

On Graduation from Default, Inflation and Banking Crises: Elusive or Illusion?

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I. Introduction

This paper addresses the elusive concept of “graduation” from external default, banking and inflation crises.¹ When does a country reach a point of political, economic and financial development so that crises occur only once a century or more, as opposed to say, every twenty years or less? Although the topic of graduation is arguably one of the most important issues in macroeconomics, there has been remarkably little theoretical or empirical investigation of the subject. For example, the large theory literature on sovereign lending and default, while producing many important insights on the fundamental distinction between willingness to pay and ability to pay, largely treats a country’s basic developmental and political characteristics as parametric. There is very little on explaining the political, social, economic and financial dynamics that ultimately lead a country to be less prone to certain types of crises.

The empirical literature on financial crises certainly does contain numerous case studies of individual country histories but, to our knowledge, there has not been any attempt to try to characterize the general feature of the process of graduation, or even to provide representative time frames or patterns of vulnerability. Given the broad sweep of time over which crises probabilities express themselves, characterizing simple measures of recidivism requires very long-dated cross country data sets, which is the approach here.

We acknowledge that the concept of graduation is a hard nut to crack. Many advanced countries had enjoyed a long hiatus from systemic banking crises after World War II, and yet had huge problems during the recent global financial crisis. Portugal defaulted on its external sovereign debt in 1560, but then did not do so again until the nineteenth century – when it defaulted on six separate occasions. Even the advanced countries had high inflation as recently

¹ The notion of “graduation” was introduced in Reinhart, Rogoff, and Savastano (2003)

as the 1970s and early 1980s, while many emerging markets had hyperinflation less than two decades ago. Is the advent of modern independent central banks sufficient to guarantee that fiscal dominance never again reasserts itself? Have the rich countries that have supposedly “graduated” from serial default on external debt, shifted the locus of risk to de jure or de facto (via inflation or tax legislation) default on domestic debt? Does the theory of sovereign default or of financial development tell us that we should expect richer and more advanced countries to be immune? Or is graduation a mirage, with the “graduates” really being at best “star pupils”, and can graduates be distinguished from patients in remission?

Our goal in this paper is fairly narrowly circumscribed. Drawing heavily on the data set developed in Reinhart and Rogoff (2009, 2010), we will attempt to characterize countries’ tendency to relapse into crisis, discriminating particularly across advanced economies and emerging markets. How long a period does a country need to go without crisis to mark a significantly reduced probability of relapse? Most of our analysis here is based on data on the dates and duration of the crises themselves. We speculate on underlying factors but do not approach them empirically, leaving the topic for future research.² Nevertheless, given the relevance of the topic, we hope the reader will find the broad patterns we document here interesting and potentially important.

The data set we employ here spans all regions for the two-century period (1800-2008). We focus particularly on the small slice of the data that catalogues dates and episodes marking different types of financial crises, with our emphasis being on sovereign default, banking crises

² Reinhart and Rogoff (2010) formally investigate the predictive power of past banking and sovereign default crises and future ones. Among their results is the finding that banking crises do help predict sovereign default crises, and that debt levels help predict crises.

and inflation crises.³ Although the various types of crises often occur in clusters, it will nevertheless be convenient to begin by treating individual crises separately, waiting until a final section to explore linkages.

We begin the paper by defining the crises that we will catalogue, in order to make the paper self-contained. In the next section of the paper, we will give a very brief overview of the early history of serial default on external debt. We show, for example, the case of France, which defaulted on its external debt no less than nine times from the middle of the sixteenth century through the end of the Napoleonic War, but has not defaulted on external debt since. France is a canonical case of what we define as an “external default graduate.” (This did not stop France from having numerous severe banking crises in the past two centuries.)

We then proceed to provide a broad aggregative historical overview of the data across different types of crises, distinguishing between advanced countries and emerging markets, and also separating out Latin America.

The final section of the paper offers a brief overview of the theoretical literature on sovereign default. We argue that the literature has ways to go of providing a satisfactory model of graduation. Unlike individuals, countries seldom default because of insolvency, willingness to pay is almost always the binding constraint. As a result, many of the canonical models (e.g., those stemming from the seminal work of Eaton and Gersovitz, 1981) do not necessarily predict that rich countries (in the sense of having a generally higher trajectory for GDP per capita) are necessarily less likely to default than poor countries, as we certainly find in the data (although the distinction is not absolute, as California’s credit problems illustrate). Some key parameters

³ Given the very large correlation between exchange rate and inflation crises over this period (Reinhart and Rogoff, 2009, 2010), we choose not to treat exchange rate crises separately.

such as the variability of terms of trade and productivity shocks, might arguably make commodity producing countries more vulnerable (as we will explore later), but are not necessarily linked to wealth. Other factors, such as discount rates of politicians or ability to commit to low taxation of capital, arguably present more severe challenges in the typical emerging market than in the typical wealthy country, but again, these factors alone would not suffice to explain graduation. The same general issues apply to banking crises.

The main empirical results from our long-dated historical time series on financial crises may be described as follows:

First, the process of “graduation”, that is emergence from frequent crisis suffering status, is a long process. False starts are common and recurrent. This is especially true in the case of banking crises, for both high and middle-low income countries.⁴

Second, the vulnerability to crisis in high-income countries versus middle-low income countries differs mostly in external default crises, to a lesser extent in inflation crises, and differs surprisingly little in banking crises.⁵

Third, the sequence of graduation for most of countries is first to graduate from external default crisis, then from inflation crisis, and eventually from banking. The last stage of graduation is extremely difficult, even for high-income countries. Among high-income countries, even though most of them have graduated from external default crisis and inflation crisis, more than 20 percent recently experienced a banking crisis, and far more when weighted by size. Schularick and Taylor (2009) speculate that advanced countries continue to experience credit

⁴ Of course, the recurrent serial nature of financial crises is a principal theme of Reinhart and Rogoff (2009, 2010), but the present study organizes the data in a way that is much more revealing about the dynamics of graduation and recidivism.

⁵ Reinhart and Rogoff (2008, 2009) emphasize that banking crises are an “equal opportunity menace.”

busts despite arguably advancing regulation and institutions, because as risks moderate, financial systems grow and restore them.

Fourth, we find that the period starting from 1980 is characterized by the widening the gap between high and middle-low income countries in term of share of countries in external default and inflation crisis. However both groups experienced a large increase in share of countries in banking crisis.

Finally, the role of IMF programs in crises is important. One interesting finding is that IMF programs preceded external debt crises (within a three-year interval) in many cases. We are not arguing that IMF programs contribute to crisis, but that in many instances they should be viewed as mitigating risk rather than preventative. There are a number of important cases, for example Argentina 2002, where a sovereign default has taken place after a country has engaged in an IMF program. IMF programs may help facilitate orderly debt workouts but do not guarantee them. We also note that in its early history, many of today's rich countries regularly drew on IMF resources, although there has been a three decade hiatus.

In the final section of the paper before the conclusions, we speculate on links between graduation and development, and the possibility for recidivism among richer countries. The fact that the canonical theory of sovereign default does not strongly predict smaller problems in richer countries (it does not strongly predict graduation) might be considered a flaw in theory. But it might also be taken as warning sign that graduation can be more difficult and take even more time, than our data of "just" a few centuries can reveal. On banking crises, the theory needs to better explain why countries never seem to graduate.

II. Definition of Crises

Before proceeding to document the history of crises and graduation, a few definitions are necessary to make this paper self-contained.⁶

External debt crisis: We distinguish between external and internal debt based on the legal jurisdiction where the debt contracts are enforced. This is a convenient construct given the history and evolution of sovereign debt. Obviously it may be useful to parse the data in other ways for some exercises, and in principle our data set allows that.

Although there are exceptions and there has been some evolution in recent years, typically in our dataset, external debt is denominated in foreign currency and held by foreign creditors. There are certainly important examples, such as Mexico's short-term Tesobono bonds in the mid 1990s, where the debt is domestic yet denominated in foreign currency and held primarily by foreign creditors. Although we regard the US abrogation of the gold clause in the early 1930s – when gold was revalued from \$21 to \$35 per ounce – to be a default on domestic debt, many non-US residents were also holding the debt at the time. In general, following standard practice, we define an external debt crisis as any failure to meet contractual repayment obligations on foreign debts, including both rescheduling or repayments and outright default. (As both of these examples make clear however, we will ultimately need to think carefully about whether graduation from external default may sometimes just mean a shift to episodic de facto and de jure internal default.)

In practice, most defaults on external debt end up being partial, with creditors typically (but not always) repaying worth fifty cents or more on the dollar, admittedly not adjusting for

⁶ For further details on crisis definitions, we refer to the reader to Reinhart and Rogoff (2009, ch. 1), or to Reinhart and Rogoff (2010).

risk. The rationale for lumping together defaults regardless of the ultimate haircuts creditors are forced to absorb is that in practice, the fixed costs of external debt default (which include difficulties in obtaining trade credits and loss of reputation) tend to be large relative to the variable costs. In principle, one could parse episodes more finely here according to, say, output or tax revenue loss depending on data availability, although we do not undertake that exercise here.

Domestic debt crises: We do not include domestic debt crises in this study, but some comment is warranted to put the overall exercise in perspective. Although overt de jure defaults on domestic debt have been received very little attention in the literature, Reinhart and Rogoff (2008, 2009) show that they were once surprisingly common, cataloging over 70 cases of domestic default.

Inflation crises: Following Reinhart and Rogoff, we define inflation crises as episodes where annual inflation exceeds 20%. This threshold is lower than the 40% we and others have used in related studies on post war data (e.g., Reinhart and Rogoff, 2004), but is a compromise reflecting that prior to World War I, average inflation rates were much lower, and 20% inflation generally represented a significant level of dysfunction. Indeed, since we are particularly interested here in inflation as vehicle for partial default, one clearly would also want to consider lower levels of sustained unanticipated inflation such as many advanced countries experienced in the 1970. Depending on the maturity structure of debt, sustained ten percent inflation can certainly be tantamount to de facto default. A proper calibration, however, would require detailed data on the maturity structure of debt (as in Missale and Blanchard, 1994) and, ideally, also on the evolution of inflation expectations. We do not attempt this here, though again, this is an important caveat to interpreting the concept of “graduation” from external debt crises.

Banking crises: Our definition of banking crises follows standard practice (e.g., Caprio and Klingebiel (2003) or Kaminsky and Reinhart (1998).) Following our own earlier work, “We mark a banking crises by 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 and (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, p. 11)

As with domestic defaults, we recognize that our listing of systemic (on a national scale) banking crises may be incomplete, especially prior to 1970, especially for crises outside the large money centers that attract the attention of the world financial press.

Exchange rate crises: We do not explore exchange rate crises here, in part because inflation and exchange rate crises are so highly correlated (see Reinhart and Rogoff, 2009, 2010). Also, it is clear that standard definitions of exchange rate crises (emphasizing very large short term exchange rate movements) would show very potential graduates.

Having set out basic definitions, we are now ready to view some basic characteristics of the data. To provide context and motivation for the concept of graduation, we begin with a brief overview of the early history of sovereign defaults, as well as predictions from the theoretical literature.

III. The early history of sovereign defaults

As Reinhart, Rogoff and Savastano (2003) and Reinhart and Rogoff (2009) emphasize, many of today’s advanced economies had recurrent problems with default on sovereign debt

during the period when they might arguably have been characterized as emerging markets. Table 1 illustrates the case of Europe for the three centuries 1550-1850, with the years listed marking the beginning of a sovereign default episode.

Table 1- External defaults: Europe, 1550-1850

<i>Country</i>	<i>Years of default</i>	<i>Number of defaults</i>
Austria-Hungary	1796, 1802, 1805, 1811, 1816	5
England	1594*	1*
France	1558, 1624, 1648	
	1661, 1701, 1715	9
	1770, 1788, 1812	
Germany (Prussia)	1683, 1807, 1813	3
Germany (Hesse)	1814	1
Germany (Schleswig-Holstein)	1850	1
Germany (Westphalia)	1812	1
Netherlands	1814	1
Portugal	1560, 1828, 1837, 1841, 1845	5
Russia	1839	1
Spain	1557, 1575, 1596,	10
	1607, 1627, 1647	
	1809, 1820, 1831, 1843	
Sweden	1812	1

Sources: Reinhart, Rogoff and Savastano (2003), Reinhart and Rogoff (2009) and sources cited therein. The “*” for England denotes our uncertainty at this time about whether its default was on domestic or external debt. The table excludes Greece (which gained independence in 1829). Note that for some countries, even if there was default on external debt, there may have been a default on domestic debt, as was the case for Denmark (1813).

As one can see clearly from the table, serial default was quite common among the major European powers during the sixteenth through nineteenth centuries, with France defaulting on its external debt nine times and Spain defaulting ten times (with three more to follow in the second half of the nineteenth century). One important observation, immediately apparent from the table, is that whereas on occasion one default episode follows on the heels of another (we require episodes to be at least two years apart to consider them independent), there is a substantial interval between defaults, typically decades, but sometimes centuries. After defaulting in 1683, Prussia's next default episode did not follow for more than a century in 1807. Portugal, after defaulting in 1560, did not default again until 1828, when the country lapsed into a period of serial default that did not end until 1890. At this writing, Portugal has not defaulted again since. Germany's most recent default occurred in 1939, Austria's in 1940 and Hungary's in 1941 (Reinhart and Rogoff, 2009). Especially interesting are the cases of Sweden and France. France, despite a near record level of defaults in its pre-Napoleonic era, has not defaulted on external debt since. Sweden, too, has not defaulted on external debt since its default at the end of the Napoleonic War in 1812. It would be interesting to explore whether war time defaults are less damaging to reputation than peacetime defaults, though of course over many episodes, it is precisely the propensity to wage war that motivates many countries to build up large debts (as in the tax smoothing model of Barro, 1979).

Reinhart and Rogoff (2009) find the kind of long cycles illustrated in Table 1 to be quite characteristic of some of today's emerging markets, many of whom have defaulted at least once during the past two to three decades. The number of emerging markets that have experienced external debt crises expands considerably if one includes "near default" episodes in which country's averted technical default thanks to IMF bridge loans. In virtually all of these cases, the

countries still suffered massive recessions as governments were forced to tighten fiscal policy as borrowing options dried up. Importantly, we do not include these in our calculations below, although arguably from the point of view of understanding macroeconomic volatility and the dangers of excessive debt accumulation, they are equally important. We return to this issue later when we study IMF programs.

IV. The Duration and Prevalence of External Default, Inflation and Banking Crises:

The Post 1800 Experience

We now proceed to consider a broader variety of crises, focusing on the more “recent” period, 1800-present. The past two centuries give a much broader sample of independent nations to study, as various regions of the world threw off the yoke of colonialization. Latin American countries, for example, gained their independence during the first half of the nineteenth century. Many Asia countries became independent only after World War II, and many African countries first gained independence in the 1960s and 1970s. In table 1 below, we present measures of crisis probability, counting only years since independence. Each measure takes the number of years a country experienced each kind of crisis (including all years and not just the initial one) divided by the number of years since independence.⁷

Table 1, which is constructed by taking years in crisis divided by total years since independence (or 1800) includes our first and perhaps the most fundamental result. The table shows that the biggest difference between high-income countries and the rest of the world lies in exposure to external default crisis. The average external default crisis probability of high-income group is less than half of middle-low income countries and almost one fifth of Latin America countries. The difference would be even larger if we included only 20th and 21st century

⁷ Again, see Reinhart and Rogoff (2009) for a listing of independence dates.

defaults. Inflation crisis probabilities are also higher in the rest of the world than in high income countries although the gap is smaller. Interestingly, the average probability of banking crises in high income countries and the rest of the world is similar.⁸

Table 2- Summary statistics of crisis probabilities

	External Default		Inflation		Banking	
	Average	Std Dev	Average	Std Dev	Average	Std Dev
World	0.19	0.18	0.12	0.12	0.06	0.07
High-income	0.07	0.13	0.06	0.05	0.05	0.04
Middle-low *	0.19	0.17	0.17	0.17	0.09	0.10
Latin America	0.34	0.13	0.12	0.07	0.04	0.04

Notes: crisis probability is calculated as the number of years in crisis divided by number of years since independence. Probabilities were calculated for each country since 1800 or country's independence year

* Excluding Latin America

Sample coverage: 66 countries for external default crisis; 67 countries for inflation and banking crisis.

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Note that inflation and banking crisis probabilities are lower in part because the average duration of these crises tends to be much shorter compared to external default crises. (Again, we are counting years in crisis, as opposed to the number of independent events.) Interestingly, inflation crisis probabilities are higher among middle-low income countries (excluding Latin America) than in Latin America, while their default crisis probability is lower. This is partly due to the fact that low income countries are often excluded from international capital markets, therefore external default crises are less common. Appendix Table A1 gives the frequency and cumulative distributions of different crisis probabilities across countries.

⁸ The similarity of banking crises across countries was first noted in Reinhart and Rogoff, 2009, ch 10, who also show that the macroeconomic effects of banking crises are remarkably similar as well across advanced economies and emerging markets.

Appendix Table A2, which gives the average duration of crises, shows the striking difference between the mean and median duration of external default crises versus inflation and banking crises. The median duration of banking crises is less than 3 years or less across all income classes, where the world median for default crises is 8 years. For inflation crises, the median is only 1 year across all income classes. Presumably this implies that a country can find ways to trudge on a state of sovereign default far more easily than it can continue any semblance of business as usual during a banking or inflation crisis.

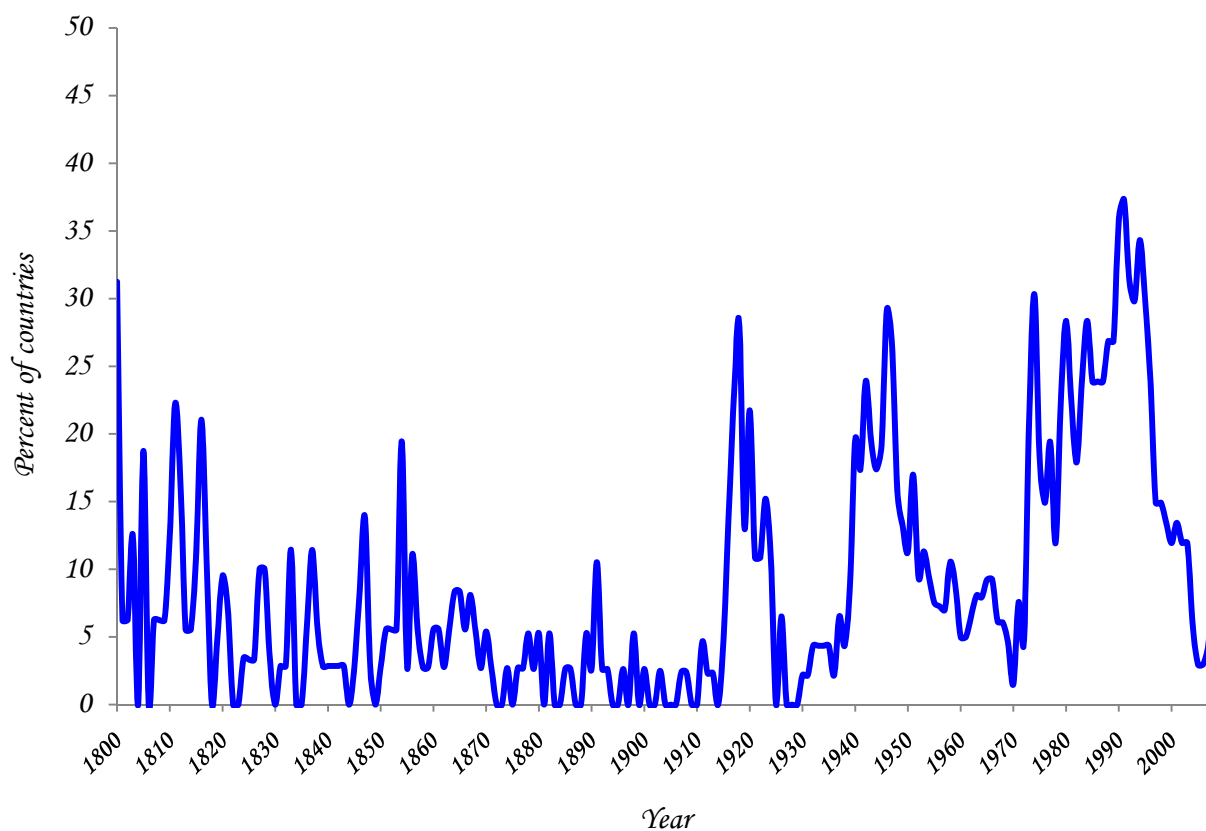
Given the long duration of external default crises, and their frequency, it is not surprising that large portions of the world have been in default over much of the last 200 years, as illustrated by Reinhart and Rogoff (2009). Some of the major default episodes include the Napoleonic Wars in the early 19th century, and then Latin America countries once independent, Greece, Spain and Portugal in the first quarter of the century. The biggest default spike occurs during the era bridged the Great Depression and World War II, when at the peak more than 40% of the world, weighted by GDP, was in default on external debt.

Figure 1 gives the share of countries in inflation crisis over the same period. Note the huge rise in inflation crises starting after World Wars I and II, again in the 1980s and early 1990s. The very recent history of low inflation throughout most of the world indeed represents a major shift from the preceding 80 years. It remains to be seen whether inflation is a scourge that has been slain. As Rogoff (2003) has argued, institutional changes, including especially the advent of independent central banks with a strong anti-inflation commitment has been an important factor in this dramatic fall in inflation, but so too was the pre-crisis boom which alleviated political pressures on central banks to engage in unanticipated inflation. It remains to

be seen whether the current period will prove merely another lull (one sees many in the Figure 1) as opposed to permanent structural shift towards universal low and stable inflation.

Indeed, if one truly believes that fiscal dominance will never again assert itself in most countries, and then arguably, historical measures of default may underestimate the true probabilities unless one believes that fiscal discipline has significantly increased. The recent explosion of public debt globally underscores this concern.

Figure 1
Share of countries in inflation crisis: 1800-2008
World

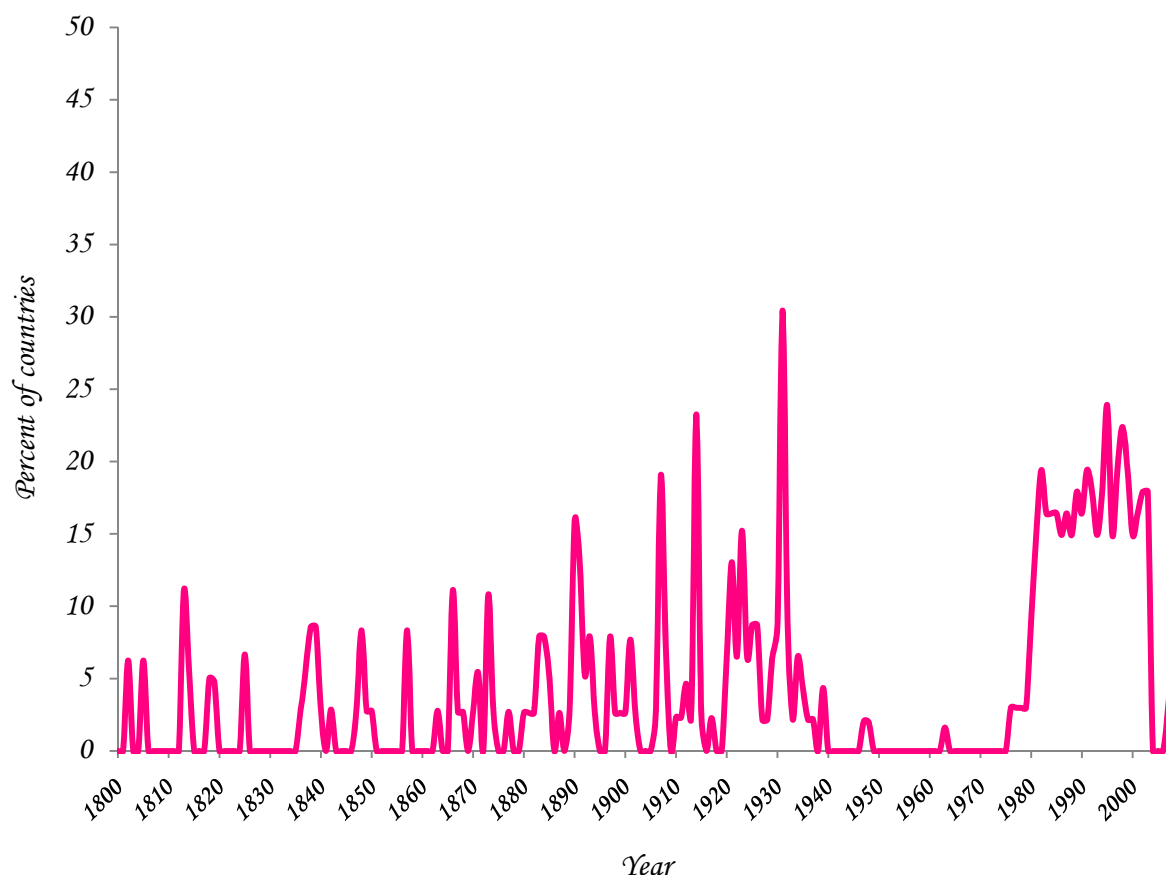


Sample coverage: 67 countries that were independent in the given year.

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Figure 2 gives the share of the world experiencing banking crises since 1800. Note the remarkably small number of banking crises during the years of financial repression that began during World War II and continued in many countries well into the 1970s. By historical standards, this was a uniquely quiescent period. It is clear also from the figure that this era has been long but seems coming to an end.

Figure 2
Share of countries in banking crisis: 1800-2008
World



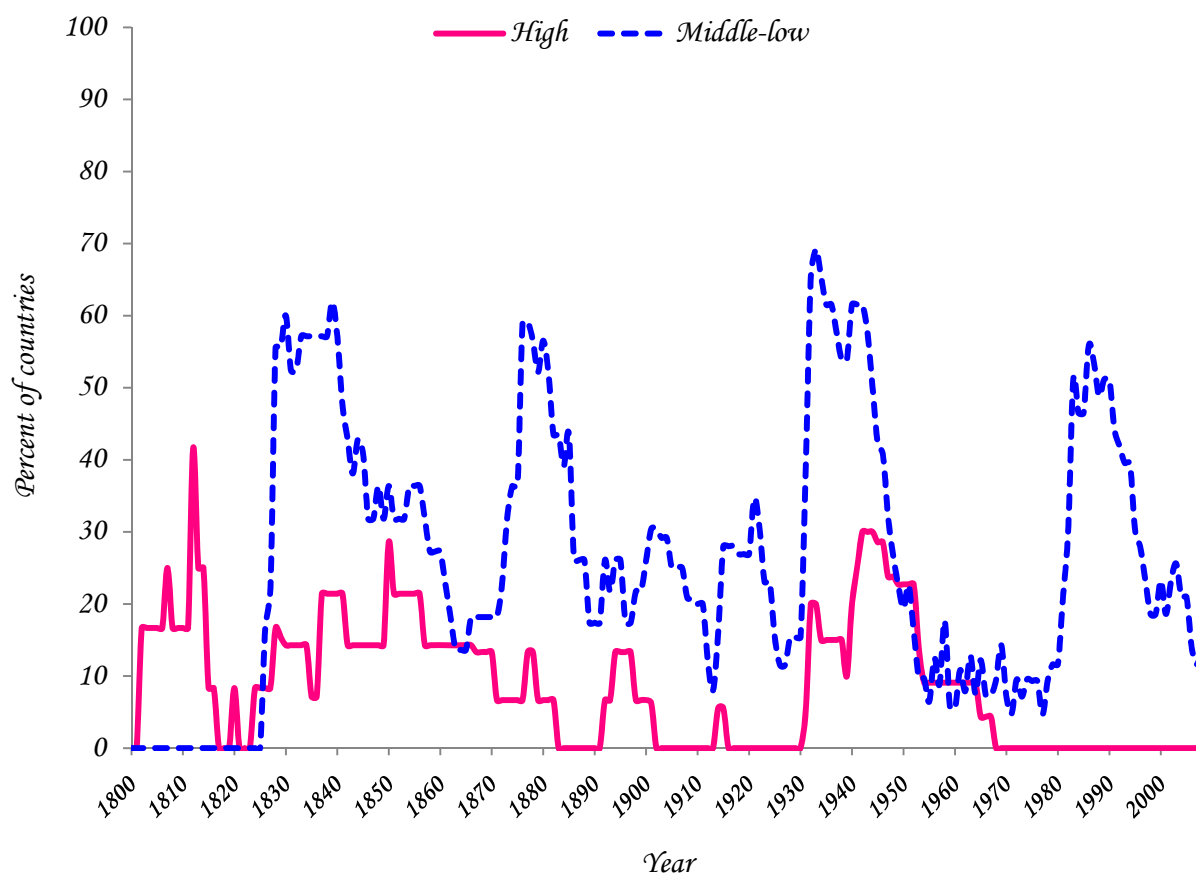
Sample coverage: 67 countries that were independent in the given year.

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

The next three figures contrast the experiences of high income countries with middle and low income countries (including Latin America). They corroborate what we have already seen

in Table 1, but give more detail. Figure 3 on external debt crises, for example, illustrates two points. First, as already noted, middle-low income countries are in technical default on external debt a significantly higher percentage of the time than high income countries. Second, the high income countries had a dramatic drop of external defaults starting in the late 1960s with none (as of this writing!) since the advent of floating exchange rates in the 1970s. Later we shall look at evidence on distance since the last default crisis. (Note: We exclude from our middle-low income countries very low income countries who do not have external default by virtue of the fact they are not able to borrow at all on private markets.)

Figure 3
Share of countries in external default crisis: 1800-2008
High income vs. Middle-low income

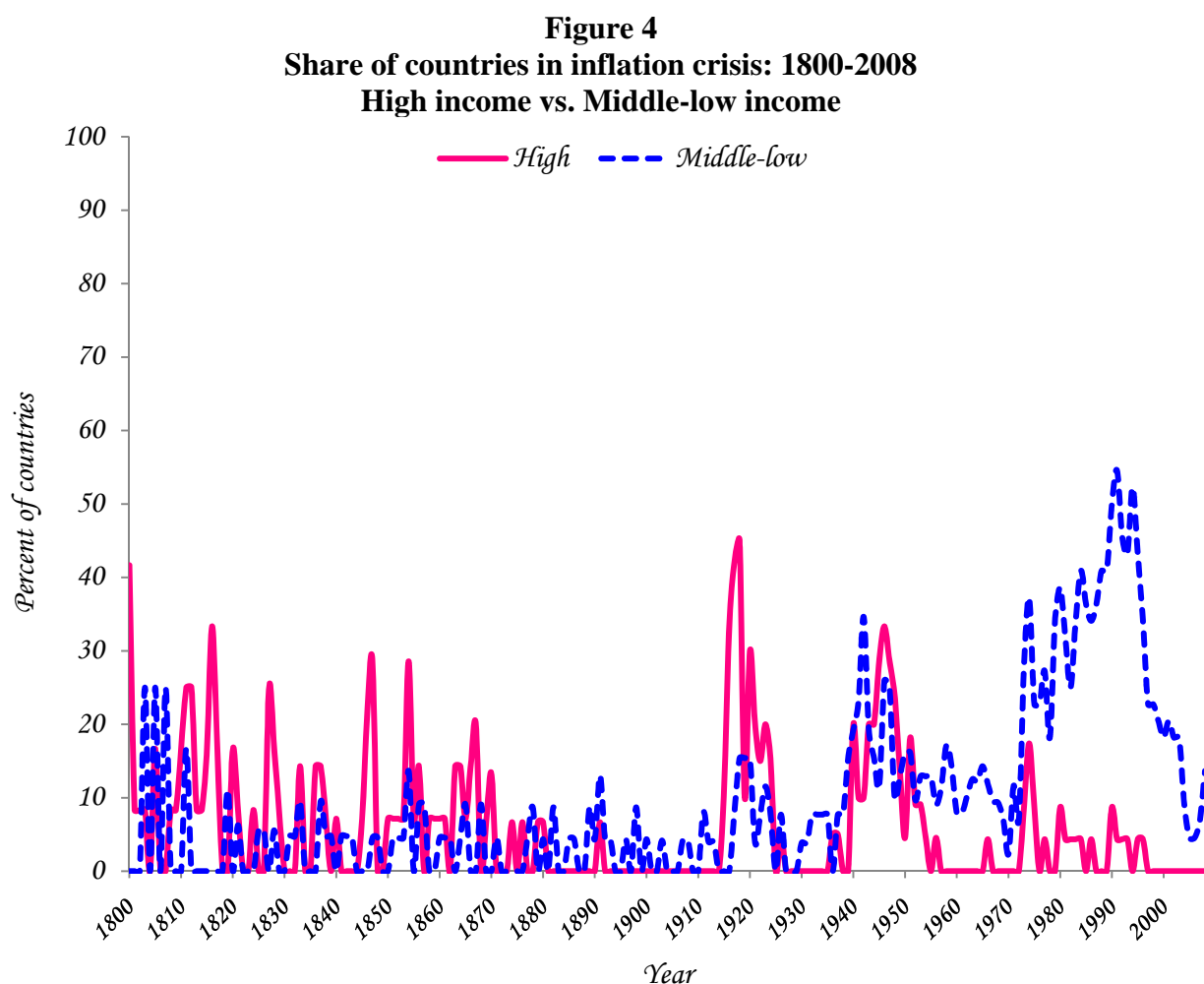


Sample coverage: 66 countries (23 high income and 43 middle-low income countries) that were independent in the given year.

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

High income countries seem to have graduated from default crisis, or at least gone into deep remission. But most middle-low income countries have not yet graduated.

Figure 4 shows inflation crises frequencies in middle-low income countries versus high income countries. High income countries have had inflation crises more recently than external default crises, but the frequency has dropped to zero since the early 1990s. For middle-low income countries, a spike in the 1990s has been followed by a sharp tapering during the 2000s.



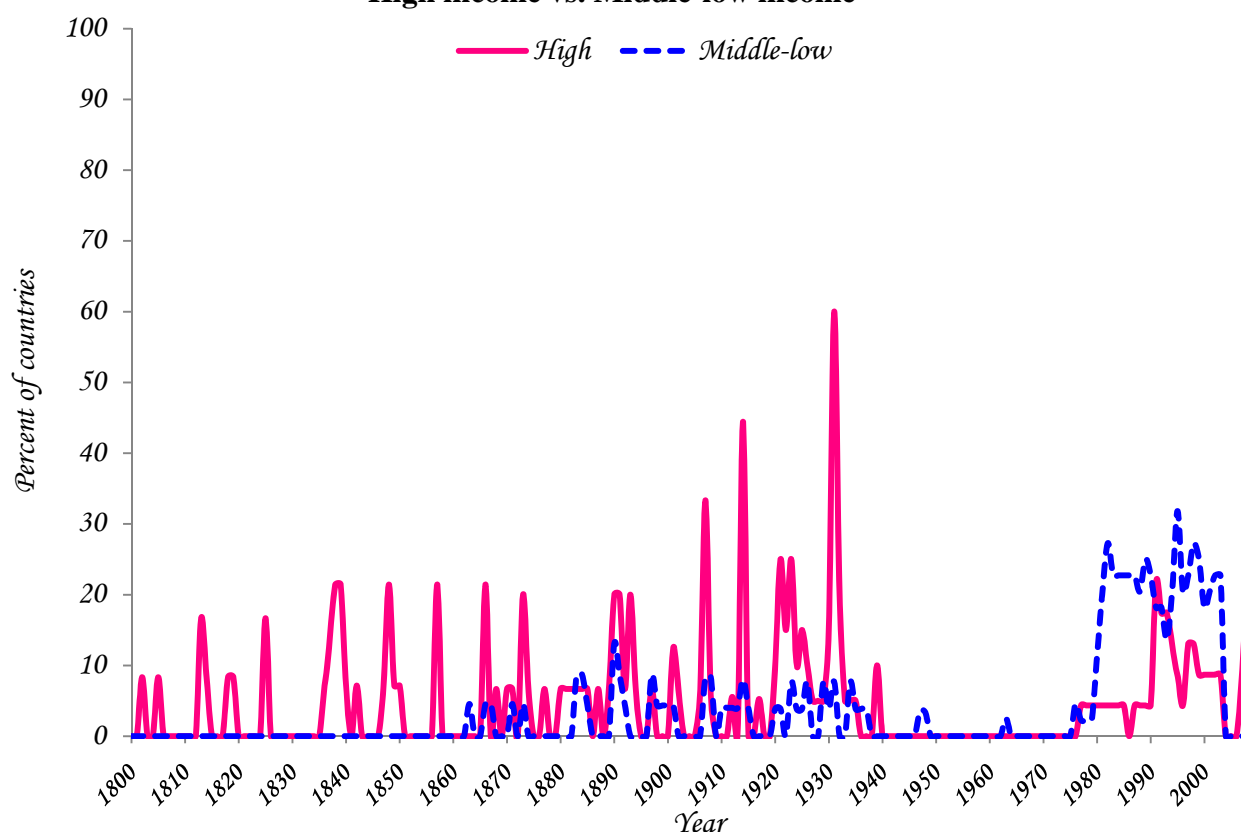
Sample coverage: 67 countries (23 high income and 44 middle-low income countries) that were independent in the given year.

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Whereas figure 4 is illustrative of the frequency of very high inflation episodes, we note that it does not capture episodes of sustained high inflation below 20% that, if significantly unanticipated and depending on the maturity structure of government debt, may represent a substantial de facto default on debt.

Figure 5 on banking crises tells a very different story (our data for developing countries begins more recently; hence the dashed line for middle-low income only begin in the 1860s; of course, many of today's developing countries did not gain their independence until later.) One can see that in sharp contrast to external default and inflation crises, banking crises are “an equal opportunity menace” (Reinhart and Rogoff, 2009, chapter 10). Although banking crises have picked up dramatically in emerging markets since 1980, they have recently picked up in rich countries as well. Again, note the hiatus in banking crises across both groups of countries during the years of financial repression from World War II until the 1970s.

Figure 5
Share of countries in banking crisis: 1800-2008
High income vs. Middle-low income



Sample coverage: 67 countries (23 high income and 44 middle-low income countries) that were independent in the given year.

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Clearly, neither high nor middle-low income countries are in imminent danger of graduating from banking crises.

For completeness, we include in the appendix figures A3-A5 that contrast the experience of Latin America with other middle-low income countries. We see again that external defaults have been significantly more frequent in Latin America, although they have still been important in other regions. Inflation crises are somewhat more common in Latin America, whereas banking crises are similar, again echoing the “equal opportunity menace” theme.

V. Waiting times between consecutive crises

Having now looked at the frequency of crises, we next turn to thinking about frequency. How long is a typical duration between crises? How long a time between crises must a country mark before one can think of “graduation”? This is clearly a very difficult question. We have seen the case of Portugal where over two centuries passed between defaults.

Indeed, as we illustrate below, one third of all cases of recidivism occur more than twenty years from the time a country cleared up its previous default episode. Almost one fifth of all cases of recidivism occur after a forty year hiatus. It takes sixty years before 94% of the cases of recidivism are subsumed. (Note that this is not a measure of time between first year of default dates, but rather between the end of the last default episode and the start of a new one.) The wait to graduate from inflation crises is slightly shorter, only 27 percent of cases of recidivism occur after 20 years, 15 percent after 40 years, and 8 percent after sixty years. Banking crises are similar, again 27 percent of recurrences occur after 20 years, 16 percent after forty years, and 9 percent after sixty years.

We recognize that all the calculations above represent unconditional measures of lulls between crises; institutions and political stability are no doubt extremely important. Yet, many of these factors, too, are highly persistent and difficult to measure, which is precisely why previous experience with crises is such a powerful predictor of future ones.⁹

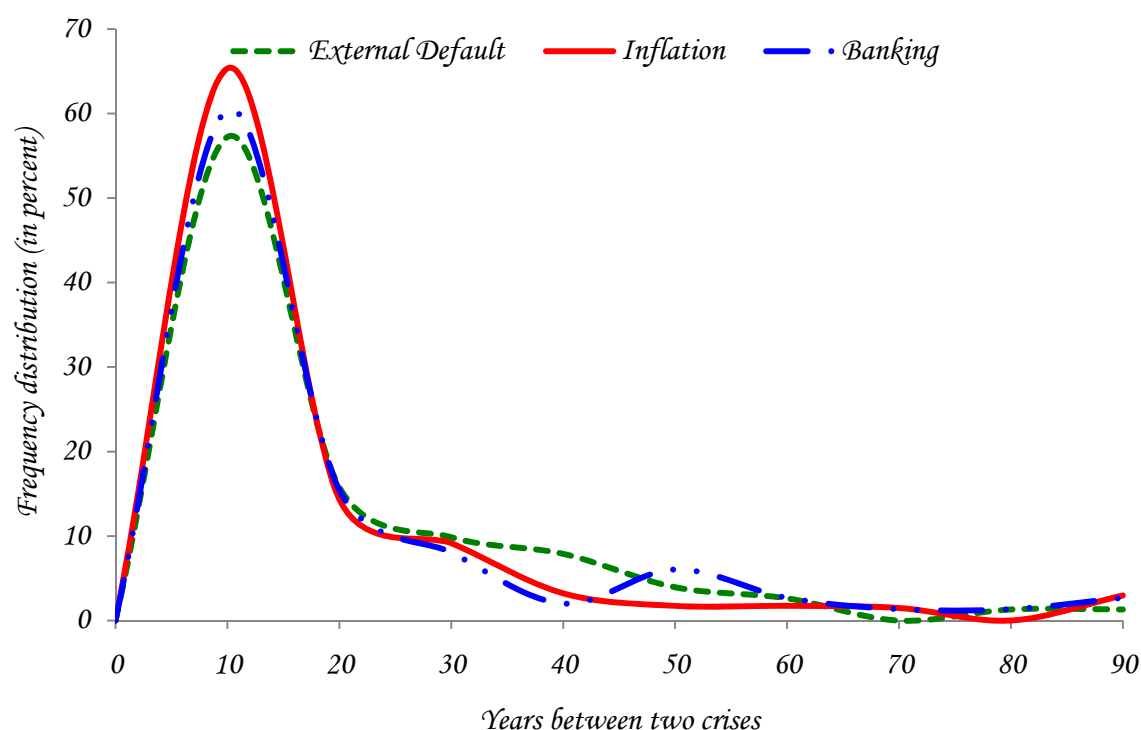
In our first pass below, we do not make any attempt to deal with the possible non-stationarity of the time series, and take simple averages. In particular, we do not deal with the possible structural breaks that occur at World War II, when default and banking crises frequencies sharply increased; in 1970, when they rose again; and in the 1990s when inflation

⁹ Again, Reinhart, Rogoff and Savastano (2003) and Reinhart and Rogoff (2010) provide concrete empirical measures of how past crises experience measures a country’s vulnerability to future crisis, an exercise we do not take up here.

crises frequencies fell dramatically. From the broader sweep of history, it is not easy to determine what constitutes a structural break, but clearly further analysis is needed. In figure 6, we look at the frequency distribution of “tranquil” periods, how long before one crisis episode stops and the next crisis starts. The figure gives the statistics separately for external default, inflation and banking crises. The frequencies are surprisingly similar, with a significant share of distribution falling between ten and twenty years.

Crisis reversal and duration

Figure 6
Duration of “tranquil time” (or crisis reversals)
Frequency distribution (in percent): 1800-2008



Note: Duration of tranquil time is calculated as number of years between end year of a crisis and start of a new crisis. For example: Argentina had defaulted in 1982 and it didn't resolve it until 1994. In 2001 Argentina entered into default crisis again. In this case the tranquil time for Argentina was between 1994 and 2001. In other words, Argentina had default reversal in 7 years.

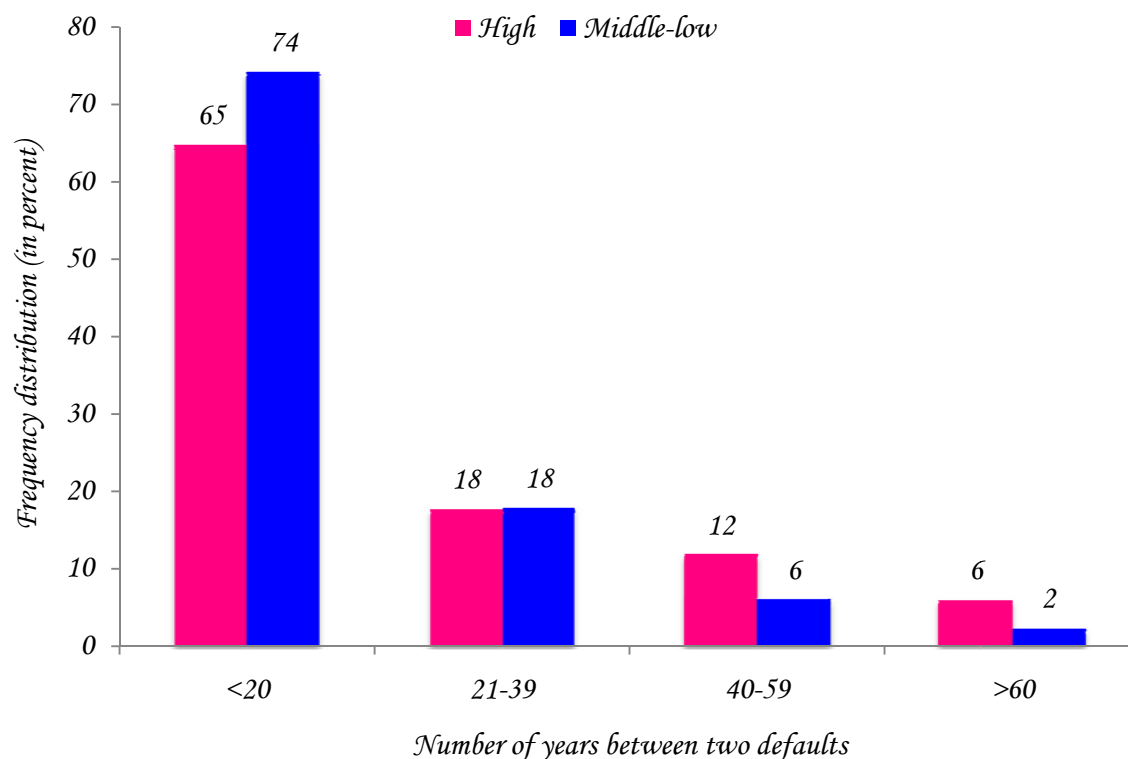
Sample coverage: 152 episodes of default crisis reversal (high income: 17, middle-low: 135), 404 episodes of inflation crisis reversals (high income: 145, middle-low: 259) and 149 episodes of banking crisis reversals (high income: 92, middle-low: 57).

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

The frequency of recidivism (conditional on a crisis recurring) is broadly similar across different types of crises. Twenty years without a default, banking or inflation crisis is hardly evidence of “graduation”. But it does appear to be a notable break, where the odds of recidivism over any medium term period, drop notably. As already mentioned and as documented in Table A6, the duration of default crises is much longer than of inflation or banking crises.

Figures 7-9 illustrate the distribution of time between crises using a histogram, and distinguishing between high and middle-low income countries. The charts give a more nuanced picture of the differences between crises than the world aggregates do. They show, for example, that whereas recidivism in external debt default occurs within 20 years seventy five percent of the time, relapses take 21 to 60 years 30 percent of the time in high income countries and 24 percent of the time in low income countries. Inflation and banking crises have similar characteristics in that a twenty year hiatus without incident is an important mark, though especially for banking crises, a long period without a crisis is not guarantee that another will not occur. For inflation, a forty year period without a relapse is somewhat more definitive.

Figure 7
External default crises: Duration of “tranquil time” (or default reversal)
Frequency distribution (in percent): 1800-2008
High vs. Middle-low income



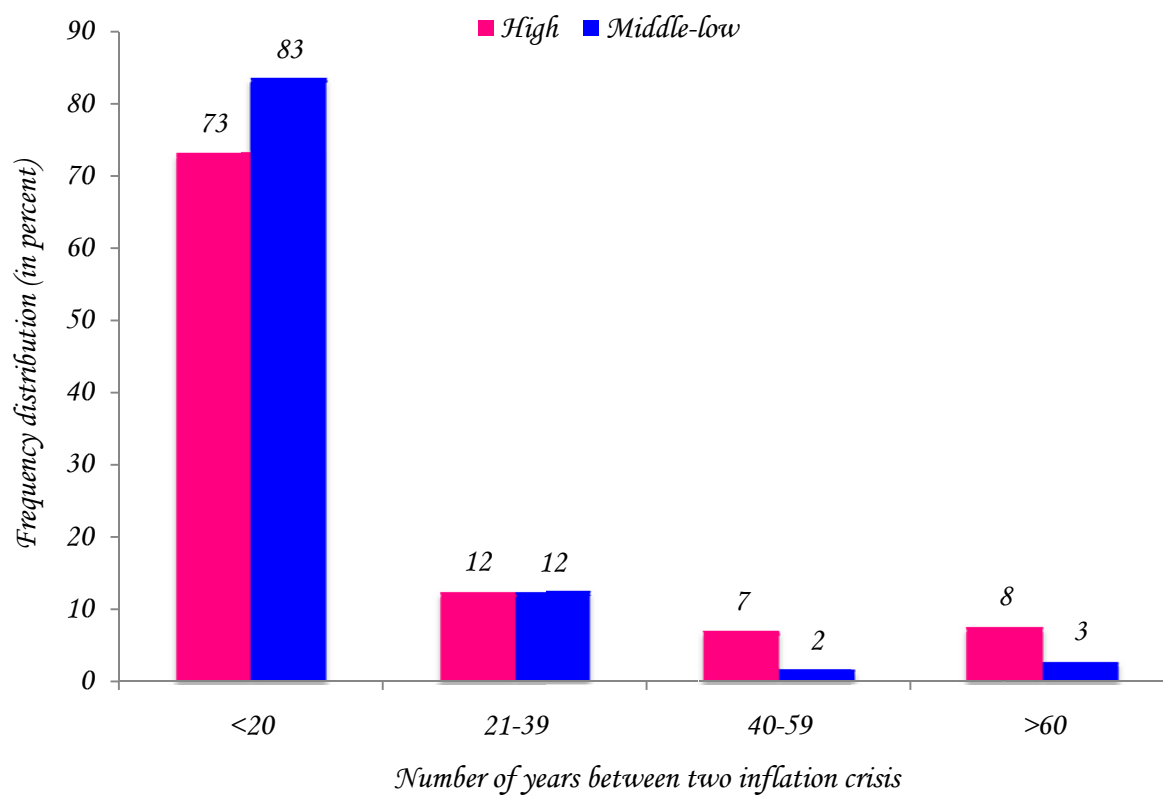
Note: Duration of tranquil time is calculated as number of years between two consecutive default episodes. The end of a default episode is considered as the year the country regains access to the capital market. In other words, as long as the country is excluded from the international capital market, it is not considered as having resolved its default crisis. The start of a new default episode is the year the country declares default on its external debt.

Sample coverage: 152 episodes of default crisis reversals (high income: 17, middle-low: 135).

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

If high income countries have default reversal, the tranquil period is slightly longer than middle-low income countries. The same exercise excluding default reversals occurred during World Wars gives similar results.

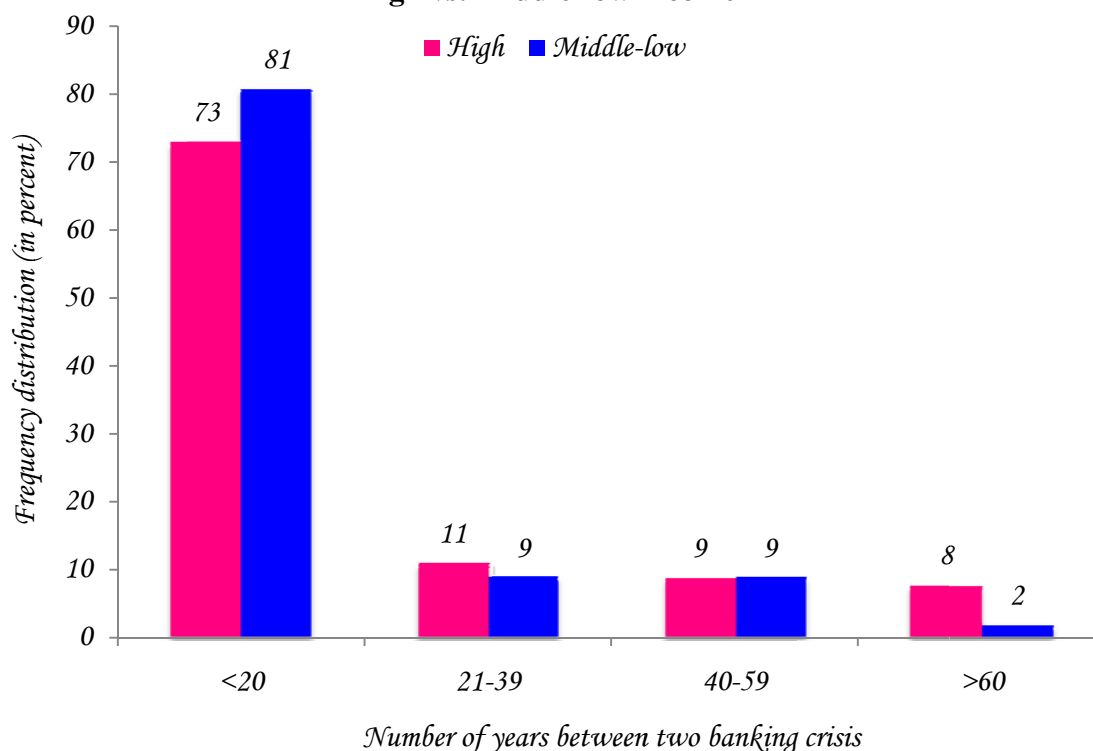
Figure 8
Inflation crises: Duration of “tranquil time”
Frequency distribution (in percent): 1800-2008
High vs. Middle-low income



Note: Duration of tranquil time is calculated as number of years between two consecutive inflation crises.
 Sample coverage: 404 episodes of inflation crisis reversals (high income: 145, middle-low: 259).
 Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Most of inflation crisis reversals happen in less than 20 years.

Figure 9
Banking crises: Duration of “tranquil time”
Frequency distribution (in percent): 1800-2008
High vs. Middle-low income



Note: Duration of tranquil time is calculated as number of years between two consecutive banking crisis episodes. Sample coverage: 149 episodes of banking crisis reversals (high income: 92, middle-low: 57). Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Most of banking crisis reversals happen in less than 20 years.

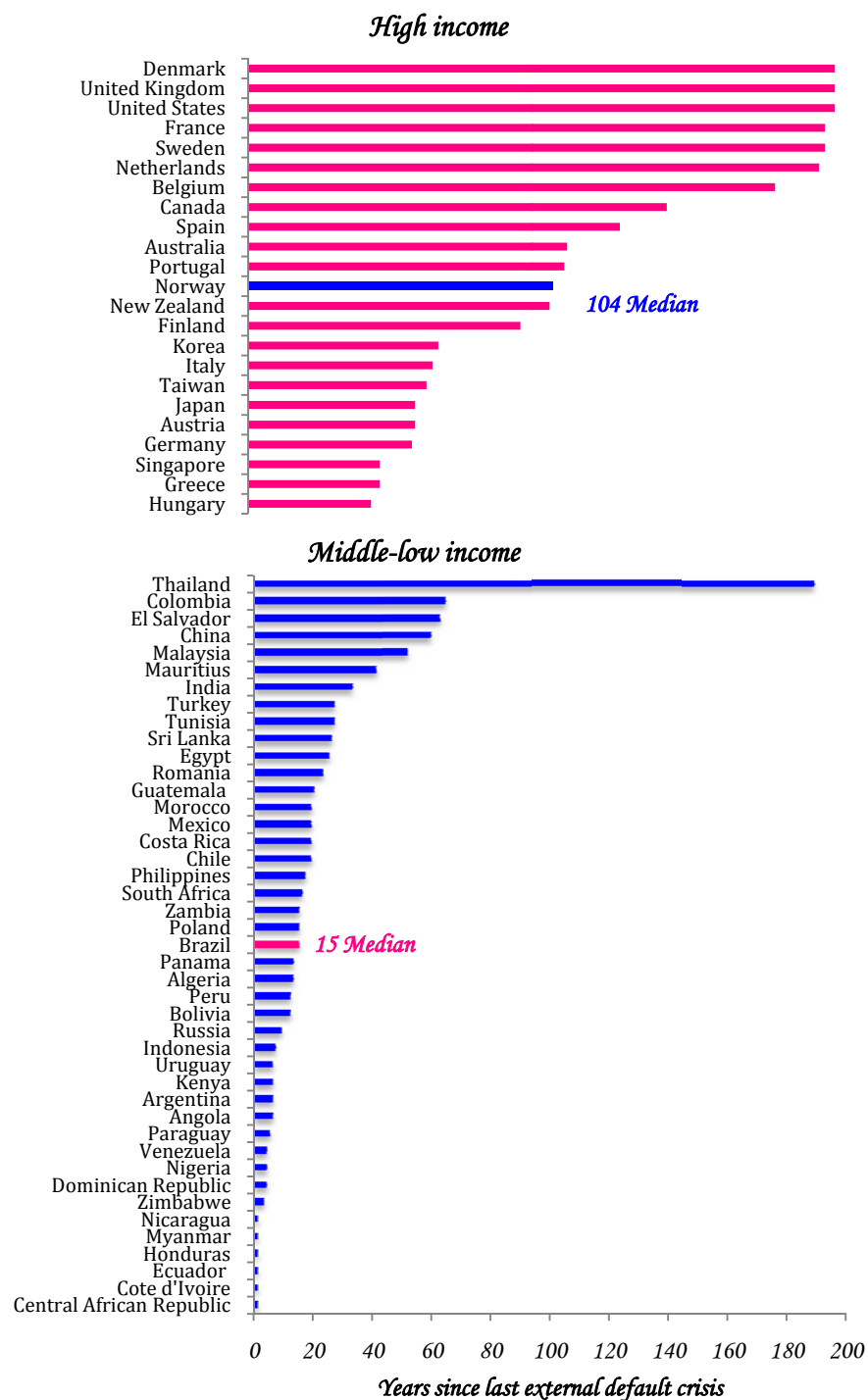
VI. Distance to last crisis

To gain a deeper insight into recidivism – or its complement, graduation -- we look at measures of distance since the last crisis. In figure 10, three countries, the United States, Denmark and the United Kingdom have been independent the entire post-1800 period and never defaulted on external debt. (Although as we have already noted, the US and UK did effectively default on domestic debt by going off the gold standard in the early 1930s; Denmark also

defaulted on domestic debt in 1813 at the end of the Napoleonic Wars). At the other extreme, a number of African countries remain in default today.

Stunningly, the median time since last default is just over a century for the advanced countries (104 years) versus only 15 years for the developing countries. The world median is 26 years.

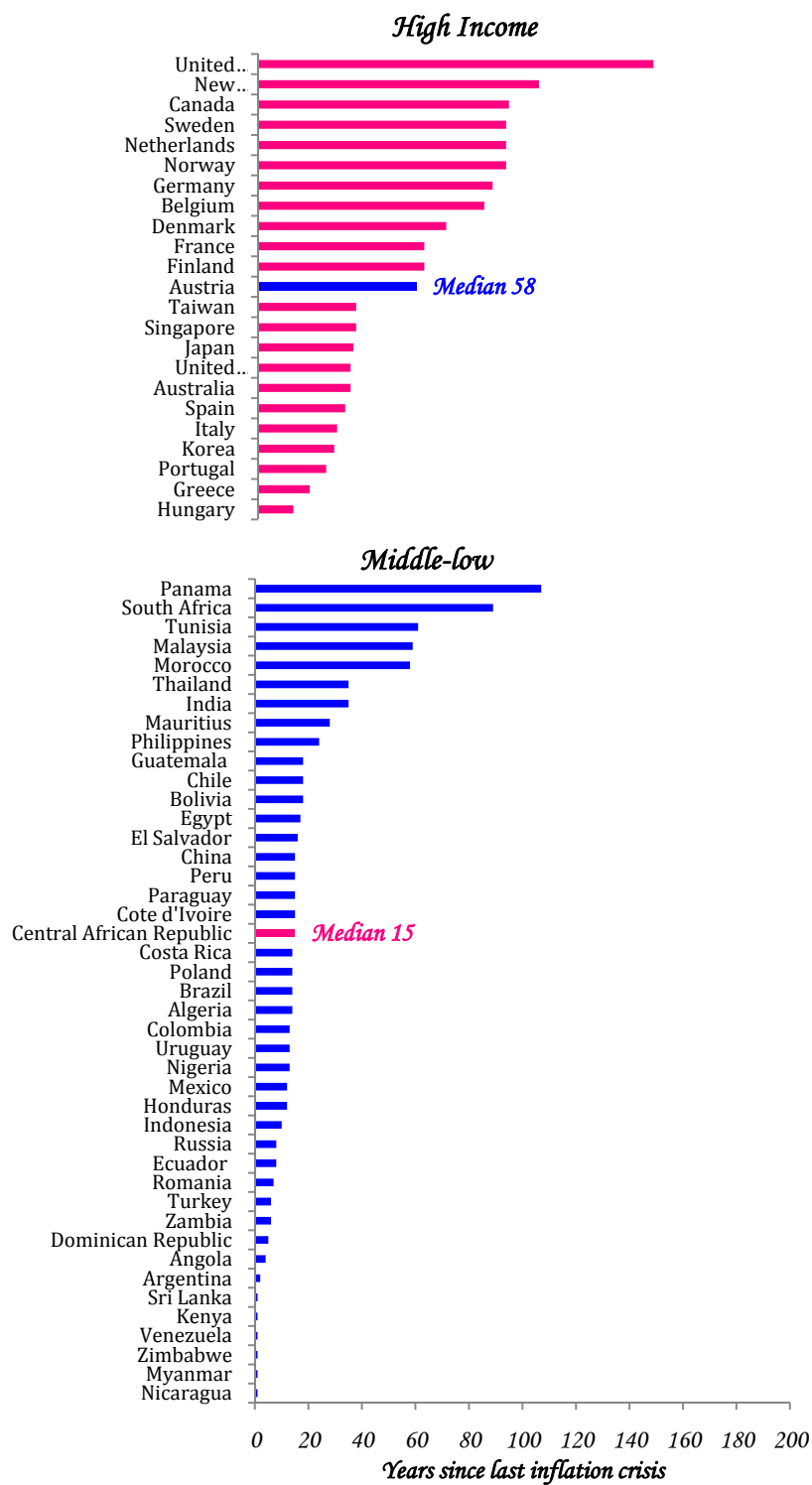
Figure 10
Distance to last external default crisis in 2009: High vs. Middle-low



Note: distance calculated as 2009 minus the last year that the country was in external default crisis.
 Sample coverage: 66 countries (23 high income and 43 middle-low income countries).
 Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Figure 11 on inflation crises tells a similar story with the median again being only fifteen years for the middle-low income countries, but 58 years for high income countries. Many high income countries, of course, had high inflation in the years after World War II, so the average time is lower than for default.

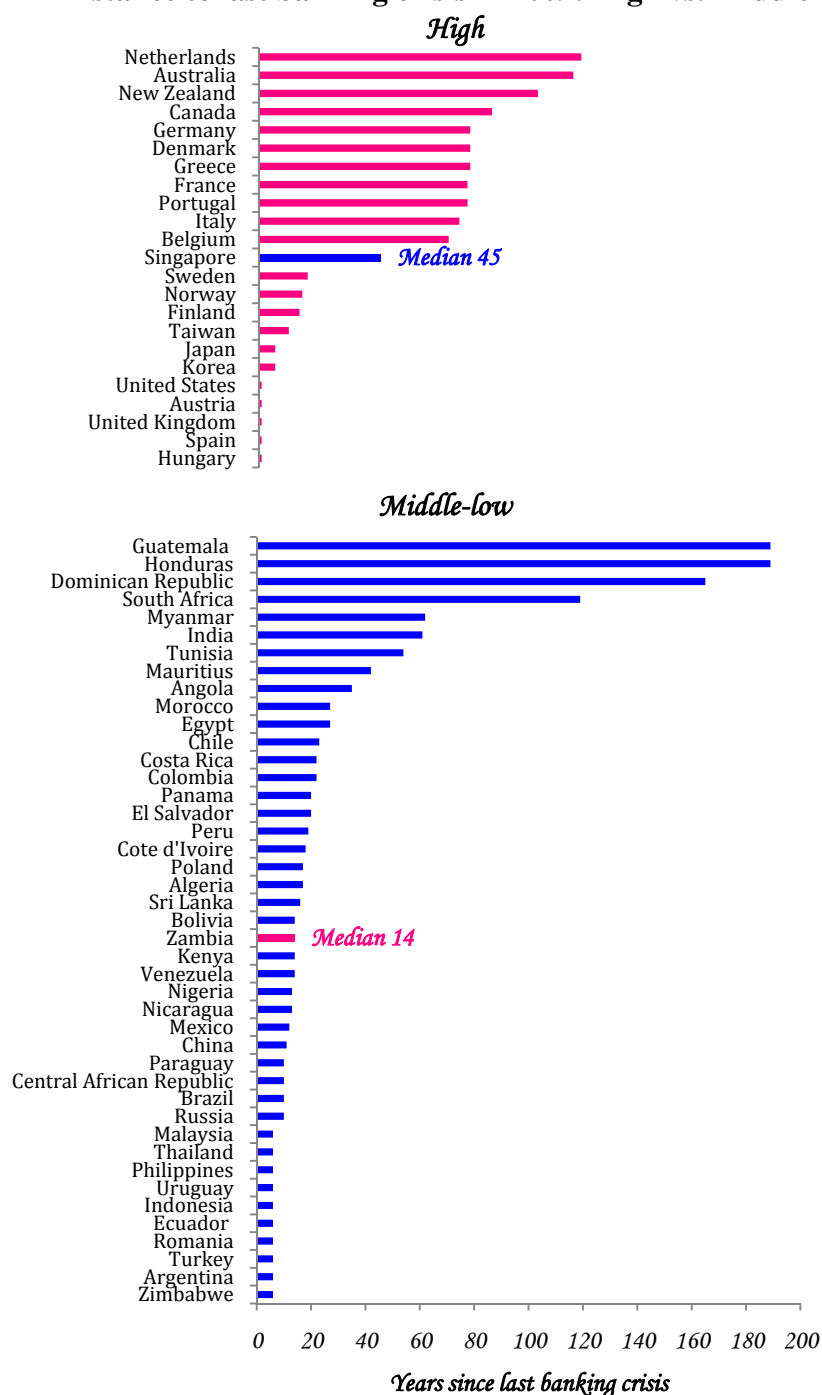
Figure 11
Distance to last inflation crisis in 2009: High vs. Middle-low



Note: distance calculated as 2009 minus the last year that the country was in inflation crisis.
 Sample coverage: 66 countries (23 high income and 43 middle-low income countries).
 Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Finally, for banking crises, the difference between income groups is even smaller, and we have not even added in the recent crisis, when advanced countries lost their lead. The interesting point is that even prior to the crisis, the distinction between high income countries and the rest of the world was not nearly the same as for other crises.

Figure 12
Distance to last banking crisis in 2009: High vs. Middle-low



Note: distance is calculated as 2009 minus the last year that the country was in banking crisis.

Sample coverage: 66 countries (23 high income and 43 middle-low income countries).

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

Indeed if we simply include Ireland and Iceland in the high-income group, the median would be 16 instead of 45 years, which makes high-income countries look much alike middle-low income countries.

Table 3- Median of distance (in years) to last crisis in 2009

Type of crisis	World	High income	Middle-low income
External default	25	105	15
Inflation	18	58	14
Banking	17	45	14

Notes: distance to last crisis is calculated as 2009 minus the last year that the country was in crisis. Medians are calculated for each income group and each type of crisis.
Sample coverage: 66 countries (23 high income and 43 middle-low income countries) for external default, inflation and banking crisis.
Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2009).

In term of banking crisis, high-income and middle-low income countries are not so different. Graduating from banking crises is hard, even for high-income countries.

Memo: Asian countries' distance to external default crisis is 49, to inflation crisis is 32, and to banking crisis is 9. Latin America countries' distance to external default crisis is 12, to inflation crisis is 14 and to banking crisis is 17.

VII. Macroeconomic volatility

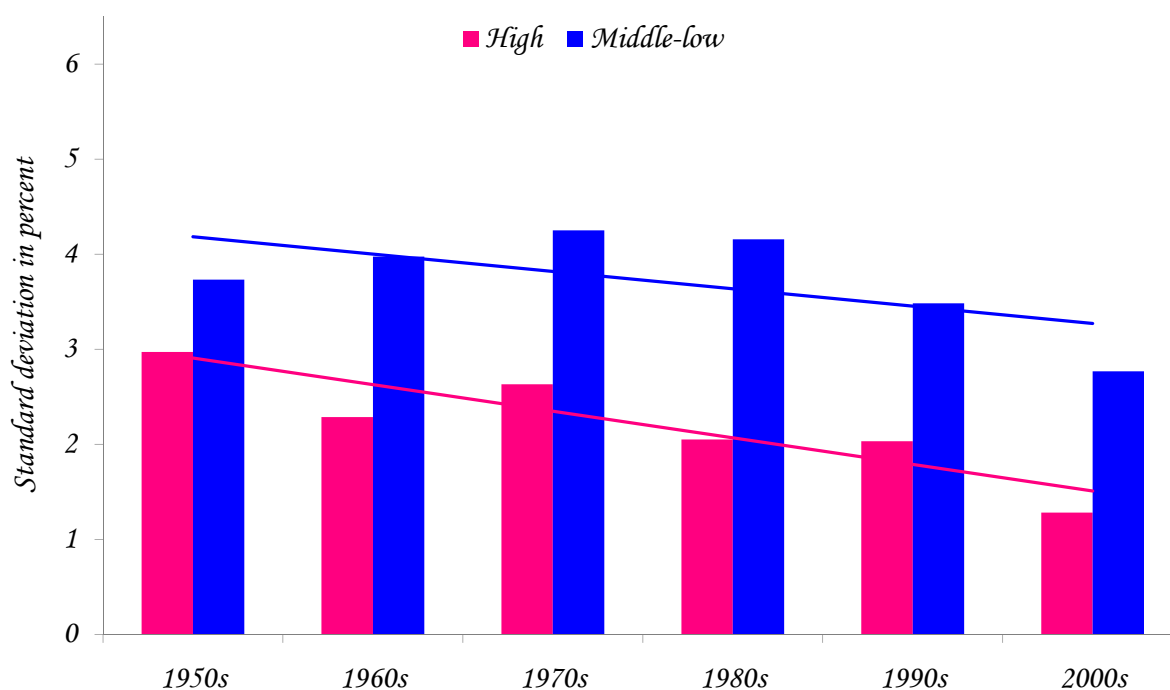
What are the reasons why, at least until the recent global financial meltdown, financial crises have become less prevalent, especially in high income countries? Certainly, one important reason was the general drop in macroeconomic volatility that took place particularly in the rich countries, that is the great moderation, as figures 13 and 14 illustrate. The figures show that even accounting for the volatility of commodity prices, greater stabilization has taken place in the

advanced economies. Given that income volatility plays a major role in most models of default, it is little surprise perhaps that the rich countries had performed better during the period of the Great moderation.

Acemoglu et al. (2003) “**Institutional causes, macroeconomic symptoms: volatility, crises and growth**” argue that countries that inherited more “extractive” institutions from their colonial past were more likely to experience high volatility, lower growth rate and more economic crises during the postwar period. This is an interesting hypothesis that merits further research, also on the difficulties of graduation. We note that countries with extractive resources are more likely to face very high terms of trade volatility and face higher risk of default for this reason as well, see Catao (2009).) Aguiar, Amador and Gopinath (2010) argue that credibility problems may endogenously create greater persistence in productivity shocks in emerging markets, while one can also make the case that the countries with abundant natural resources are more likely to experience a generalized tragedy of the commons problem in governance, as emphasized in the voracity model of Tornell and Lane (1999). The institutional failure of coordinating interests of different power groups might be another reason why some countries, facing similar external shocks, are more prone to default than others, as it is modeled in Qian (2010).

Figures 13 and 14 give an overview of the data on how macroeconomic volatility has evolved.

Figure 13
Evolution of GDP growth rate volatility: 1950-2006
High vs. Middle-low income



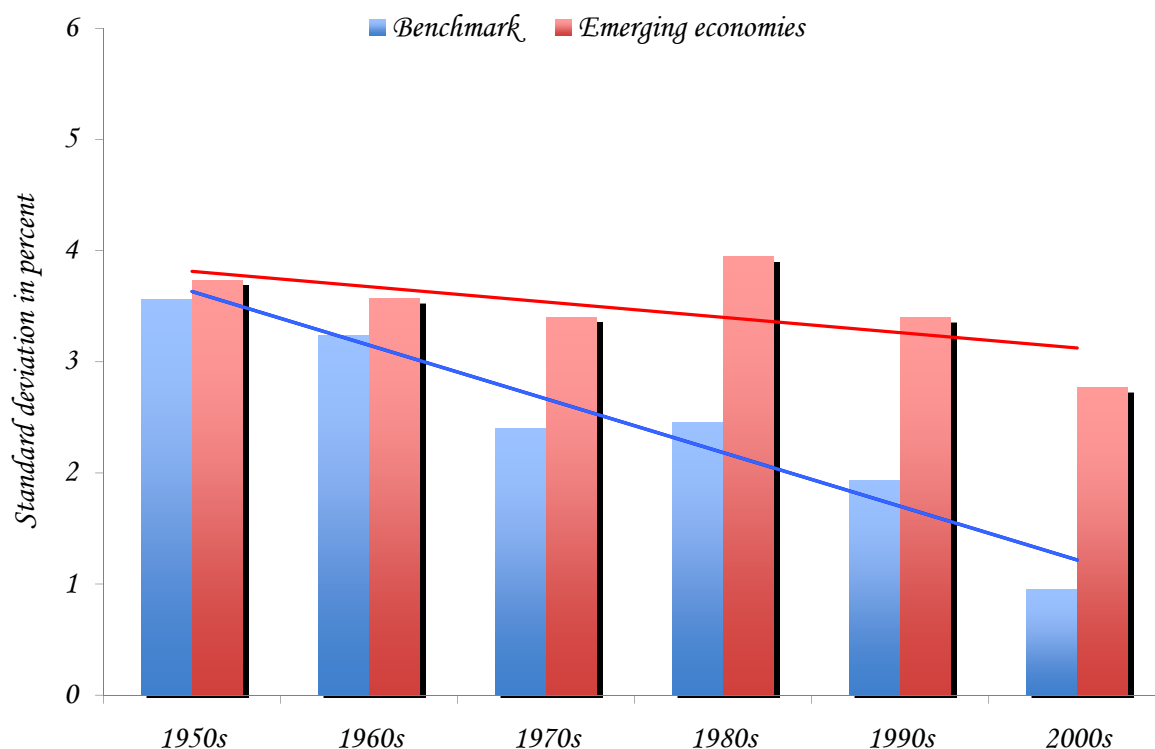
Notes: For each country the volatility is calculated as the standard deviation of its growth rate during the 10 years interval.

Sample coverage: 66 countries (23 high income and 43 middle-low income countries) that were independent in the given year.

Source: Maddison (2004), Total Economy Database (2008).

Middle-low income countries always had higher volatility than high-income countries, but they have been reducing it in recent years.

Figure 14
Evolution of GDP growth rate volatility: 1950-2006
Commodities exporting countries: Emerging vs. Benchmark



Notes: For each country the volatility is calculated as the standard deviation of its growth rate during the 10 years interval.

Benchmark: Australia and New Zealand. Emerging economies: Argentina, Bolivia, Brazil, Chile, Columbia, Cote d'Ivoire, India, Indonesia, Kenya, Malaysia, Mexico, Nigeria, Peru, Philippines, South Africa, Thailand, Uruguay and Venezuela.

Source: Maddison (2004), Total Economy Database (2008).

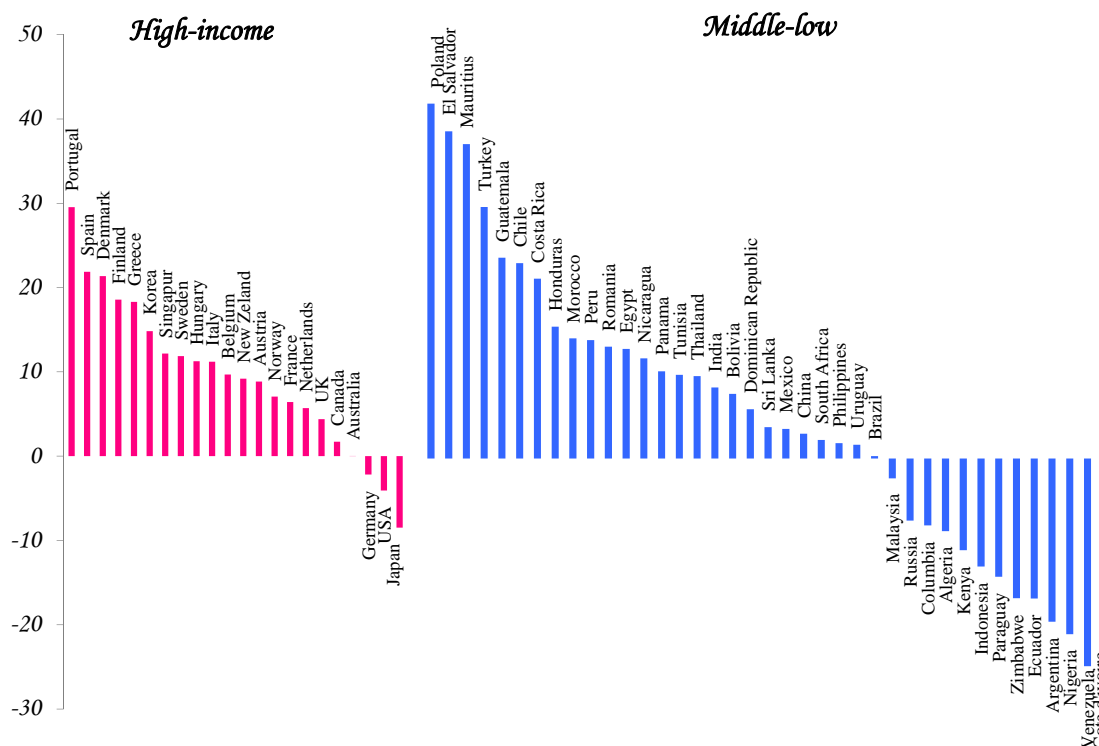
Emerging economies that are commodities exporters always had higher growth volatilities than their high income benchmark countries. Although emerging economies have been decreasing its volatilities in recent years, the gap between the two groups has widened. Similar patterns emerge using swing¹⁰ of GDP growth rate instead of volatilities.

¹⁰ Calculated as the average swing of each group. For each country the swing is calculated as the difference between the maximum growth rate and the minimum growth rate during the 10 years interval.

VIII. Recent graduates vs. Ratings (1979-2008)

So far, we have mainly focused on characterizing the statistical frequency of crises and the tendency towards recidivism. But shouldn't rating agency rankings incorporate this historical information and much more? Reinhart and Rogoff (2010) find that rating agencies are lagging indicators of crisis probabilities. One indicator that appears to have more value is the Country Credit Ratings reported by Institutional Investor, denoted as IIR. These are based on survey data of senior economist and risk analysts at financial institutions. Data is available from 1979 to 2008. During this period, 74% of countries improved its rating. If we separate the sample into high and middle-low income countries, 73% of the high-income group and 64% of the middle-low income group improved their ratings.

Figure 15
5 years average change of IIR (1979-2008): High vs. Middle-low



Note: 5 years average change is calculated as the average of 1979-1983 IIR minus the average of 2004-2008 IIR.

Point to point change can be found in the appendix.

Sample coverage: 61 countries (23 high income and 38 middle-low income countries), 1979-2008.

Source: Institutional Investor.

Who are the losers of this period? Table-4 shows the countries that had largest negative changes on their ratings.

Table 4- List of fallen angels

Country	Change
Algeria	-8.48
Argentina	-19.05
Cote d'Ivoire	-26.31
Ecuador	-16.34
Indonesia	-12.60
Kenya	-10.70

Nigeria	-20.49
Paraguay	-13.79
Venezuela	-24.24
Zimbabwe	-16.29

Note: These countries had their 5 years average change one standard deviation lower than the world average.
Source: Institutional Investor.

Pull versus Push

Who are the winners? Table 5 lists countries that have dramatically improved their IIR ratings.

Table 5- List of new graduates

Country	Change
Poland	41.40
El Salvador	38.17
Mauritius	36.67
Portugal	29.53
Turkey	29.33
Guatemala	23.42
Chile	22.78
Spain	21.87
Denmark	21.35

Note: These countries had their 5 years average change one standard deviation higher than world average. Source: Institutional Investor.

Countries in table 5 have made a big effort on showing the world that they have improved their political, economical and institutional system. But countries followed quite different routes to improvement. Members of EU were asked to follow Union's even before joining it; the pull effect on their graduation process is clearly marked in the IIR ratings, although it remains to be seen how much the EU effect can shortcut the usual long slow process of graduation. Other countries like Chile, being isolated from advanced economies and surrounded by "debt-intolerant" countries had to exert much harder to improve their institutions and gain a respectable place in the international market. It is very unclear whether these countries gains will prove durable in the wake of the recent financial crisis.

IX. Crisis and Role of IMF programs: 1952-2007

We next turn to look at IMF programs. The presence of the IMF constitutes a major structural change. Crises have been more frequent but shorter since the advent of the IMF. What is interesting is how often the introduction of the IMF program does not necessarily halt the ultimate crisis. A famous example is Argentina, which received large (as a share of GDP) bailout packages in 2000 and again in 2001, but nevertheless went ahead and defaulted in 2002. But the case of Argentina is hardly exceptional as Table 6 illustrates.

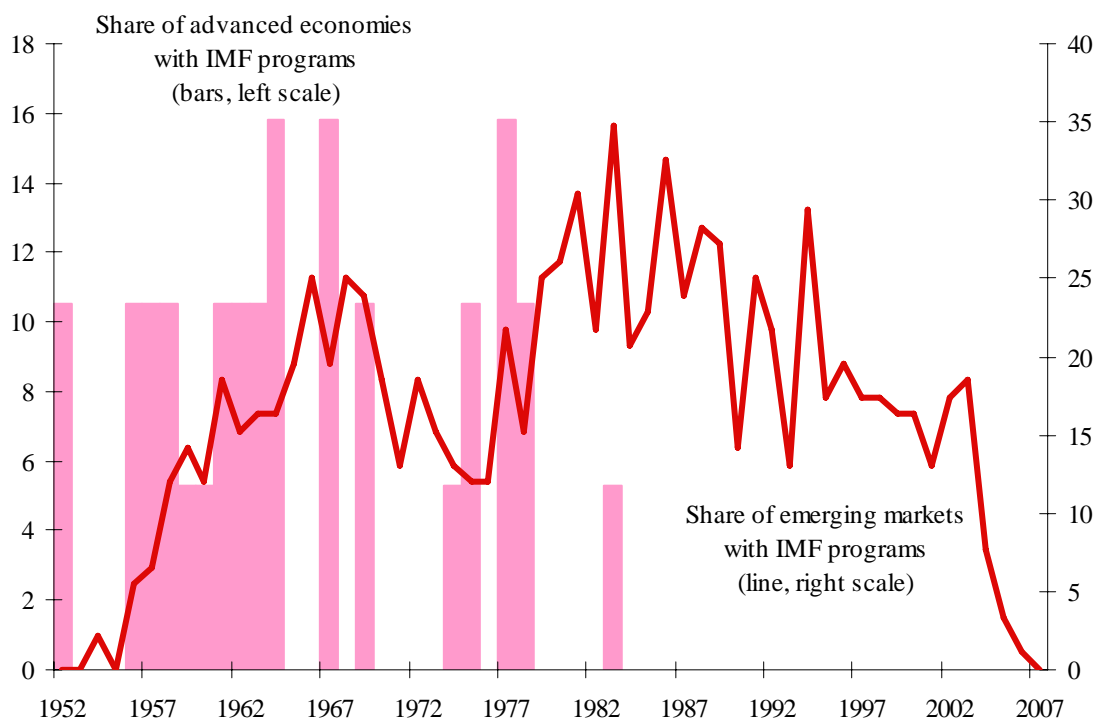
Table 6- Examples of cases where IMF programs are introduced but there is subsequent default

	Default starting year	Program year	IMF program		Amount in millions of SDRs
			Approved date	Expiration /cancellation date	
India	1958	1957	3/11/57	3/10/58	72.5
Chile	1961	1959	4/1/59	12/31/59	8.1
		1961	2/16/61	2/15/62	75
	1963	1963	1/15/63	1/14/64	40
	1966	1964	2/14/64	1/15/65	25
Costa Rica	1962	1961	10/4/61	10/3/62	15
	1981	1980	3/12/80	6/16/81	60.5
Paraguay	1968	1966	9/1/66	8/31/67	7.5
Peru	1969	1967	8/18/67	8/17/68	42.5
	1978	1977	11/18/77	9/14/78	90
	1980	1978	9/15/78	8/9/79	32.2
		1979	8/10/79	12/31/80	285
	1983	1982	6/7/82	4/26/84	650
Turkey	1982	1980	6/18/80	6/17/83	1250
Panama	1983	1982	4/28/82	4/27/83	29.7
Uruguay	1983	1983	4/22/83	4/21/85	378
	1987	1985	9/27/85	3/26/87	122.9
	2003	2002	4/1/02	3/18/03	1988.3
Guatemala	1989	1988	10/26/88	2/28/90	54
Venezuela	1990	1989	6/23/89	3/22/93	3703.1
Indonesia	1998	1997	11/5/97	8/25/98	8338.2
	2002	2000	2/4/00	1/29/02	3638
Argentina	2001	2000	3/10/00	1/23/03	16936.8
Dom Republic	2005	2003	8/29/03	1/30/05	438

During 1952-2008, there were in total 85 default episodes and 538 IMF programs. If one restricts attention to cases where IMF programs were implemented 1-2 years before the crisis, we have 36 cases, or 42% of all default episodes.

Finally, in figure 16, we graph the incidence of IMF programs across advanced and emerging economies. The United Kingdom famously called repeatedly on IMF help, but so too did many other advanced economies until the early 1980s. So it is important to recognize that even though countries “graduated” from external default, there can be a further transition period of calling on outside help in “near default” incidents.

Figure 16
The Incidence of IMF Programs in Advanced and Emerging Economies: 1952-2007



Source: Reinhart and Rogoff (2009), Reinhart (2010).

X. Graduation and the Theory of Sovereign Default

Having now given an overview of the remarkable serial nature of sovereign default, banking and inflation crises, what does the theory literature say about graduation? Since by far the most striking empirical differences between advanced economies and middle-low income countries are for sovereign debt, we will focus mainly on this question.

At one level, the inferior performance of middle-low income countries is easy to explain. Emerging market countries face deeper and more permanent shocks (as Aguiar and Gopinath emphasize), at the same time, tend to engage in procyclical macroeconomic policy, as Kaminsky, Reinhart and Vegh (2004) document. During periods of surges in global capital flows, emerging markets rush in with a plethora of supposedly high return projects, at the risk of being stuck with incomplete, illiquid investments if capital flows reverse or capital evaporates. Corruption and the influence of interest groups is another important factor in developing countries that can undermine fiscal stability and potentially over borrowing as it is showed in Qian (2010). France's status as a centuries long serial defaulter during its years of monarchy has often been blamed on the government's failure to establish a rationale and orderly system of centralized tax collection (see MacDonald, 2006). Clearly, "graduation" if it can be achieved is also linked to a country's institutions and not just its level of wealth.

At another level, explaining graduation is quite difficult, because standard models of default (following Eaton and Gersovitz, 1981) do not necessarily suggest that richer countries should be able to borrow less (as a percent of their income) or that they should necessarily be more prone to default. As detailed in Obstfeld and Rogoff, the key penalty to default in the canonical model is a cutoff from international capital markets and an inability to smooth national consumption through international markets. As Obsteld and Rogoff show, the calibration of the costs to default is quite similar to that of Lucas (1988) on the gains to smoothing out business

cycles. Obstfeld and Rogoff (1996, p. 369) find that, in fact, the empirical cost of exclusion from international markets is considerably greater for emerging markets than for rich countries. Admittedly, the canonical models illustrate model implicit contracts, so the issue of actual default is left in the background. Following Hart (1986), Bulow and Rogoff (1989a) and Grossman and Van Huyck (1988) argue that if shocks are observable but not verifiable, then optimal contracts may call for a premium in good states of nature, and negotiate partial default in bad states of nature, depending on the two sides' relative bargaining power. In any event, the fact that actual insolvency is seldom an issue in sovereign debt contracts, and that willingness to pay is invariably the binding constraint, underscores the point that countries cannot be expected to graduate simply by virtue of growing richer.

Of course, one way countries can graduate from default on external debt is by borrowing entirely (or almost entirely) through domestically administered markets. As Reinhart and Rogoff (2009) show, domestic debt has long been a quite important source of debt for most countries in the world, even though this fact has not been widely recognized. Also contrary to conventional belief, there are many cases of outright default on domestic debt (Reinhart and Rogoff document over seventy). Some of these defaults involved breaking indexation clauses (to inflation, gold, etc.), but in some cases, countries prefer outright default on domestic debt to achieve the same end through inflation.

In general, the fact that rich countries tend to have far fewer problems with serial default, most likely traces to collateral outside the usual type considered in the literature (see Cole and Kehoe, 1995 or Bulow and Rogoff, 1989b, for discussions of possible collateral outside the direct risk sharing gains from financial integration. For example, a breakdown in debt payments can spill over into reputation in trade relationships.)

At the other extreme are models of banking and financial crises that certainly do not suggest any reason why richer countries should be less prone. As already noted, Schularick and Taylor (2009) argue that even where greater macroeconomic and policy stability ought to ensure a more stable environment and fewer crisis, the financial system may expand to become crisis prone, offsetting the benefits of greater stability.

XI. Conclusions

In this paper, we have taken a first pass at exploring the elusive –and perhaps illusory – concept of “graduation”. We have seen that countries do seem to graduate from external default crises and, to a lesser extent from inflation crises. They do not graduate from banking crises, and whether or not they graduate from domestic debt crises is an open question that requires further investigation of de facto and de jure domestic debt crises. A basic empirical finding is that if a country goes twenty years without a crisis (of any type), it would appear to have achieved some level of graduation, in that roughly 75% of “repeat offenses” occur within two decades, for all three types of crisis. For inflation crises, forty years is a sufficiently long time that one may speak of a harder form of graduation. For banking and sovereign default crises, one needs to see more than a century pass, and even then one can only speak of long term remission. Graduation is indeed an elusive concept.

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Appendix

Table A1- Frequency and cumulative distribution of crisis probabilities

Crisis probability	Type of Crisis					
	External Default		Inflation		Banking	
	Freq dist	Cum dist	Freq dist	Cum dist	Freq dist	Cum dist
0.0	23	23	7	7	16	16
0.1	12	35	45	52	66	82
0.2	21	56	33	85	13	96
0.3	17	73	6	91	3	99
0.4	14	86	3	94	0	99
0.5	6	92	4	99	1	100
0.6	6	98	0	99	-	-
0.7	2	100	1	100	-	-

Notes: crisis probability calculated as the number of years in crisis divided by number of years since independence. Probabilities were calculated for each country since 1800 or country's independence year. Sample coverage: 66 countries for external default crisis; 67 countries for inflation and banking crisis. Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Table A2- Average duration of crises

	External Default		Inflation		Banking	
	Median	Average	Median	Average	Median	Average
World	8	15.1	1	2.3	1	2.5
High-income	9	20.7	1	1.6	1	1.7
Middle-low*	4	14.1	1	2.4	3	4.0
Latin America	9	14.6	1	3.2	2	2.7

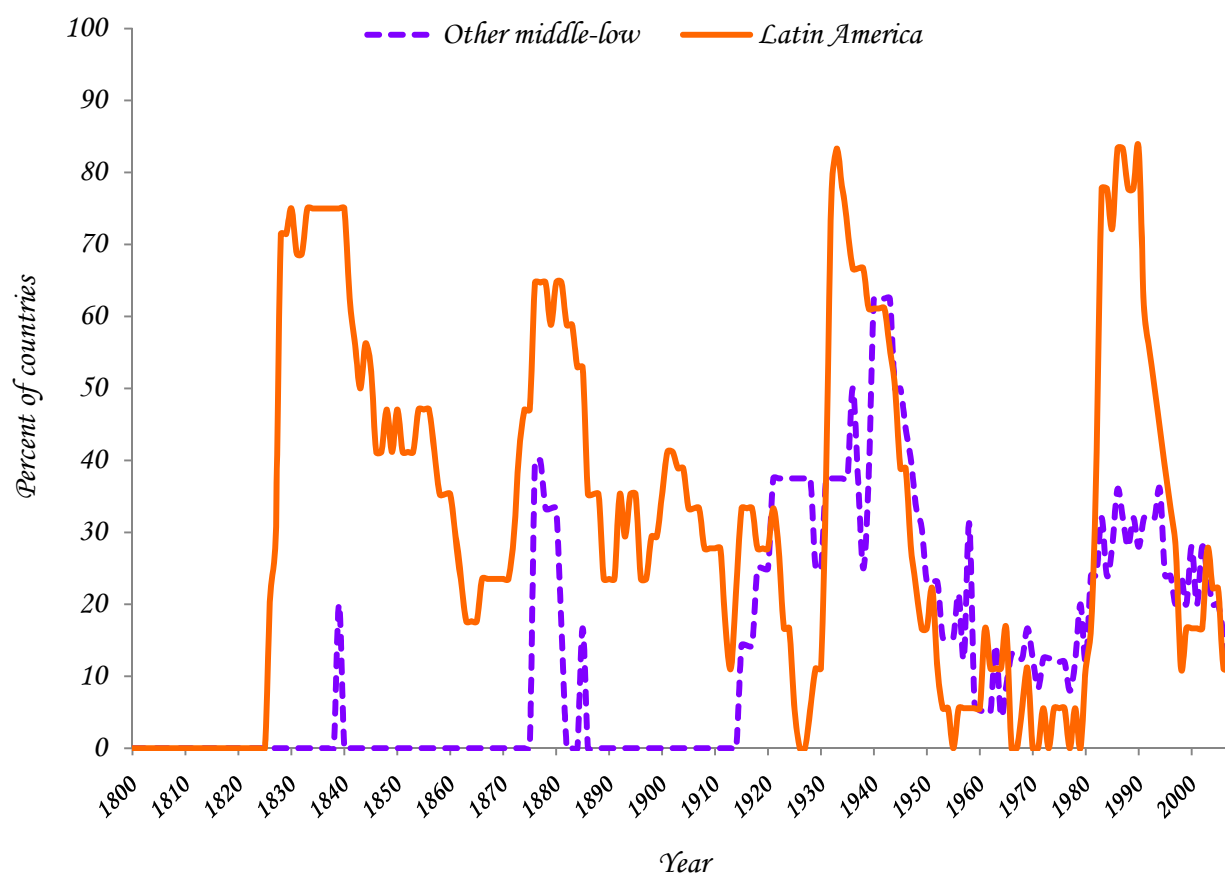
* Excluding Latin America

Note: Duration of a crisis is calculated as number of years between the starting year and end year of the crisis. For example: Argentina had defaulted in 1982 and it didn't resolve it until 1993. In this case, the duration of this episode of default crisis is 12.

Sample coverage: 198 episodes of default crisis (high income: 28, middle-low: 170); 462 episodes of inflation crisis (high income: 166, middle-low: 296); 201 episodes of banking crisis (high income: 108, middle-low: 93).

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Figure A3
Share of countries in external default crisis: 1800-2008
Other middle-low income vs. Latin America

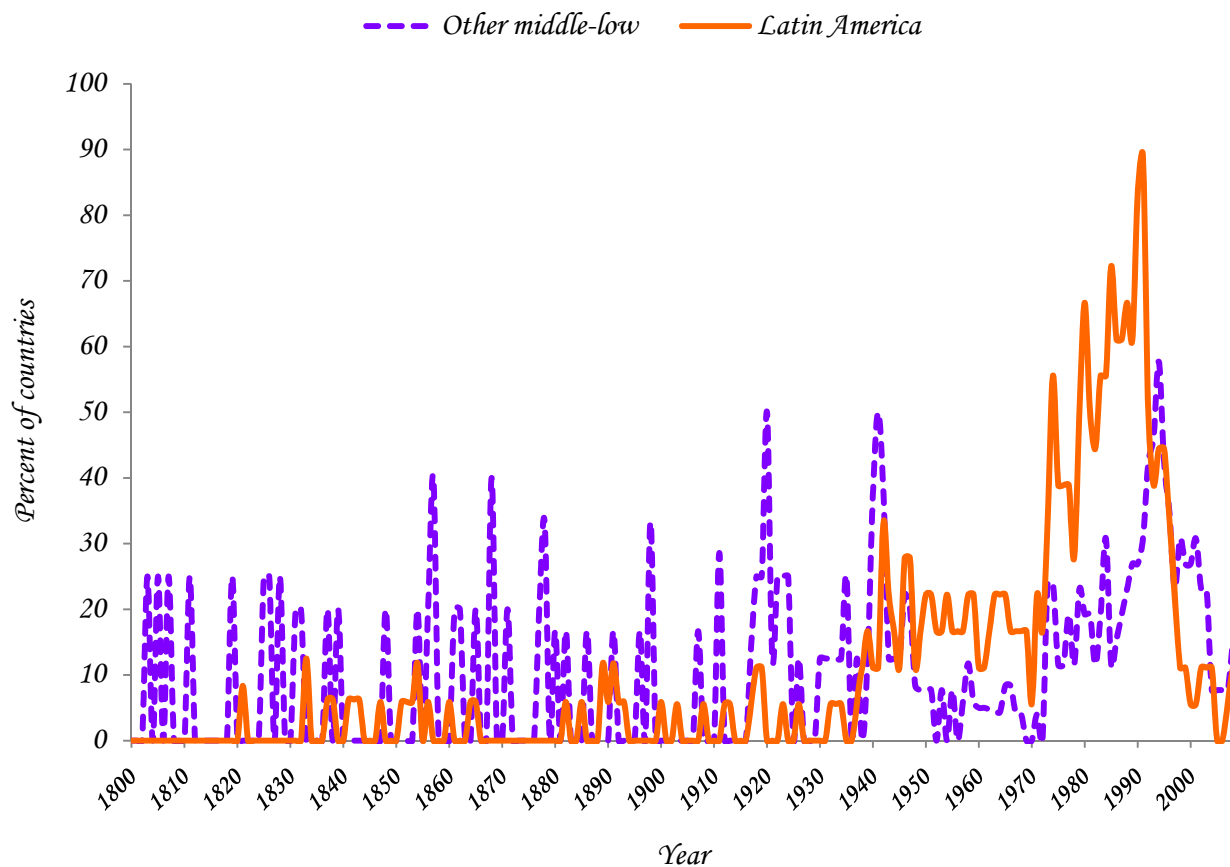


Sample coverage: 66 countries (23 high income and 43 middle-low income countries) that were independent in the given year.

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Latin America countries suffer default crisis the most.

Figure A4
Share of countries in inflation crisis: 1800-2008
Other middle-low income vs. Latin America

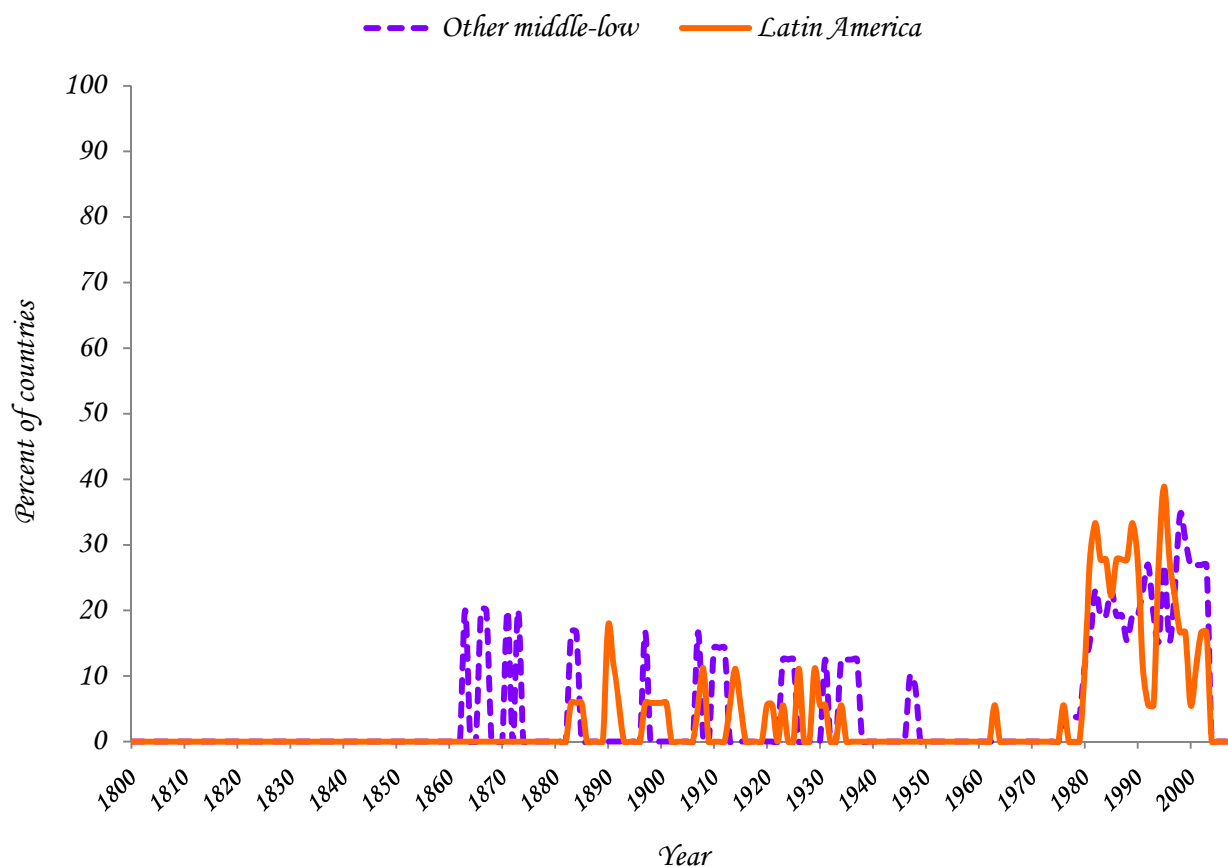


Sample coverage: 67 countries (23 high income and 44 middle-low income countries) that were independent in the given year.

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Latin America countries had few inflation crises than other middle-low income countries until mid-1940s. Thereafter, more Latin America countries began to have frequent inflation crises.

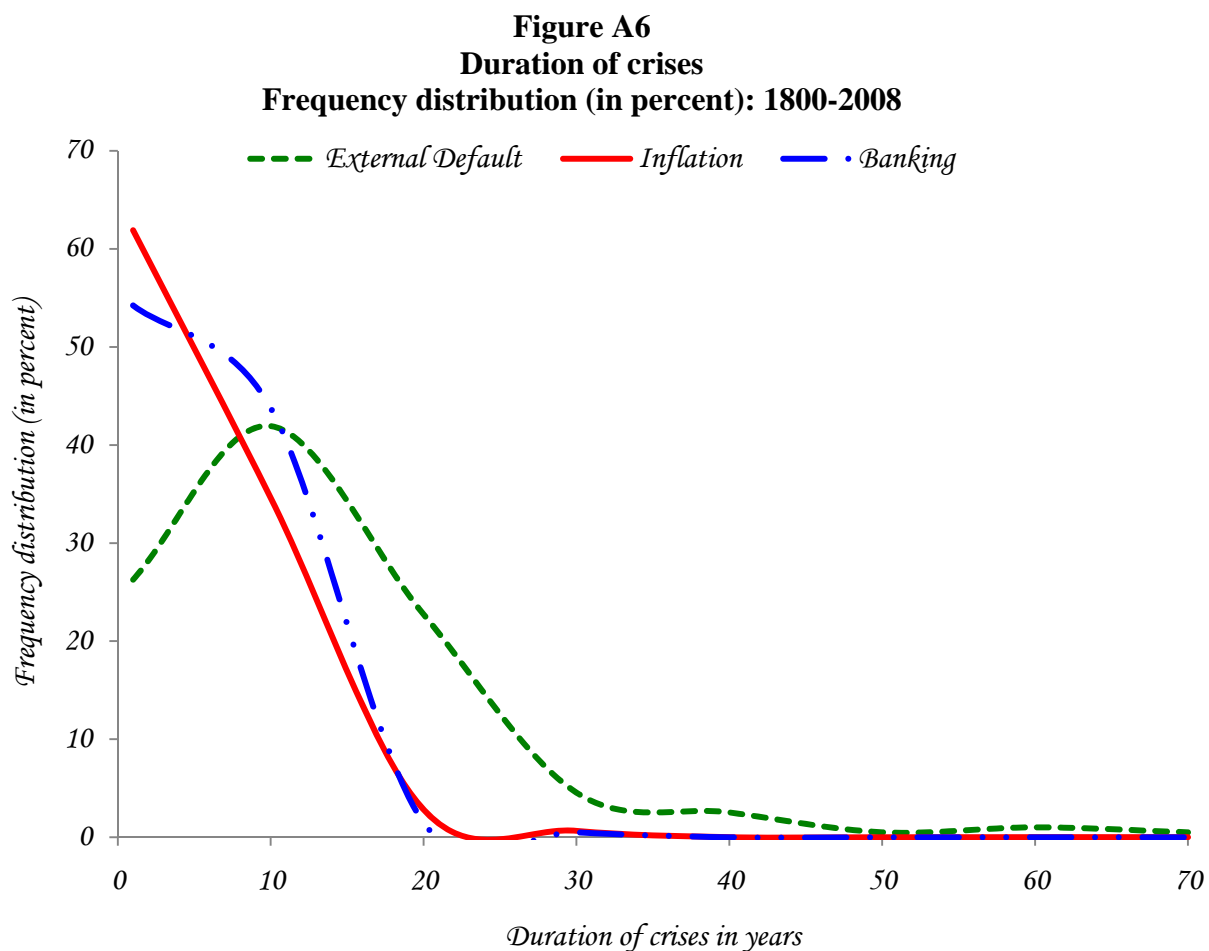
Figure A5
Share of countries in banking crisis: 1800-2008
Other middle-low income vs. Latin America



Sample coverage: 67 countries (23 high income and 44 middle-low income countries) that were independent in the given year.

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Figure 11 gives the frequency distribution of the duration of crises. As already noted, default crises last much longer and banking crises tend to be resolved the most quickly.

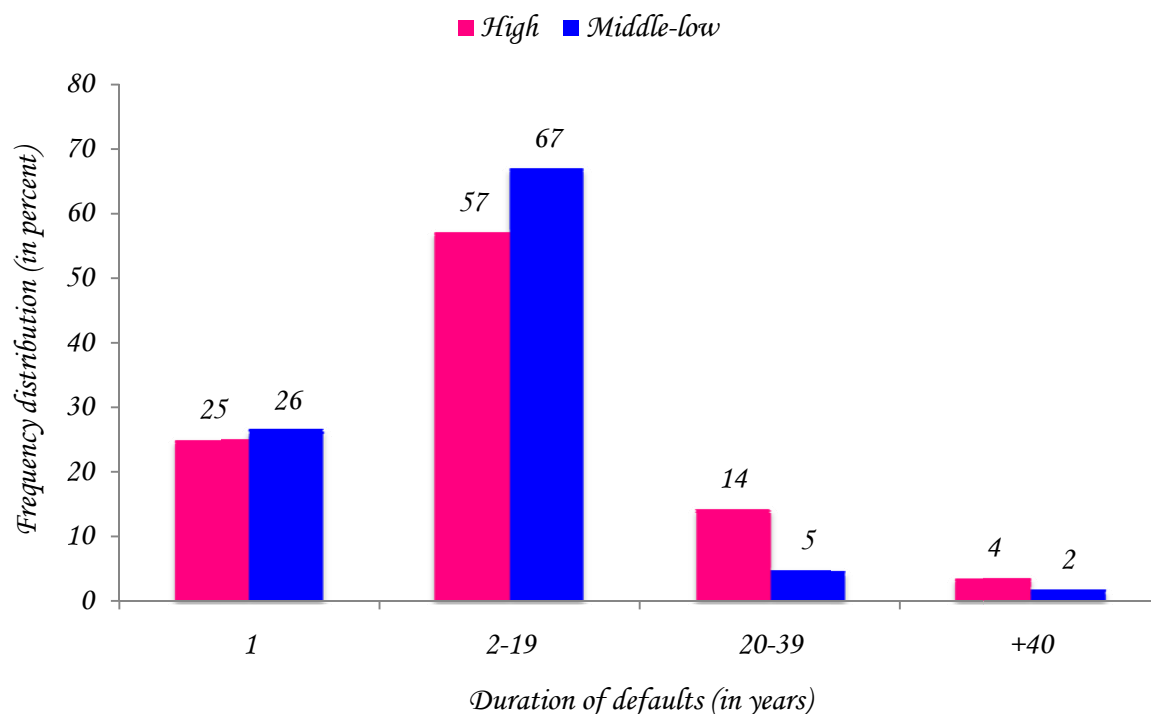


Note: Duration of a crisis is calculated as number of years between the starting year and end year. For example: Argentina had defaulted in 1982 and it didn't resolve it until 1993. In this case, the duration of this episode of default crisis is 12.

Sample coverage: 198 episodes of default crisis (high income: 28, middle-low: 170); 462 episodes of inflation crisis (high income: 166, middle-low: 296); 201 episodes of banking crisis (high income: 108, middle-low: 93).

Sources: Gerald Caprio, Jr. and Daniela Klingebiel (2003), Carmen M. Reinhart and Kenneth S. Rogoff (2008).

Figure A7
Duration of external default crises
Frequency distribution (in percent): 1800-2008
High vs. Middle-low income



Note: Duration of defaults is calculated as number of years between start of a default crisis and the year that is resolved. The end of a default episode is considered as the year the country regains access to the capital market. In other words, as long as the country is excluded from the international capital market, it is not considered as having resolved its default crisis.

Sample coverage: 198 episodes of default crisis (high income: 28, middle-low: 170).

Sources: Carmen M. Reinhart and Kenneth S. Rogoff (2008).

In term of duration of external defaults, both groups resolve crises in less than 20 years.

IIR rating performance

How do ratings perform to predict crisis? And how ratings react after crises? We measure the performance using a noise-to-signal ratio system. Consider the following two-by-two matrix:

	Getting out or Getting into external default crisis occurs in the following year	Status quo
IIR issues a signal	A	B
IIR does not issue a signal	C	D

If IIR signals and a change occur (counted in cell A) the signal is considered accurate. If IIR signals and status quo (counted in cell B), the signal is said to be a false alarm or noise. Therefore, a perfect indicator would only have entries in cells A and D. The noise-to-signal ratio is given by the number of entries in $[B/(B+D)]/A/(A+C)$. It is the ratio of false signals to all possible bad signals divided by the ratio of good signals to all possible good signals.

Defining a signal: we need to define how much IIR has to change to be considered as a signal of change, either graduation (getting out from external default crisis) or reversal (getting into a external default crisis). Choosing the optimal threshold involves a trade-off. Our goal is to test the null hypothesis that we are in status quo, which means if a country was in external default crisis previously, it will continue to be in external default crisis; if it wasn't, it won't enter into a new one the following year. If we choose a low threshold, for example a 5% change of IIR, we would catch all the changes but it is also likely to generate a lot of false alarms. Then the probability of rejecting the null hypothesis when it is true would be high (type I error), while the probability of accepting null hypothesis when it is false would be low (type II error). Conversely, if we choose a high threshold, for example a 20% change of IIR as signal, we will find few signals of change, decreasing type I error and increasing type II error.

Table A1 - Selecting the signal threshold for IIR

Threshold	Noise to Signal ratio	Type I Error	Type II Error
8%	62	0.23	0.63
14%	51	0.10	0.81
20%	76	0.04	0.95

Notes: The first column lists thresholds to define a signal. Each one represents a yearly change of IIR. Noise to signal ratio is calculated as $[B/(B+D)]/A/(A+C)$ according to table X. Type I error is calculated as $B/B+D$ and type II error is calculated as $C/A+C$.
This table only shows few points of a fine grid that we perform to find the appropriate threshold. The grid ranged from 5% to 25%.
Sample coverage: 61 countries (23 high income and 38 middle-low income countries), 1979-2008.
Source: Institutional Investor, Carmen M. Reinhart and Kenneth S. Rogoff (2008).

A 14 percent change of IIR minimizes the noise to signal ratio, our chosen threshold to conduct the following analysis.

Table A2 - IIR performance

Accurately called signals	Percent
Total	17
Graduation (getting out from a crisis)	22
Reversal (getting into a crisis)	12
Premature victory	27
Resistant to downgrade	67

Note: Accurately called signals are calculated as total number of signals (IIR increases or decreases by more than the threshold) followed by a change, either graduation or reversal, divided by total number of changes (sum of graduations and reversals). Accurately called graduation is calculated as number of positive signals (i.e. IIR increases by more than the threshold) followed by graduation divided by total number of graduation years. Accurately called reversal is calculated as number of negative signals (i.e. IIR decreases by more than the threshold) followed by reversal divided by total number of reversal years. Premature victory is calculated as number of positive signals that are not followed by graduation, divided by total number of positive signals. Resistant to downgrade is calculated as number of reversals not followed by a downgrade of IIR (IIR does not change or decreases by less than the threshold) divided by total number of reversal years.
Sample coverage: 61 countries (23 high income and 38 middle-low income countries), 1979-2008.
Source: Institutional Investor, Carmen M. Reinhart and Kenneth S. Rogoff (2008).

As it is showed in table 8, the performance of IIR to predict a crisis is far from being satisfactory. Premature victories are common and resistance to downgrade when crises occur is problematic.