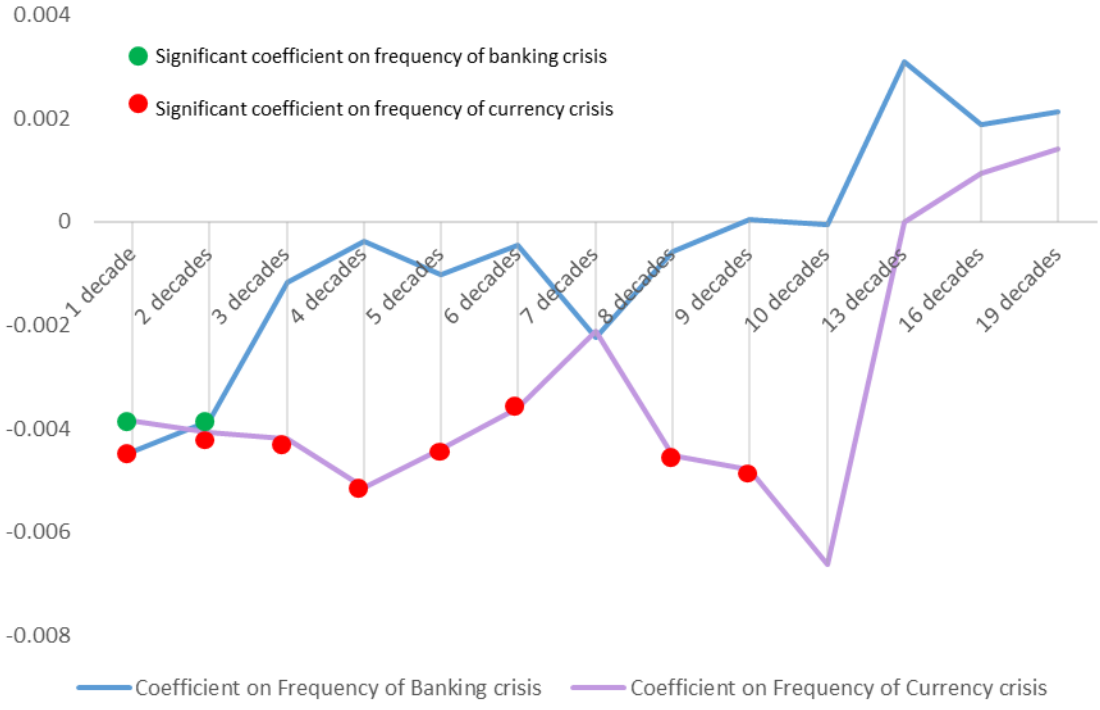


Figure 1.26. Coefficients of Frequency of Banking Crisis and Currency Crisis for Different Time Windows

As this figure shows, we can see an obvious upward-sloping trend, with the blue line representing the coefficients of the frequency of banking crisis, and the purple line the coefficients of the frequency of currency crisis. The green dot represents the statistically significant coefficients of the frequency of banking crisis, while the red dot represents the significant coefficients of the frequency of currency crisis. It is clear that the coefficients of frequency of banking crisis remain significantly negative from time window of 1 decade to 2 decades, their negative effects gradually turning positive, while the coefficients of frequency of currency crisis have more significantly negative values overall, and both the coefficient of frequency of banking crisis and the coefficient of frequency of currency crisis turn positive as the time window increases to 13 decades.

Some of the coefficients of frequency of banking crisis and frequency of currency crisis are not statistically significant, but economically significant, since they are of great magnitude.

Since financial risk-taking lies behind financial crisis, then the net effect of financial risk-taking remains significantly negative in the short run, changing to positive, though statistically insignificant, in the longer run. It is noteworthy that currency crises are more destructive than banking crises overall. In other words, since a currency crisis is the realization of potential risks that are more foreign-involved in a severe speculative attack, roughly speaking, the price for a country to take more financial risk to finance investment and further economic growth (risky path) is much higher when international dimensions of risks are involved than in circumstances without international dimensions of risks.

5. Conclusion remarks

Financial development boosts economic growth while financial crises are typically associated with slower economic growth. As financial crises have been occurring more frequently, more research exploring the relationship between them and growth is being conducted. Due to data availability, most of these studies focus on the short-run. However, it is not clear which one of the two effects dominate economic growth across countries in the long-run.

In this paper, we use a multi-country dataset to address the relationship between the long-term nexus between banking crises, currency crises and growth. To broaden the current datasets, we combine the three leading datasets of financial crises from Bordo et

al. (2001), Reinhart and Rogoff (2011) and Laeven and Valencia(2013) and a dataset of output per worker and growth rate of population from Tamura et al. (2016). This composite dataset covers 130 economies from around the world, some from 1800 with the rest beginning in later years.

Our panel analyses and cross-sectional analyses show that the coefficients of frequency of banking crisis remain significantly negative from time window of 1 decade to 2 decades, with its negative effect turning positive gradually, while the coefficients of frequency of currency crisis have more statistically significantly negative values overall, and both coefficient of frequency of banking crisis and coefficient of frequency of currency crisis turn positive when the time window increases to 13 decades.

We find the effects of both the frequency of banking crisis and the frequency of currency crisis remain significantly negative in the short run, changing positive though statistically insignificant in the longer run. While the frequency of currency crisis has much more adverse effect on growth from short run to medium run (10 decades) than the frequency of banking, though both effects on growth become insignificantly positive in the longer run. In other words, the net effect of banking crisis on growth is relatively less destructive than the net effect of currency crisis in the short run, though both seem to boost growth in the long run (longer than 10 decades).

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APPENDIX

Table A1. List of Banking crises and Currency crises from 1800 to 2010 for 153 countries

	Banking crises	Currency crises
Algeria	1990-1994	1988;1944
Argentina	1890-1891	1885;1890;1908;1914;1929-1932;1950;1959;1962;1967;1975;1980;1987;2002
Australia	1828;1843;1893	1915;1932-1933;1949
Austria	1873;1924;1929;1931;2008-2010	1800-1801;1804;1807;1813;1815-1817;1850-1851;1853;1856;1859-1960;1863;1866;1915;1918;1923;1933;1945-1850
Bangladesh	1987	1976
Belgium	1838-1839;1842;1848;1870-1871;1914;1925-1926;1931;1934;1939;2008-2010	1914;1924;1935;1938;1949
Bolivia	1986;1994	1932-1933;1936-1937;1950;1953;1956;1958;1963;1973;1981
Botswana		1984
Brazil	1890-1891;1897;1900-1901;1914;1923;1963;1990-1998	1818-1816;1820-1821;1827-1829;1837;1842;1868;1889;1898;1914;1930-1931;1934;1937;1959;1962-1963;1965;1976;1982;1987;1992;1999
Burkina Faso	1990-1994	1994
Burundi	1994-1998	
Cameroon	1987-1912;1995-197	1994
Cape Verde	1993	
Canada	1837;1866;1923	1891;1893;1908;1914;1921;1929;1931;1950;1962
Central African Rep	1976;1995-1996	1943-1944;1959;1994
Chad	1983;1992-1996	1994
Chile	1889;1898;1907;1914;1925;1976;1981-1985	1887;1889;1898;1931;1953;1962;1968;1972;1982
Colombia	1982;1998-2000	1906;1909;1920;1932;1951;1962;1965;1967;1985

Comoros		1994
Congo, Rep	1992	1994
Costa Rica	1987-1991;1994-1995	1920;1922;1933;1935;1981;1991
Denmark	1813;1857;1885;1907;1914;1931;2008-2010	1914;1921-1922;1931-1932
Djibouti	1991-1995	
Dominican Rep	2003-2004	1985;1990;2003
Ecuador	1982-1986;1998-2002	1921-1922;1924;1931;1934-1935;1938;1982;1999
Egypt	1907;1980	1949;1962;1979;1990
El Salvador	1989	1986
Equatorial Guinea	1983	1980;1994
Eritrea	1993	
Estonia	1992-1994	1992
Fiji		1998
Finland	1990;1921;1931;1939;1991-1995	1914;1921;1931;1949;1993
France	1802;1805;1882;1889;1907;1930-1932;2008-2010	1813-1814;1816;1888;1914;1923;1926;1936-1937;1948;1957;1968
Gabon		1994
Gambia		1985;2003
Germany	1857;1901;1931	1913-1815;1962-1863;1872;1893;1907;1914;1931;1934;1949
Ghana	1982-1983	1949;1967;1978;1983;1993;2000;2009
Greece	1931;2008-2010	1885;1914;1931-1932;1950;1983
Guatemala		1986
Guinea	1985;1993	1982;2005
Guinea-Bissau	1995-1998	1980;1994
Guyana	1983	1987
Haiti	1994-1998	1992;2003
Honduras		1990
Iceland	2008-2010	1932;1947;1950;1960;1975;1981;1989;2008
India	1863;1866;1908;1913-1916;1921-1922;1929-1931;1947-1948;1993	1894;1920-1921;1950;1967

Indonesia	1997-2001	1948-1949;1952-1954;1957-1959;1962-1964;1966-1968;1979;1998
Iran		1985;1993;2000
Ireland	1836;1856;2008-2010	1865;1919;1931;1939;1967
Israel	1977	1975;1980;1985
Italy	1866;1868;1891;1893;1907;1914;1921;1930-1931;1935;2008-2010	1894;1908;1935-1936;1964;1981
Ivory coast	1988-1992	1943-1944;1994
Jamaica	1996-1998	1978;1983;1991
Japan	1901;1907;1917;1927;1997-2001	1864;1900;1904;1908;1917;1921;1931-1932
Jordan	1989-1991	1989
Kenya	1985;1992-1994	1993
Kuwait	1982-1995	
Latvia	1995;2008-2010	1992
Lebanon	1990-1993	1984;1990
Lesotho		1985
Liberia	1991-1994	
Lithuania	1995-1996	1992
Luxembourg	2008-2010	
Madagascar	1988	1984;1994;2004
Malawi		1994
Malaysia	1997-1999	1902;1920;1948;1998
Mali	1987-1991	1994
Mauritania	1984	1993
Mexico	1981-1985;1994-1996	1914;1931;1938;1948;1954;1977;1982;1995
Morocco	1980-1984	1918;1921;1929-1931;1943-1944;1947;1949-1950;1958-1959;1981
Mozambique	1987-1991	1987
Myanmar		1975;1990;1996;2001;2007
Namibia		1984
Nepal	1988	1984;1992
Netherlands	1819-1929;1897;1914;1921;1939;2008-2010	1914;1914;1921;1923;1935;1949

New zealand	1890-1895	1967;1984
Nicaragua	1990-1993;2000-2001	1903-1905;1907;1909;1911-1912;1937-1939;1946;1979;1985;1990
Niger	1983-1985	1994
Nigeria	1991-1995;2009-2010	1950;1983;1989;1997
Norway	1814;1921-1923;1931;1991-1993	1820-1821;1864;1914;1931;1949
Pakistan		1972
Panama	1988-1989	
Papua New Guinea		1995
Paraguay	1890;1995	1920;1930-1931;1933;1935-1936;1941;1943;1951;1954-1956;1958;1984;1989;2002
Peru	1872-1876;1983	1921;1930;1932;1938-1939;1950;1953;1958;1968;1976;1981;1988
Philippines	1983-1986;1997-2001	1962;1983;1998
Portugal	1828;1846-1847;1891;1920;1923;1931;2008-2010	1801;1815;1891;1931;1983
Rwanda		1991
Senegal	1988-1991	1994
Sierra Leone	1990-1994	1983;1989;1998
Singapore		1892-1894;1901-1902;1920;1950
Slovak Rep	1998-2002	
South Africa	1865-1869;1877;1881;1890-1892	1933;1940;1950;1967;1984
South Korea	1997-1998	1946;1948-1952;1954-1955;1962-1963;1966;1998
Spain	1814-1817;1829;1846-1847;1920;1924-1925;1931;1977-1981;2008-2010	1931;1958;1967;1983
Sri Lanka	1989-1991	1920;1931;1939;1956;1968;1978
Sudan		1981;1988;1993
Suriname		1990;1995;2001
Swaziland	1995-1999	1985
Sweden	1811-1814;1897;1907;1931-1932;1991-1935;2008-2010	1815;1819;1914;1931-1932;1949;1993

Switzerland	1870;1931;1933;2008-2010	1964;1914;1936;1939
Syria		1988
Taiwan		1946;1950;1955
Thailand	1983;1997-2000	1985;1990
Tanzania	1987-1988	1862-1963;1883;1894;1922;1932;1942;1950;1954;1998
Togo	1993-1994	1994
Tunisia	1991	1944;1946;1949-1950;1958;1965
Turkey	1931;1982-1984;2000-2001	1809-1810;1820;1822;1828-1829;1831;1862-1863;1920-1921;1946;1957;1959;1978;1984;1991;1996;2001
Turkmenistan		2008
Uganda	1994	1980;1988
United Kingdom	1810-1811;1815;1825;1837-1840;1847-1850;1857;1866;1890;2007-2010	1815;1914;1931;1947;1949;1961;1964-1968
United States	1818-1819;1825;1836-1839;1857;1884;1893;1907;1914;1930-1933;2007-2010	1814;1862;1876;1891-1892;1933;1960
Uruguay	1893;1898;1981-1985;2002-2005	1919;1930-1931;1938-1939;1948-1949;1957-1958;1963-1965;1967-1968;1972;1983;1990;2002
Venezuela	1994-1998	1984;1989;1994;2002
Zaire	1983;1991-1998	1976;1983;1989;1994;1999;2009
Zambia	1995-1998	1950;1983;1989;1996;2009
Zimbabwe	1995-1999	1983;1991;1998;2003

Note: There are 248 banking crises and 458 currency crises in our sample.

CHAPTER TWO

CAPITAL ACCOUNT OPENNESS AND GROWTH

ABSTRACT

This paper examines the effect of capital account openness on growth using two measurements of capital account openness, i.e., CAPITAL (1955-2004) and The Chinn-Ito Index (1970-2014). I find that capital account openness had a positive effect on 5-year average growth, 10-year average growth and 20-year average growth based on panel analyses, but an insignificant even negative effect on growth in the long run based on cross-sectional regressions. The results are robust to controlling country dummy and time dummy.

1. Introduction

The effect of capital account openness on economic growth has received considerable attention. As the proponents claim, capital account openness, in certain circumstances increases efficient allocation of international capital, while capital control incurs high administrative costs of imposing capital controls, capital control has possible prevention of adaptation to changing international circumstances, and necessary adjustments in policies in the context of financial globalization might be postponed.

While the opponents claim that international capital flows tend to be highly sensitive to macroeconomic policies, to the soundness of the banking system and to economic and political developments. Inflows might be excessive which cause instability. On the other hand, capital controls are effective in reaching the intended goal; and controls may help to support a weak financial system, and controls on inflows seem to make monetary policy more independent.

The evidence of the effect of capital account openness on growth is not so clear. Alesina, Grilli, and Milesi-Ferretti (1994) find no association between the levels of capital account openness and growth for advanced industrial nations. Grilli and Milesi-Ferretti (1995) find no effects of capital account openness on growth in emerging market nations. The most widely cited study of the correlation of capital account liberalization with growth is Rodrik (1998), which finds no correlation between capital account liberalization and growth, based on a sample of 100 industrial and developing countries for the period 1975-1989.

Quinn (1997), however, shows that changes in capital account openness are associated with higher long-run growth. Henry (2000) and Bekaert and Harvey (2000) find that stock market liberalizations decrease the cost of capital, which leads to greater investment and increased per-worker output, at least in the immediate aftermath of liberalization.

As Eichengreen (2001) points out that neither theoretical models nor empirical analyses has highly consensus on whether capital account openness has significant positive effect on growth.

Edwards (2001) finds capital account liberalization has strong positive effect on growth for 10-year intervals, however, limited mainly to high-income countries. Using Edwards's data, Arteta et al (2001) analyze the 10-year average of the growth rate for 61 countries from 1980 to 1989, find the effects vary with time, with how capital account liberalization is measured, and with how the relationship is estimated. There is some evidence that the positive growth effects of liberalization are stronger in countries with strong institutions, as measured by standard indicators of the rule of law, but only weak evidence that the benefits grow with a country's financial depth and development. They also find that macroeconomic imbalances that could possibly create avenue for capital flight such as black market premiums.

MW Klein (2003) finds an inverted-U shaped relationship between growth and capital account openness with respect to income per capita. Middle-income countries benefit significantly from liberalizing capital account while rich and poor countries do not.

Henry (2003) shows when countries liberalize their capital accounts and stock markets, the costs of capital to industrial firms are reduced, and further boosts growth. Arteta et al. (2001) find only limited evidence of a positive growth effect when capital account openness is conditioned on law and order. Klein (2005) finds that capital account liberalization in countries with better institutions does promote growth.

In contrast, Quinn and Toyoda (2008) find no evidence that capital account liberalization positively affects economic growth, even though it has a high level of institutional quality.

Klein et al (2008) show a statistically significant and economically relevant effect of open capital accounts on financial depth and economic growth in a cross-section of countries over the periods 1986–1995 and 1976–1995, however, these results are mainly driven by OECD countries included in the sample.

Henry (2007) points out, neoclassical theory predicts only temporary growth effects on a country's transition to a new steady state, helping to understand that most papers do not find clear evidence for a relationship between capital account liberalization and growth. He criticizes most of the existing empirical literature by "analysing capital account liberalization at the level of the firm instead of the country provides greater clarity about the channels through which liberalization affects the real economy." (p. 889). Bussière and Fratzscher(2008) find that a time-varying relationship between financial openness and growth for 45 industrialized and emerging market economies: countries tend to gain in the short term, immediately following capital account liberalization, but may not grow faster or even experience temporary growth reversals in the medium to long term.

G Bekaert et al (2011) show that the growth boost from openness outweighs the detrimental loss in growth from global or regional banking crises. The countries that are more financially developed or have higher quality of institutions experience larger productivity growth responses.

Kunieda et al (2014) investigate the data from 1985 to 2009 for 109 countries, and find that empirical evidence indicating that capital account liberalization is beneficial to less corrupt countries, but is disadvantageous to highly corrupt countries.

This paper examines the effect of capital account openness on growth using two measurements of capital account openness, i.e., CAPITAL (1955-2004) and the Chinn-Ito Index (1970-2014). I find that capital account openness had positive effect on 5-year average growth, and 10-year average growth and 20-year average growth, but insignificantly negative effect on longer-run growth.

This paper is structured as follows. Section 2 introduces the prevalent measures of capital account openness in the literature. Section 3 presents the empirical analyses. Sections 4 concludes.

2. Measure of Capital Account Openness

2.1. De Jure Measures

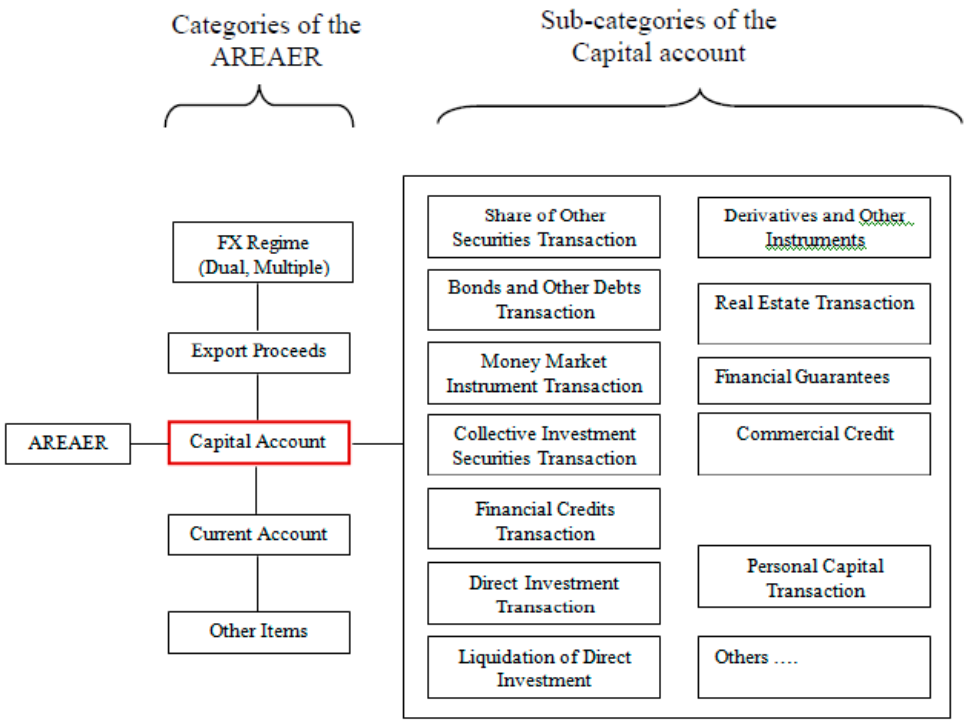

Figure 2.1. Categories of AREAER

Researches on the effect of capital account liberalization on growth are limited by data availability. The first commonly used data is from the IMF's annual publication, Annual Report on Exchange Arrangements and Exchange Restrictions (henceforth AREAER), from 1966 to 1995, whose categories are shown in Figure 2.1. It is often considered to be too rough, however, as the de jure 0, 1 indicator (hereafter, IMF_BINARY) of the presence of absence of capital controls take the countries substantially but no completely open with countries that are completely closed as one category. In addition, IMF_BINARY reports restrictions only on residents without any information about nonresident capital account restrictions on, e.g., inward foreign direct investment (see Quinn and Toyoda, 2008).

Another leading measure of capital account openness is created by Chinn and Ito (2008), called KAOPEN. Construction of KAOPEN is based on the four binary dummy variables reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). These variables are: i) variable indicating the presence of multiple exchange rates; ii) variable indicating restrictions on current account transactions; iii) variable indicating restrictions on capital account transactions; and iv) variable indicating the requirement of the surrender of export proceeds. These variables are to provide information on the extent and nature of the restrictions on external accounts for a wide cross-section of countries.

These studies have all made progress based on the original 0, 1 dummy. However, they still simply measure the presence or absence of controls in a given category. One of new indexes called CAPITAL was created and updated recently (Quinn and Toyoda, 2008) go beyond this limitation. Quinn (1997) constructs indicators on capital account (CAPITAL) and financial current account (FIN_CURRENT) regulations based on a coding of the AREAER text. They measure only if there is restriction, but how severe of those restrictions.

2.2 De Facto and Hybrid De Facto/De Jure Measures

De jure measures have the advantage of reflecting the institutional development. However, the capital controls on paper in many countries may be very strict, but there is no practical effect. On the contrary, many other countries are legally open to foreign capital,

but the actual transaction of capital is not so active. Then the de jure measure does not reflect the degree of capital market openness.

On the other hand, the advantage of de facto measures is that it reflects the actual transaction of the capital, but it suffers from measurement errors. This justifies why hybrid de facto / de jure measures are developed (see Quinn and Toyoda, 2008).

Lane and Milesi-Ferretti (2007) Index (TOTAL) may be one of the most widely used de facto indicators, TOTAL is calculated as the total assets of the state plus the liabilities relative to the gross domestic product. (Edison and Warnock, 2003), the convergence of external and domestic interest rates (Dooley, Mathieson and Rojas-Suarez, 1997; Quinn and Jacobson, 1989). Sub-index of Control of capital movement and people of Economic freedom index from Fraser institute (henceforth, EF), whose rating starts at 0 to 10 in three aspects: i) Foreign ownership / investment restrictions; ii) Capital controls. iii) Freedom of foreigners to visit. There are some other hybrid measures of capital account openness in the literature (see details, QUINN et al, 2011)

3. Data

This paper adopts two measures of capital account openness, i.e., CAPITAL(Quinn and Toyoda, 2008) and the version of KAOPEN(Chinn and Ito, 2008) in 2014. CAPITAL covers 94 countries for period 1955-2004 and KAOPEN covers 182 countries for period 1970-2014. In addition, the data of GDP and population are collected from Penn World Tables version 9.0, which cover 182 countries for period 1950-2014.

I use two different measures of capital account openness for comparison, so there are two sets of regressions in this paper, one set of regressions based on data of GDP per capita, Population growth and CAPITAL, which cover 94 countries from 1955 to 2004, the other set of regressions are based on the data of GDP per capita, Population growth and KAOPEN, which cover 155 countries from 1970 to 2014.

Table 2.1 shows the definitions and sources of the variables used in this paper.

Table 2.1. Definitions and Sources of Variables

Variable	**Definition and construction**	**Source**
GDP per capita	In 2011 US dollars	PWT 9.0
Growth rate of GDP per capita	Log difference of GDP per capita	PWT 9.0
Growth rate of Population	Log difference of Population	PWT 9.0
CAPITAL	Measure of capital account openness	Quinn and Toyoda(2008)
KAOPEN	Measure of capital account openness	The Chinn-Ito Index(2015)
Region Dummy	Western Countries : 1 Southern Europe : 2 Central and Eastern Europe : 3 Newly Industrialized Countries : 4 Asia : 5 Sub-Saharan Africa : 6 Latin America : 7 Middle East : 8 North Africa : 9	Tamura *et al*(2016)

Table 2.2 shows the summary statistics of the dataset.

Table 2.2. Summary Statistics

Statistics	**Number of**	**Mean**	**Median**	**Min**	**Max**	**Std Deviation**

	countries					
Growth rate of GDP per capita	182	0.04168	0.04326	- 0.16900	1.11667	0.08719
Growth rate of Population	182	0.01842	0.01903	-0.19901	0.17625	0.01619
CAPITAL	94	55.75915	50	0	100	28.9838
KAOPEN	155	0.44129	0.30201	0	1	0.35874

Figure 2.1 depicts CAPITAL from 1950 to 2004, Figure 1.3 depicts KAOPEN from 1970 to 2014 and Figure 2.4 depicts the growth rate of GDP per capita for countries from 1950 to 2014.

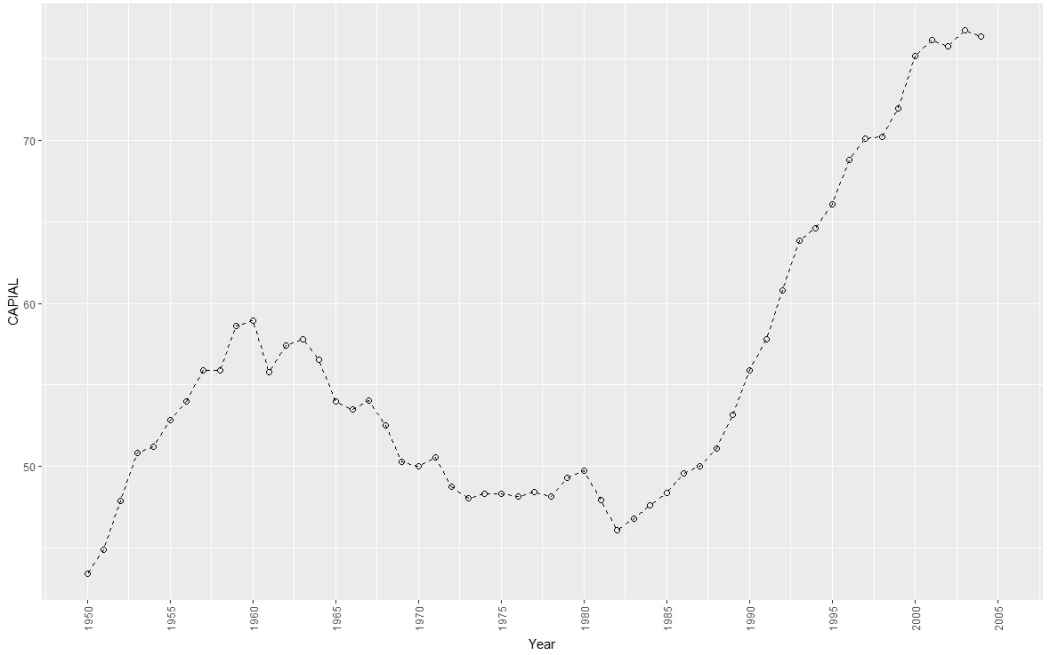

Figure 2.2. Cross-country average of CAPITAL from 1948 to 2004

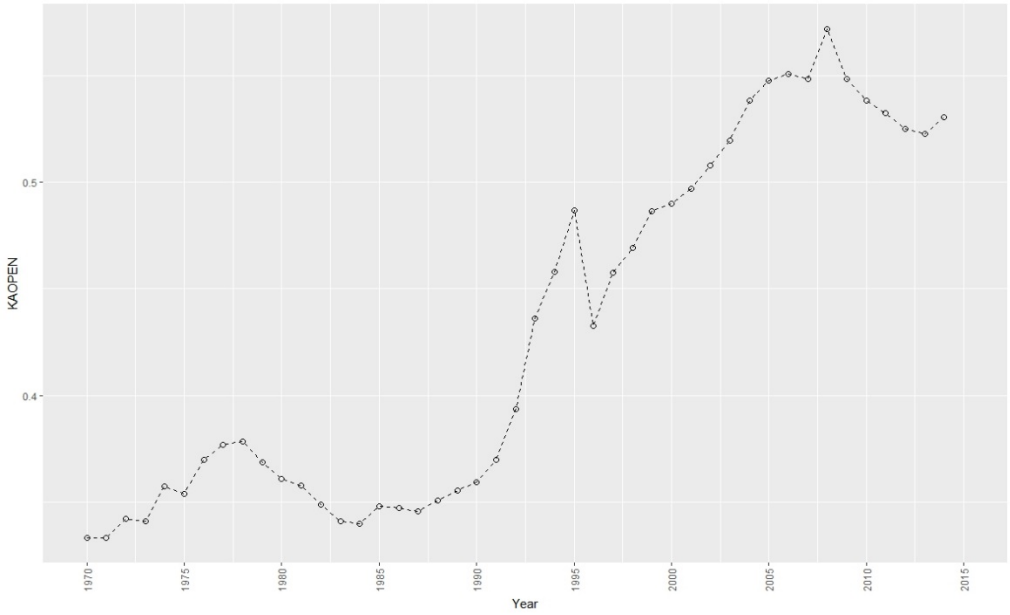

Figure 2.3. Cross-country average of KAOPEN from 1970 to 2014

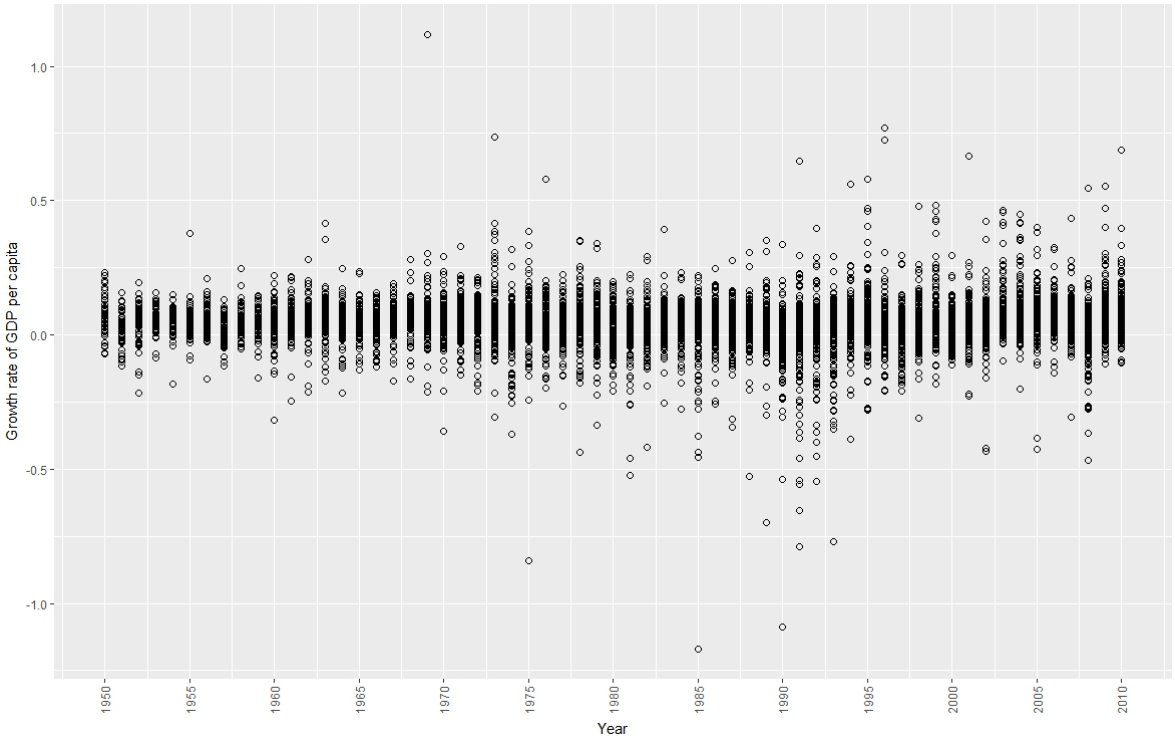

Figure 2.4. Growth rate of GDP per capita from 1950 to 2014

4. Model and Estimation

When there exist unobservable, country-specific characteristics, which might affect the dependent variable and might be correlated with the independent variables, fixed effects models are particularly suitable. Moreover, because these data are not from a random sample, but are the universe of data that are available, fixed effects models are generally appropriate. (see Hsiao, 1986 for detail). In addition, the datasets of CAPITAL and KAOPEN cover 50 years and 45 years respectively, there is no reason to ignore the time effects across time windows of 5 years, 10 years and 20 years. Henceforth we control both country effect and time effect in panel analysis, though most of the papers mentioned above do not take time effect into consideration, which might be misleading.

4.1 Baseline models

1) Panel regression

$$\Delta y_{it} = \beta_0 + \beta_1 CAO_{it} + \beta_2 \Delta CAO_{it} + \beta_3 initial\_lgdp\_pc_{it} + \beta_4 g\_pop_{it} + \mu_i + \varepsilon_{it} \quad (3.1.1)$$

2) Cross-sectional regression

$$\Delta y_i = \beta_0 + \beta_1 CAO_i + \beta_2 \Delta CAO_i + \beta_3 initial\_lgdp\_pc_i + \beta_4 g\_pop_i + \beta_5 R_i + \varepsilon_i \quad (3.1.2)$$

(3.1.1) represents the baseline model for panel regressions, where $\Delta \boldsymbol{y_{it}}$ represents the average annual growth rate of GDP per capita for country i during period t, which equals log difference of ***GDP per capita***; μ_i represents country dummy.

CAO_{it} and ΔCAO_{it} are the two core variables in baseline model. CAO_{it} represents

the measure capital account openness(CAPITAL or KAOPEN in this paper) in the initial year for country i during period t, and ΔCAO_{it} represents the change of capital account openness during period t. This paper attempts to examine if high level of capital account openness brings higher growth, and if capital account liberalization (change in capital account openness) boosts growth.

$initial\_lgdp\_pc_{it}$ and g_pop_{it} are the control variables, $initial.lgdp\_pc_{it}$ represents log of GDP per capita in the initial year for country i during period t, and g_pop_{it} represents average annual growth rate of Population for country i during period t. $\boldsymbol{\varepsilon_{it}}$: Error term.

(3.1.2) stands for the baseline model for cross-sectional regressions, which is similar to panel regression (3.1.1), the difference is cross-section model uses regional dummy instead of country dummy in panel model.

4.2. Estimation results

4.2.1 Panel regressions controlling country effect and time effect

This sub-section provides panel analysis for time windows of 5 years, 10 years, 15 years, 20 years based on baseline model (3.1.1). Table 2.3 shows panel regressions of time window of 5 years, Table 2.4 shows panel regressions of time window of 10 years, Table 2.5 shows panel regressions of time window of 20 years. Most of the previous papers do not control time effect, which might overestimate the influence of capital account openness on growth, hence both country effect and time effect are controlled in this paper.

Table 2.3. Panel regressions of time window of 5 years

Dependent variable: Average annual growth rate of GDP per capita

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**CAPITAL(1955-2004, 55 years)**	**KAOPEN(1970-2014, 45 years)**
Initial level of capital account openness	0.00012 (0.00008)	0.00056 (0.00953)
Change of capital account openness	0.00015 ** (0.00007)	0.01310 * (0.00807)
Log of initial GDP per capita	-0.02880 *** (0.00644)	-0.02719 ** (0.01065)
Average growth rate of Population	1.91480 ** (0.75018)	0.94630 *** (0.35032)
Number of Countries	94	155
Number of Periods	9	7
Number of Observations	783	1058
R-squared	0.123	0.067
F statistics/ **P value**	23.783/ < 2.22e-16	15.917/ 1.3579e-12

* p<0.01 ** p < 0.05. *** p < 0.01.

The dummies of country and time are not reported

Table 2.3 shows panel analysis of time window of non-overlapping 5 years for different measures of capital account openness of CAPITAL and KAOPEN. The sample period of regression of CAPITAL is divided into 12 sub-periods 1955-1959, 1960-1964, …, 2000-2004, and the sample period of regression of KAOPEN is divided into 9 sub-periods 1970-1974, 1975-1979, …, 2010-2014. Then the average growth rate of GDP per capita and the change of CAPITAL/KAOPEN are over these sub-periods, while the initial level of CAPITAL/KAOPEN and the log of initial GDP per capita are values in the first year of these sub-periods.

Overall, the significance and magnitude of the coefficients of regressions of CAPITAL and KAOPEN are very close to each other although they differ in sample periods. The coefficients on *Initial level of capital account openness of both CAPITAL and KAOPEN* are insignificant, but the coefficients on *Change of capital account openness* are significant for both regressions. The average growth rate of GDP per capita over 5 years would increase by 0.001% as the change of CAPITAL over five years increase by one, and the average growth rate of GDP per capita over 5 years would increase by 1.38% as the change of KAOPEN over five years increase by one.

The coefficients on log of initial GDP per capita for both regressions are significantly negative, which means the richer a country is, the slower it grows relatively. The coefficients on average growth rate of population for both regressions are significantly positive, which implies the demographic dividend stands out in the short-run. These two coefficients are stand to the literature.

Finally, we can safely conclude that the short-run effect of increasing capital account openness on growth is significantly positive even though the initial level of capital account openness has insignificant influence on growth yet still positive.

Table 2.4. Panel regressions of time window of 10 years

Dependent variable: Average annual growth rate of GDP per capita

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**CAPITAL(1955-2004, 50 years)**	**KAOPEN(1975-2014, 40 years)**
Initial level of capital account openness	0.00018 * (0.00011)	0.00688 (0.00917)
Change of capital account openness	0.00023 **	0.01557 **

	(0.00009)	(0.00753)
Log of initial GDP per capita	-0.04385 *** (0.01066)	-0.05320 *** (0.00917)
Average growth rate of Population	1.29780 *** (0.84676)	1.07917 *** (0.41285)
Number of Countries	94	155
Number of Periods	5	4
Number of Observations	374	510
R-squared	0.254	0.262
F statistics/ **P value**	23.118/ < 2.22e-16	30.896/ < 2.22e-16

* p<0.01 ** p < 0.05. *** p < 0.01.

The dummies of country and time are not reported

Table 2.4 shows panel analysis of time window of non-overlapping10 years for different measures of capital account openness of CAPITAL and KAOPEN. The sample period of regression of CAPITAL is divided into 5 sub-periods 1955-1964, 1965-1974, …, 1995-2004, and the sample period of regression of KAOPEN is divided into 4 sub-periods 1975-1984, 1984-1995, 1985-1994, 2005-2014.

The coefficient on *initial level of CAPITAL* is significantly positive, 0.00018 while the coefficient on *initial level of KAOPEN* is positive yet statistically insignificant, 0.00688. The same as the regressions for time window of 5 years, the coefficients on *Change of capital account openness of both CAPITAL and KAOPEN* are statistically significant for time window of 10 years. The average growth rate of GDP per capita over 10 years would increase by 0.023% as the change of CAPITAL over five years increase by one. And the

average growth rate of GDP per capita over 10 years would increase by 1.557% as the change of KAOPEN over 10 years increase by one.

The coefficients on log of initial GDP per capita for both regressions are significantly negative, which means the richer a country is, the slower it grows relatively. The coefficients on average growth rate of population for both regressions are significantly positive.

Table 2.5. Panel regressions of time window of 20 years

Dependent variable: Average annual growth rate of GDP per capita

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Time-window	**CAPITAL(1965-2004, 40 years)**	**KAOPEN(1975-2014, 40 years)**
Initial level of capital account openness	0.00024 * (0.00013)	0.00980 (0.01307)
Change of capital account openness	0.00013 * (0.00007)	0.01516 * (0.00721)
Log of initial GDP per capita	-0.03309 *** (0.00564)	-0.06547 *** (0.00572)
Average growth rate of Population	0.12572 (0.53435)	0.41092 (0.39202)
Number of Countries	81	134
Number of Periods	2	2
Number of Observations	139	232
R-squared	0.537	0.112
F statistics/ **P value**	15.372/ 2.0838e-08	41.761/ < 2.22e-16

* p<0.01 ** p < 0.05. *** p < 0.01.

The dummies of country and time are not reported

Table 2.5 shows panel analysis of time window of 20 years for different measures of capital account openness of CAPITAL and KAOPEN. The sample period of regression of CAPITAL is divided into 2 sub-periods 1965-1984 and 1985-2004, and the sample period of regression of KAOPEN is divided into 2 sub-periods 1975-1994, 1995-2014.

The coefficient on *initial level of CAPITAL* is significantly positive, 0.00024 while the coefficient on *initial level of KAOPEN* is positive yet insignificant, 0.00980. The coefficients on change of CAPITAL and KAOPEN keep significantly positive as that for time window of 5 years and 10 years.

The average growth rate of GDP per capita over 20 years would increase by 0.013% as the change of CAPITAL over five years increase by one. And the average growth rate of GDP per capita over 20 years would increase by 1.516% as the change of KAOPEN over 20 years increase by one.

The coefficients on log of initial GDP per capita for both regressions are significantly negative, and the coefficients on average growth rate of population for both regressions turn into insignificantly positive. And most of the regional dummies have significant coefficients, which implies the characteristics of economic growth within each region is very significant.

4.2.2. Cross-sectional regressions

In this sub-section, cross-sectional regressions are carried out to explore the long run relationship between level of capital account openness, change in capital account and growth.

Table 2.6. Cross-sectional Regression: Growth and capital account openness

Dependent variable: Average annual growth rate of GDP per capita

(Heteroscedasticity robust standard errors are presented below the corresponding coefficient)

Explanatory Variables	**CAPITAL** **1955-2004, 50 years**	**KAOPEN** **1970-2014, 45 years**
Initial level of capital account openness	-0.00015 (0.00009)	-0.00946 (0.00633)
Change of capital account openness	-0.00015 (0.00010)	-0.00124 (0.00404)
Log of initial GDP per capita	-0.00127 (0.00140)	-0.00087 (0.00074)
Average growth rate of Population	0.55330 * (0.31138)	0.89439 *** (0.22653)
Region: Western Countries	0.05913 *** (0.01978)	0.03899 *** (0.00975)
Region: Southern Europe	0.06791 *** (0.02096)	0.03914 *** (0.00906)
Region: Central and Eastern Europe		
Region: Newly Industrialized Countries	0.08731 *** (0.02127)	0.06297 *** (0.01065)
Region: Asia	0.05635 ** (0.02440)	0.04994 *** (0.00957)
Region: Sub-Saharan Africa	0.04363 ** (0.01857)	0.01814 * (0.01017)
Region: Latin America	0.05220 *** (0.01790)	0.03790 *** (0.00949)
Region: Middle East		0.03476 *** (0.01182)

Region: North Africa	0.08049 *** (0.01943)	0.04468 *** (0.01027)
Number of countries	43	96
Adjusted R-squared	0.964	0.934
F statistics/ **P value**	106.2/ < 2.2e-16	113.6 / < 2.2e-16

* p<0.01 ** p < 0.05. *** p < 0.01.

Table 2.6 shows cross-sectional regressions for different measures of capital account openness of CAPITAL and KAOPEN. The sample period of regression of CAPITAL spans 50 years from 1955 to 2004, and the sample period of regression of KAOPEN spans 45 years from 1970 to 2014.

Contrary to the short run panel analyses, the coefficients of cross-sectional regressions on both *initial level of CAPITAL* and *KAOPEN* are negative though insignificantly, so do the coefficients on Change of *CAPITAL* and *KAOPEN*.

The coefficients on log of initial GDP per capita for both regressions are insignificantly negative, and the coefficients on average growth rate of population for both regressions still keep significantly positive, 0.55330 for regression of *CAPITAL* and 0.89439 for regression of *KAOPEN*.

4.2.3. Estimation Summary

We can clearly see the panel analyses based on time windows of 5 years to 20 years show that both level and change of capital account openness boost growth, especially for the latter, while the cross-sectional regressions show that both of level and change of capital

account openness do not have significant effect on growth in the long run (45 years to 50 years in this paper).

The results from panel analyses are consistent with most of the literature, while the results from cross-sectional analyses are consistent Bussière and Fratzscher(2008), they find that countries tend to gain in the short term, immediately following capital account liberalization, but may not grow faster or even experience temporary growth reversals in the medium to long term.

5. Conclusion Remarks

The field of capital account openness on growth is very controversial, and the evidence is mixed at best. This paper explores the relationship between capital account openness on growth using two measures of capital account openness, i.e., CAPITAL (1955-2004) and Chinn-Ito Index (1970-2014).

My results show the evolutionary effects of capital account openness on growth over time. Specifically, capital account liberalization tends to boost economy temporarily in the short run, while shows no long-run growth-enhancing effect.

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CHAPTER THREE

INCOME INEQUALITY AND GROWTH: EVIDENCE FROM CHINA

ABSTRACT

The relationship between income inequality and economic growth is complex itself, the debate about it is still ongoing. Either the evidence of positive relationship or negative relationship between them are reported in the literature.

Using data of Gini coefficient, GDP per capita, ratio of fixed capital to GDP and ratio of labor to GDP from China for period 1978-2013, this paper attempts to explore long run and short run causality relationship between income inequality and growth. My findings show there exist neither long run nor short run causality link between Gini coefficient and log of GDP per capita.

1. Introduction

The causal relationship between income inequality and economic growth is itself complex. Ongoing efforts to understand this causal relationship in the literature have been yielding mixed results. Theoretically, the causality between income inequality and economic growth could run either way and through different mechanisms. Some studies have either find positive relationships between them, while others find negative relationships or no relationship at all. Consequently, a number of important policy-related questions have emerged. These include whether inequality is harmful to economic growth, whether growth is good for the poor, and whether highly unequal societies experience slower economic growth than more egalitarian ones.

1) On the one hand, about the causality that income inequality affects economic growth. Some scholars believe that income inequality show itself to be beneficial, to some degree, in ensuring the efficiency of the economy, which enhances economic growth. Okun (1975) argues that pursuing equality could reduce economic efficiency. As we all know, high inequality provides incentives to work harder, invest and undertake risks to take advantage of high rates of return (Mirrlees, 1971; Lazear and Rosen, 1981). For example, if highly educated people are much more productive, then high differences in rates of return may encourage more people to seek education. In addition, higher inequality fosters aggregate savings, and therefore capital accumulation, if the rich have a lower propensity to consume (Kaldor, 1956; Bourguignon, 1981).

As is well known, the Lewis model (Lewis, 1954) gives support to the argument that increasing inequality is not only an inevitable consequence of economic growth but also a

necessary condition for economic growth. The basic argument is that the savings are essential to increase productivity and boot growth, and then the income distribution towards top earners who tend to save and invest improve the economy growth. However, Kuztnets (1955) also points out that in a less-developed-countries context there is no guarantee that the higher□income groups will save a significant proportion of their income in their own country. According to Todaro (1994), unlike the historical experience of the now developed countries, the rich in developing countries are characterized by spending in luxury consumption usually imported and saving abroad.

While some researchers believe that greater inequality might harm growth. It is not hard to think of Keynes' theory that poor people have higher marginal propensity of consumption, then income inequality will depress aggregate demand and economic growth, and even permanent income theory of consumption. Moreover, in the presence of financial bottleneck, different individuals to invest depends more on their income and wealth level, then the poor individuals may not be able to afford worthwhile investments. For example, lower-income households may choose to leave full-time education if they cannot afford the fees, even though the rate of return (to both the individual and society) is high. In turn, under-investment by the poor implies that aggregate output would be lower than the case of perfect financial markets. We refer to this view, first formalized by Galor and Zeira (1993, 1998), as the "human capital accumulation" theory.

Benabou (1996a), Benabou (2000), Durlauf (1996), and Mookherjee and Ray (2003) provide additional theoretical contributions and Perotti (1996) and Easterly (2001) provide evidence in support of this link between equality, human capital and growth.

The most recent pro-equality evidence by OECD[1] shows that when income inequality rises, economic growth falls. One reason is that poorer members of society are less able to invest in their education.

In addition to the introduced channels above that income inequality affects economic growth, inequality can also generate greater market volatility and instability. One of the channels is through its impact on the generation of finance-driven business cycles (Galbraith, 2012). Some evidence of this has been seen in the much-debated relationship between inequality and the onset of economic recession. Both the Great Depression of the 1930s and the 2007-2008 Great Recession were preceded by sharp increases in income, wealth inequality and by a rapid rise in debt-to-income ratios among lower- and middle-income households (Kumhof and Rancière, 2010).

Kennickell (2009) shows us some evidence from SCF data, which confirms that rich families hold riskier assets. In 2007 the top 10% of the income held 60.5% of the holdings of checking, savings, money market and call accounts and 50.3% of the holdings of certificates of deposits, but 90.4% of direct holdings of stocks and 87.9% of bonds, 51.9% of mutual funds and hedge funds, and 38.1% of tax-deferred retirement accounts, such as IRAs, Keoghs and 401(k) accounts. This obviously support the viewpoint that wealthier households hold riskier assets. This fact tends to support the viewpoint that income inequality being one of the factors in bringing bubbles and financial crises (see Lysandrou (2011)).

[1] http://www.oecd.org/els/soc/Focus-Inequality-and-Growth-2014.pdf

2) On the other hand, the evidence about causality between growth and income inequality is also inclusive. Kuznets (1955) hypothesized that income inequality worsens in the early stages of economic growth and after reaching a peak, it declines at the later stages of economic growth, this is the famous "Kuznets inverted-U curve" as Figure 3.1 shows.

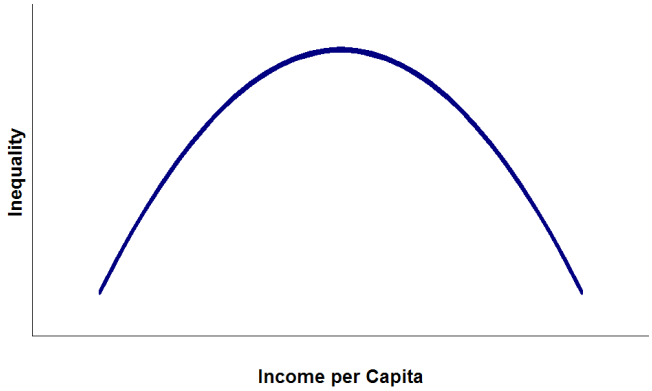

Figure 3.1. Kuznets inverted-U curve

Kuznets explained that, excluding government intervention, there are two forces that explain the income inequality before taxes: the concentration of savings in the upper-income groups and the industrial structure of the income distribution. The former yields inequality in savings, which, all other the conditions being equal, has a cumulative effect of increasing the proportion of income-yielding assets in the hands of the upper-income groups leading to larger income shares of these groups and their descendants. The latter force is the result of the process of industrialization and Urbanization, this is, economic growth accompanied by the shift away from agricultural activities.

On one hand, the process increases the urban share in total population, which is assumed more unequal than the rural population. On the other hand, since average per

capita income of the rural population is usually found to be lower than that of the urban. Kuznets (1955), argues that this gap in relative mean incomes tends to widen the as a result of a more rapid growth of the per capita productivity in economic urban activities than in agriculture.

Saith (1983) re-estimates the inverted U-curve using only the 41 LDC sub-sample, excluding the "outliers" (the poorest and the richest countries). He shows that a better fit is provided not by the inverted U-curve but rather by the an inverted-L the curve. Braking, Ahluwalia, Carter, And Chenery (1979) use a 36 LDCs The sample of 16 countries which are beyond the "turning point" estimated from cross-The country data and only Taiwan shows some evidence of experiencing the second The phase of the inverted-U curve. These findings suggest that, in the case of LDCs, the relationship between economic growth and inequality could be better described by an inverted-L curve rather than an inverted U curve. However, this discussion is focused only on the Relevance of the level of growth and/or the rate of growth. Also, the when conjecturing about the inverted L-curve, heterogeneity Among the LDCs is ignored.

Later, the Fields (1991), using a papers Produced for 20 countries as part of a research project launched by the World Bank in 1985 and adding information of another 35 countries, confirms his previous finding (Fields, 1988) that there is not a definite relationship between changes in inequality and the level or the rate of economic Growth, but that those changes seem to be associated with the "the pattern of growth". Further support to this view is given by Matyas, Konya and Macquarie (1998), who, using a two a panel data set of 47 and 62 countries, find that it is not the per GDP Capita which explains

income inequalities but rather the specific characteristics of a country such as social structure, political system, and natural resources.

Lewis (1954), Kaldor (1957), and Pasinetti (1962) have predicted positive association between growth and income inequality. While Alesina and Rodrik (1994) and Persson and Tabellini (1994), who find a significant and negative relationship between growth and income inequality. While Hongyi Li and Hengfu Zou (1998) suggest inequality does not harm growth.

Ugo (2002) uses a cross-state panel for the United States to study the relationship between inequality and growth, and supports a negative relationship between inequality and growth. Been-lon Chen(2003) propose an inverted-U relationship between initial income distribution and long-term economic growth using cross-country data for 54 countries from 1970 to1992.

Guanghua Wan et al.(2006) analyze the growth–inequality relationship in post-reform China, finding that this relationship is nonlinear and is negative irrespective of time horizons.

Grigor(2007) uses with data from the transition economies of Central and Eastern Europe and the Commonwealth of Independent States, he finds inequality has significantly negative on growth.

Christian(2008) suggests that under leftwing governments, inequality is negatively associated with growth while the association is positive under rightwing governments. Barro (2008) shows a negative effect of income inequality on economic growth, and this effect diminishes as per capita GDP rises and may be positive for the richest countries.

Dierk(2012) uses heterogeneous panel cointegration techniques to estimate the long-run effect of income inequality on per-capita income for 46 countries over the period 1970–1995. And find that inequality has a negative long-run effect on income, both for the sample as a whole and for important for different country groups: developed countries, developing countries, democracies, and non-democracies.

Daniel et al(2014) find that higher inequality helps economic performance in the short term but reduces the growth rate of GDP per capita farther in the future. The long-run effect of higher inequality tends to be negative.

Using data of Gini coefficient, GDP per capita, ratio of fixed capital to GDP and ratio of labor to GDP from China for period 1978-2013, this paper attempts to explore long run and short run causality relationship between income inequality and growth. I conclude that a long-run equilibrium relationship exists between these four variables, and Gini coefficient exhibits a negative correlation with GDP in the long run.

The layout of this paper is as follows. Section 2 describes the data. Section 3 shows the empirical analysis. Section 4 concludes.

2. Data description

This paper uses Gini coefficient to measure income inequality, Log of GDP per capita; and Growth rate of GDP per capita, i.e., Difference of Log of GDP per capita, Ratio of Fixed capital to GDP and Ratio of labor income share to GDP. The data of Gini coefficient of China for period 1978-2006 are cited from Jiandong Chen *et al* (2010), and that from 2007-2013 are collected from National Bureau of Statistics of China (NBSC), and Ratio of

Fixed capital to GDP are supposed to affect economic growth, the former is collected from NBSC and its time span is from 1978 to 2008 and the latter is cited from Haizheng Li *et al*(2014) and its time span is from 1985 to 2010. For exploring how Lewis model works in China, I collected the labor income share in national income, denoted as Labor_GDP.

Figure 3.2 shows Gini coefficient of China from 1978 to 2013, which increases from 0.3 to almost 0.5 in 2009, and then decreases gradually.

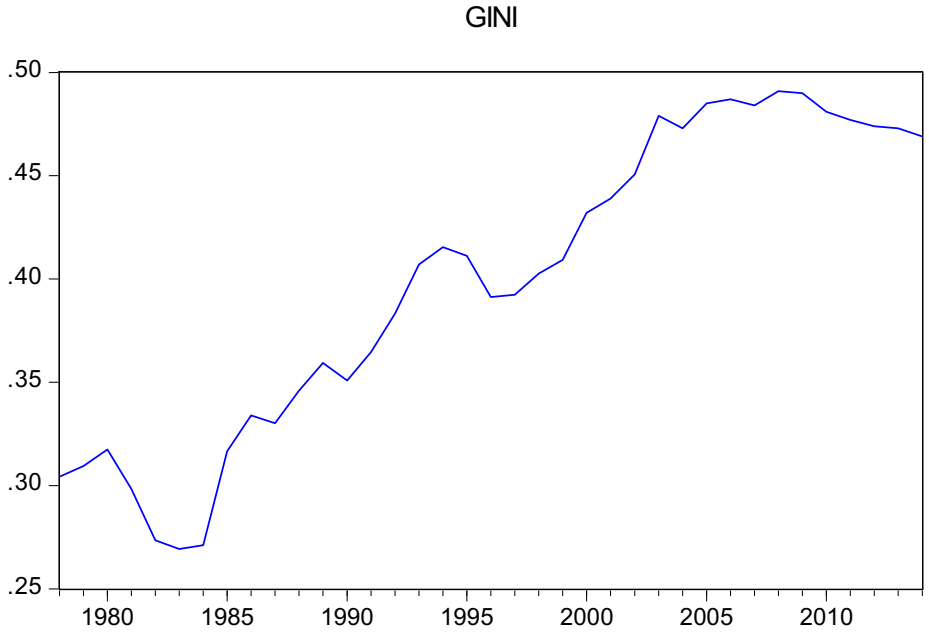

Figure 3.2. Gini coefficient of China from 1978 to 2013

Figure 3.3 shows the scatter of GDP per capita and Gini coefficient, which is close to Kuznets inverted U curve, and currently China is entering the right leg of curve.

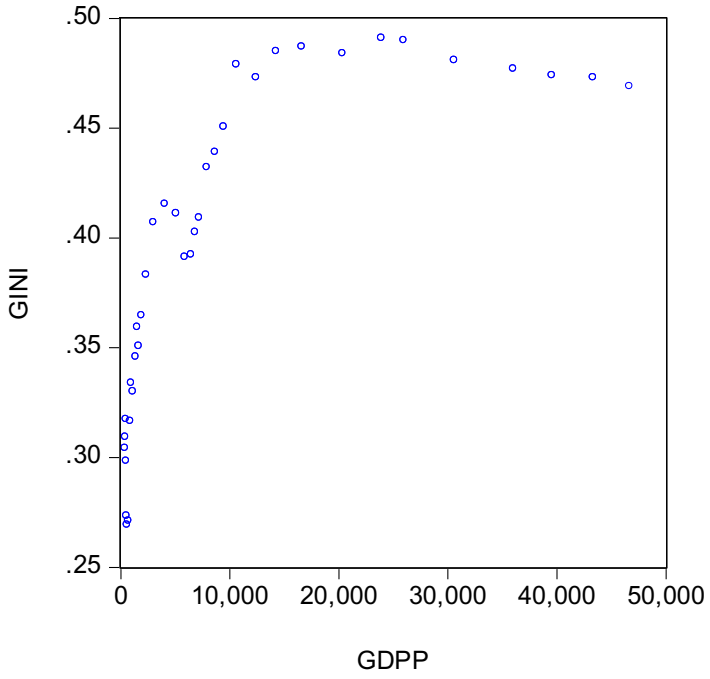

Figure 3.3. Kuznets inverted U curve in China

Figure 3.4 shows Log of GDP per capita of country from 1978 to 2013.

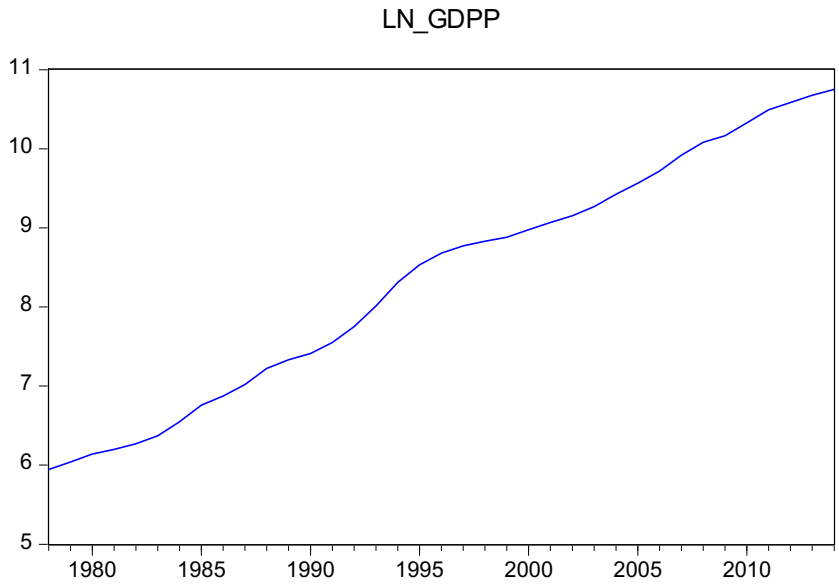

Figure 3.4. Log of GDP per capita of China from 1978 to 2013

The ratio of fixed physical capital to GDP from 1978 to 2008 in Figure 3.5.

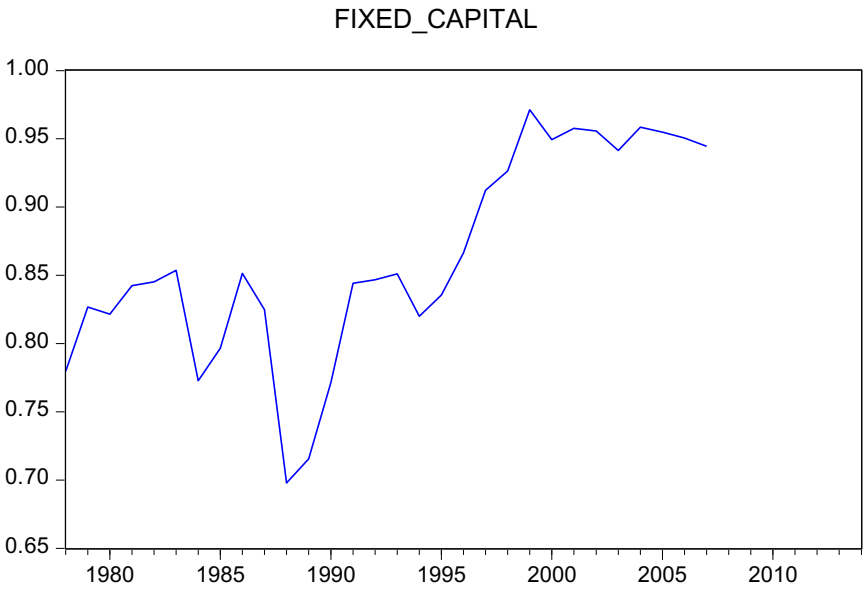

Figure 3.5. Ratio of fixed physical capital to GDP

Figure 3.6 shows the ratio of labor to GDP from 1978 to 2013.

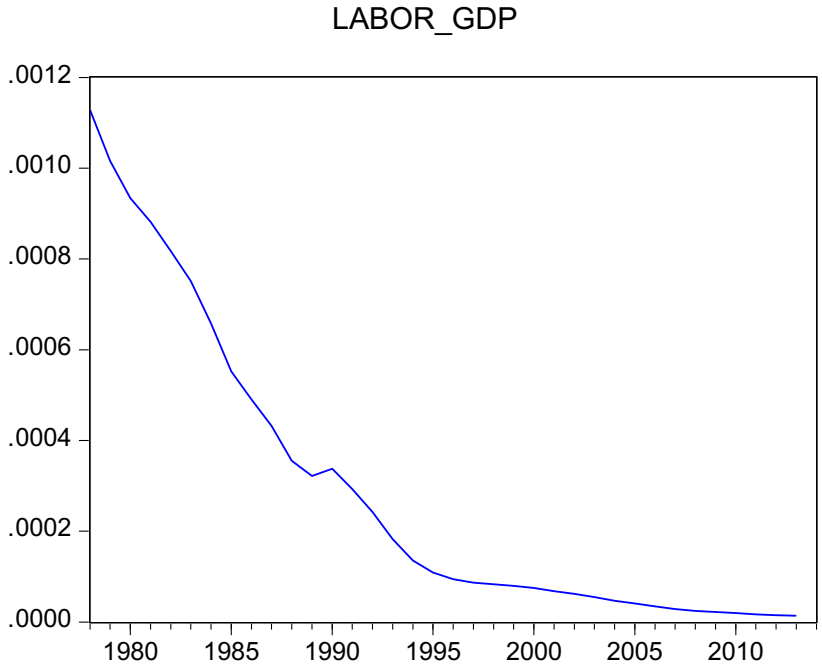

Figure 3.6. Ratio of labor to GDP

Table 3.1. Summary statistics

	GINI	LN_GDPP	CAPITAL_GDP	LABOR_GDP
Mean	0.379560	7.884651	0.862883	0.000346
Median	0.387250	7.881200	0.848942	0.000212
Maximum	0.487000	9.920197	0.971346	0.001128
Minimum	0.269300	5.945421	0.697870	2.87E-05
Std. Dev.	0.068374	1.267802	0.075884	0.000340
Observations	30	30	30	30

2.1 Test for stationarity

We use our Augmented Dickey–Fuller test to test stationarity of the series of the variables listed above, and the results are shown in Table 3.2.

Table 3.2. Unit root test

Variable	Notation	P-value for original data	P-value for its difference	Order of Integration
Log of GDP per capita	LN_GDPP	0.25	0.028	1
GINI coefficient	GINI	0.77	0.002	1
Ratio of fixed capital to GDP	CAPITAL_GDP	0.25	0.002	1
Ratio of labor to GDP	LABOR_GDP	0.15	0.027	1

As we can see in table 3.2, the P-values for rejecting the null hypothesis that the original series has a unit root are shown in in the third column, and P-values for rejecting the null hypothesis that the difference of original series has a unit root are shown in in the fourth column. And the order of integration for the data are shown in the fifth column.

3. Empirical Analysis

3.1 Traditional model

Most of the empirical studies introduced in section 1 use panel data to study how income inequality affects economic growth, and they usually estimate the following equation:

$$\ln y_t - \ln y_{t-1} = \alpha \ln y_{t-s} + X_{t-1}\beta + \gamma Ineq_{t-s} + \varepsilon_t \quad (1)$$

where i denotes a particular country and s denotes time interval. The variable $\ln y_t$ is the log of real GDP per capita so that the right-hand side of equation (1) approximates s-year growth in a country. On the left hand-side, $Ineq_{t-s}$ denotes one measure of inequality (typically, the Gini index); per capita GDP (y_t) is the standard control for convergence, and the vector X contains variable controlling for human and physical capital.

And some studies(say Edgar Begrakyan and Aleksandr Grigoryan, 2012) study how economic growth affect income inequality, they tend to estimate the following equation:

$$Ineq_t = \alpha \ln y_t + X_{t-1}\beta + \varepsilon_t \quad (2)$$

where X denotes the control variable vector, like industry structure variables, poverty and so on.

However, both types of researchers just ignored an important fact that the causality relationship between income inequality and economic growth can be bi-directional. In this case, VAR or VECM model would possibly be better.

3.2. Co-integration and VEC Granger causality test

Two or more variables are said to be cointegrated, if they share common trend(s). As Papana *et al*(2014) points out that the cointegration technique made a significant contribution towards testing Granger causality. Although co-integration does not provide any information about the direction of causality, if two variables are cointegrated, there should be causality in at least one direction (Granger, 1988). To this respect, a cointegration test can be viewed as an indirect test of long-run dependence (Engle and Granger, 1987). Causality in non-stationary time series (in mean) is typically investigated through vector error correction models (VECM) in econometrics, and it is subdivided into short-run and long-run causality. To explore the relationship between the relevant variables including GDP per capita and Gini coefficient, I conduct Johansen Cointegration test among I(1) variables: LN_GDPP, GINI, CAPITAL_GDP, and LABOR_GDP.

Table 3.3. VAR Lag Order Selection

VAR Lag Order Selection Criteria
Endogenous variables: GINI LN_GDPP CAPITAL_GDP LABOR_GDP
Exogenous variables: C
Sample: 1978 2013
Included observations: 26

Lag	LogL	LR	FPE	AIC	SC	HQ
0	286.0914	NA	4.43e-15	-21.69934	-21.50579	-21.64361
1	441.1026	250.4027	1.02e-19	-32.39251	-31.42474	-32.11383
2	467.5998	34.65017*	5.05e-20	-33.19999	-31.45801*	-32.69836
3	493.4475	25.84766	3.12e-20	-33.95750	-31.44130	-33.23293
4	518.9297	17.64153	2.82e-20*	-34.68690*	-31.39649	-33.73938*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The lag length of Johansen integration test model is the lag length of VAR model of these four endogenous variables minus one. As table 2.3 shows, model of lag order 2 is selected under two criteria LR and SC, model of lag order 4 are selected under three criteria, i.e., FPE, AIC and HQ. Then I take the lag length of VAR model is chosen optimally as 4, then model of lag 4 stands out as the most selected. Henceforth the optimal lag length of Johansen cointegration test is 3 (the optimal lag of VAR model minus one).

Table 3.4. Johansen co-integration test

Sample (adjusted): 1982 2007
Included observations: 26 after adjustments
Trend assumption: Linear deterministic trend
Series: GINI LN_GDPP CAPITAL_GDP LABOR_GDP
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.851532	90.65841	47.85613	0.0000
At most 1 *	0.633355	41.06638	29.79707	0.0017
At most 2	0.419375	14.97902	15.49471	0.0597
At most 3	0.031945	0.844125	3.841466	0.3582

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.851532	49.59203	27.58434	0.0000
At most 1 *	0.633355	26.08736	21.13162	0.0092
At most 2	0.419375	14.13489	14.26460	0.0524
At most 3	0.031945	0.844125	3.841466	0.3582

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

If the variables are cointegrated, a VECM should be estimated rather than a VAR as in a standard Granger causality test (Granger, 1988). Since VAR models suggest a short run relationship between the variables because long run information is removed in the first differencing, while a VECM can avoid this issue. In addition, the VECM can distinguish between a long run and a short run relationship among the variables and can identify causality in Granger's sense. VECM shows two underlying causalities: error correction term, shows long-run causality; and lagged variables, show short-run causality, and the model for LN_GDPP, GINI, LABOR_GDP, and CAPITAL_GDP are shown in equations (3)-(6):

$$\Delta GINI_t = \alpha_1 + \sum_{i=1}^{l} \beta_{1i}\, \Delta GINI_{t-i} + \sum_{i=1}^{m} \gamma_{1i}\, \Delta LN\_GDPP_{t-i} + \sum_{i=1}^{n} \alpha_{1i}\, \Delta CAPITAL\_GDP_{t-i} + \sum_{i=1}^{o} \delta_{1i}\, \Delta LABOR\_GDP_{t-i} + \xi_1 ECT_{t-1} + u_{1t} \quad (3)$$

$$\Delta LN\_GDPP_t = \alpha_2 + \sum_{i=1}^{l} \beta_{2i}\, \Delta GINI_{t-i} + \sum_{i=1}^{m} \gamma_{2i}\, \Delta LN\_GDPP_{t-i} + \sum_{i=1}^{n} \alpha_{2i}\, \Delta CAPITAL\_GDP_{t-i} + \sum_{i=1}^{o} \delta_{2i}\, \Delta LABOR\_GDP_{t-i} + \xi_2 ECT_{t-1} + u_{2t} \quad (4)$$

$$\Delta CAPITAL\_GDP_t = \alpha_3 + \sum_{i=1}^{l} \beta_{3i}\, \Delta GINI_{t-i} + \sum_{i=1}^{m} \gamma_{3i}\, \Delta LN\_GDPP_{t-i} + \sum_{i=1}^{n} \alpha_{3i}\, \Delta CAPITAL\_GDP_{t-i} + \sum_{i=1}^{o} \delta_{3i}\, \Delta LABOR\_GDP_{t-i} + \xi_3 ECT_{t-1} + u_{3t} \quad (5)$$

$$\Delta LABOR\_GDP_t = \alpha_4 + \sum_{i=1}^{l} \beta_{4i}\, \Delta GINI_{t-i} + \sum_{i=1}^{m} \gamma_{4i}\, \Delta LN\_GDPP_{t-i} + \sum_{i=1}^{n} \alpha_{4i}\, \Delta CAPITAL\_GDP_{t-i} + \sum_{i=1}^{o} \delta_{4i}\, \Delta LABOR\_GDP_{t-i} + \xi_4 ECT_{t-1} + u_{4t} \quad (6)$$

where Δ is the difference operator, ECT_{t-1} refers to the error correction term derived from the long run-cointegrating relationship via the Johanssen maximum likelihood procedure, i.e.,

$$ECT_{t-1} = \beta_1 GINI_{t-1} + \beta_2 LN\_GDPP_{t-1} + \beta_3 FIXED\_CAPITAL_{t-1} + \beta_4 LABOR\_GDP_{t-1} \quad (7)$$

and $u_{i,t}{}'s$ (for $i = 1,2,3,4$) are serially uncorrelated random error terms with mean zero. Equation (3) will be used to test causation from GDP, ratio of fixed capital to GDP, and ratio of labor to GDP to Gini coefficient, and equation (4) will be used to test causality from Gini coefficient, ratio of fixed capital to GDP, and ratio of labor to GDP to GDP and so on.

Table 3.5. VECM

Vector Error Correction Estimates
Sample (adjusted): 1981 2007
Included observations: 27 after adjustments
Standard errors in ( )

Cointegrating Eq:	CointEq1	CointEq2		
GINI(-1)	1.000000	0.000000		
LN_GDPP(-1)	0.000000	1.000000		
CAPITAL_GDP(-1)	-0.605061 (0.17853)	-10.25745 (2.23578)		
LABOR_GDP(-1)	-1232.146 (161.148)	-11799.58 (2018.12)		
C	0.516918	4.507590		
Error Correction:	**D(GINI)**	**D(LN_GDPP)**	**D(CAPITAL_GDP)**	**D(LABOR_GDP)**
CointEq1	-0.499287 (0.16985)	0.052549 (0.76558)	-1.663808 (0.60659)	0.000533 (0.00024)
CointEq2	0.053301 (0.01494)	-0.010794 (0.06732)	0.134200 (0.05334)	-4.13E-05 (2.1E-05)
D(GINI(-1))	-0.059356 (0.29308)	-0.105297 (1.32107)	2.777943 (1.04671)	-0.000291 (0.00042)
D(GINI(-2))	0.321095 (0.24893)	0.731783 (1.12206)	0.965776 (0.88903)	-0.000566 (0.00035)
D(LN_GDPP(-1))	0.085170 (0.08489)	1.246492 (0.38264)	0.149808 (0.30317)	-0.000286 (0.00012)
D(LN_GDPP(-2))	-0.331663 (0.12128)	-0.417720 (0.54667)	0.605633 (0.43314)	8.65E-05 (0.00017)

D(CAPITAL_GDP(-1))	0.191770	0.283430	-0.116715	-9.01E-05
	(0.08492)	(0.38276)	(0.30327)	(0.00012)
D(CAPITAL_GDP(-2))	0.085645	0.251140	-0.081063	-0.000219
	(0.05999)	(0.27042)	(0.21426)	(8.5E-05)
D(LABOR_GDP(-1))	-493.8889	397.3477	1812.968	0.023835
	(232.541)	(1048.18)	(830.497)	(0.33005)
D(LABOR_GDP(-2))	-186.1018	343.3875	1360.590	-0.314569
	(291.499)	(1313.93)	(1041.06)	(0.41373)
C	0.010381	0.047407	3.71E-05	-1.05E-05
	(0.00573)	(0.02583)	(0.02047)	(8.1E-06)
R-squared	0.736449	0.686828	0.509481	0.875855
Adj. R-squared	0.571730	0.491096	0.202907	0.798264
Sum sq. resids	0.001663	0.033788	0.021211	3.35E-09
S.E. equation	0.010195	0.045954	0.036410	1.45E-05
F-statistic	4.470941	3.509020	1.661854	11.28815
Log likelihood	92.57076	51.91575	58.20088	269.6252
Akaike AIC	-6.042278	-3.030797	-3.496362	-19.15742
Schwarz SC	-5.514345	-2.502863	-2.968428	-18.62949
Mean dependent	0.006170	0.140012	0.004557	-3.35E-05
S.D. dependent	0.015579	0.064417	0.040782	3.22E-05
Determinant resid covariance (dof adj.)		7.34E-21		
Determinant resid covariance		9.05E-22		
Log likelihood		500.8905		
Akaike information criterion		-33.25115		
Schwarz criterion		-30.75546		

Table 3.5 can be divided into two parts, the first part is the co-integration equations part, while the second part is the error correction equation part. The two co-integration equations are

$$GINI = -0.517 + 0.605 * CAPITAL\_GDP + 1232.146 * LABOR\_GDP \quad (8)$$

$$LN\_GDPP = -4.508 + 10.257 * CAPITAL\_GDP + 11799.580 * LABOR\_GDP \quad (9)$$

As the (8) and (9) show, there exists long run equilibrium relationship between Gini coefficient, Ratio of fixed physical capital and Ratio of labor to GDP, and there also exists long run equilibrium relationship between log of GDP per capita, ratio of fixed capital to

GDP and ratio of labor to GDP. Then we can see there exist no long run equilibrium relationship between Gini coefficient and log of GDP per capita.

For test the temporal causality, I conduct Granger causality/Block Exogeneity Wald tests based upon VEC model shown in Table 3.6.

Table 3.6. Granger causality/Block Exogeneity Wald tests

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1978 2013
Included observations: 28

Dependent variable: GINI

Excluded	Chi-sq	df	Prob.
LN_GDPP	0.950908	2	0.6216
CAPITAL_GDP	0.479882	2	0.7867
LABOR_GDP	1.698443	2	0.4277
All	9.701780	6	0.1378

Dependent variable: LN_GDPP

Excluded	Chi-sq	df	Prob.
GINI	0.881276	2	0.6436
CAPITAL_GDP	7.085170	2	0.0289
LABOR_GDP	5.022048	2	0.0812
All	7.961938	6	0.2409

Dependent variable: CAPITAL_GDP

Excluded	Chi-sq	df	Prob.
GINI	6.982444	2	0.0305
LN_GDPP	13.18490	2	0.0014
LABOR_GDP	11.26572	2	0.0036
All	23.14216	6	0.0008

Dependent variable: LABOR_GDP

Excluded	Chi-sq	df	Prob.

GINI	1.709970	2	0.4253
LN_GDPP	10.87571	2	0.0043
CAPITAL_GDP	11.44861	2	0.0033
All	19.58939	6	0.0033

The results shown in Table 3.6 about the temporal causality links among the four variables are summarized in Figure 1.7. We can also see no temporal causality link between Gini coefficient and log of GDP per capita. Bi-lateral temporal causality links exist between log of GDP per caita and ratio of fixed capital to GDP, ratio of fixed capital to GDP and ratio of labor to GDP. Unidirectional causality links run from Gini coefficient to ratio of fixed capital to GDP, and from log of GDP per capita to ratio of labor to GDP.

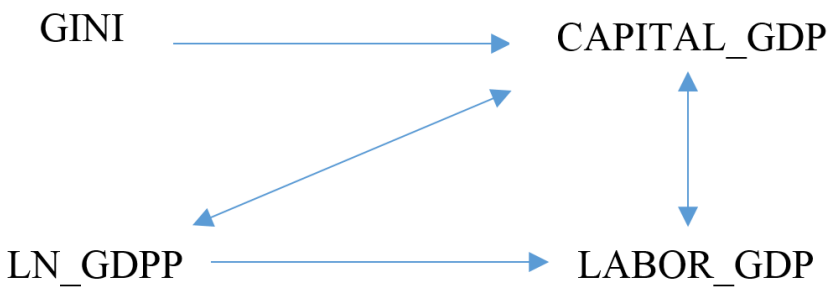

Figure 3.7. Temporal Causality Links

4. Conclusion Remarks

In this study, causality link is investigated between Gini coefficient, GDP per capita, ratio of fixed capital to GDP and ratio of labor to GDP in China from 1978 to 2013. Evidence from the study shows there exist neither long run nor short run causality link between Gini coefficient and log of GDP per capita.

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