



Munich Personal RePEc Archive

Assessing Indicators of Currency Crisis in Ethiopia: Signals Approach

Megersa, kelbesa and Cassimon, Danny

Institute of Development Policy and Management (IOB) –
University of Antwerp

22 May 2013

Online at <https://mpra.ub.uni-muenchen.de/47151/>
MPRA Paper No. 47151, posted 23 May 2013 09:41 UTC

Assessing Indicators of Currency Crisis in Ethiopia: Signals Approach

Kelbesa A. Megersa¹ and Danny Cassimon²

May, 2013

Abstract

Currency crises, generally defined as rapid depreciations of a local currency or loss of foreign exchange reserves, are common incidents in modern monetary systems. Due to their repeated occurrence and severity, they have earned wide coverage by both theoretical and empirical literature. However, unlike advanced and emerging economies, currency crises in low-income countries have not received due attention. This paper uses the signals approach developed by Kaminsky et al. (1998) and assesses currency crisis in Ethiopia over the time frame January 1970 to December 2008. Using the Exchange Market Pressure Index (EMPI), we identify three currency crisis episodes, Oct. 1992 - Sep. 1993; Mar. – Jul. 1999 and Oct. – Dec. 2008. This timing shows the importance of both local and international dynamics in determining currency crises. The crisis periods coincide with the liberalisation following the fall of Ethiopian socialism, the Ethio-Eritrean border conflict, and the zenith of the global financial crisis, respectively. More macro-economic indicators picked up the first crisis in a 24 month signalling window, compared to the latter two. Three categories of indicators were used: current account, capital account and domestic financial sector. None of the capital account indicators were significant based on the noise-to-signal ratio rule. One possible explanation for this might be the weak integration of the Ethiopian economy with global capital markets.

Key words: Currency crisis, financial crisis, early warning systems, signals approach, Ethiopia

¹Institute of Development Policy and Management (IOB) – University of Antwerp, Lange Sint-Annastraat 7, 2000 Antwerpen, Belgium ; E-mail address: kelbesa.megersa@ua.ac.be

² Institute of Development Policy and Management (IOB) – University of Antwerp, Lange Sint-Annastraat 7, 2000 Antwerpen, Belgium ; E-mail address: danny.cassimon@ua.ac.be

We are grateful to Dennis Essers for his suggestions and perceptive comments on a draft version of the paper.

1. Introduction

Following the recurrence of instability in international financial and capital markets over the past two decades, currency crisis and other forms of financial crisis, such as banking and debt crises, have become the subject of rigorous research (see Reinhart and Rogoff, 2008 and 2009; Adrian and Shin, 2009 and Berg and Pattillo, 1999). The immediate cause of currency crisis is often a severe volatility of foreign exchange markets. However, the fundamentals behind the volatility are different for different economies. So far, the empirics are mostly based on advanced and emerging economies, whose nature is very different from those of small low-income economies.³ For instance, the East-Asian financial crisis of 1997-98 was caused by massive short term financial transactions and debt linked to global financial markets. The Asian economies that were at the centre of the crisis (such as Thailand, Indonesia, and South Korea) were emerging economies receiving huge sums of external capital and investment.⁴ On the contrary, the amount of financial transactions and foreign investments are less significant in countries like Ethiopia.

This research tries to contribute to the limited body of literature on currency crisis in low-income developing economies by examining the phenomenon in Ethiopia. The paper uses the signals approach in identifying currency crises. Kaminsky et al. (1998) have suggested a non-parametric method, known as the signals approach to foresee banking and currency crisis. It makes an ex-post study of the behaviour of various macroeconomic indicators and tries to see if the indicators exhibit 'unusual' behaviour prior to a currency crisis. The indicators will be categorized as showing 'unusual' behaviour when they cross a certain threshold. These thresholds are calculated as a certain percentiles out of the distribution of the indicators which minimize their noise-to-signal ratio.⁵ A composite index is then developed out of the ensuing signals, which is in turn, converted to conditional crisis probabilities.

The paper is structured in the following manner. Section 2 gives a brief overview of the Ethiopian economy, describing in particular the history and current state of the financial system. Section 3 explains the methodology of the signals approach. In this section, issues such as crisis definition, indicator variables, the composite crisis index and probabilities of a currency crisis will be addressed. Section 4 discusses the results and section 5 gives the conclusion.

³ The East-Asian financial crisis of 1997-98 was the first real platform for the 'Financial Early Warning' literature.

⁴ Short-term debt owed by the rapidly growing East Asian countries to foreign banks was steadily rising throughout the 1990s, before culminating in crisis in 1997. This kind of fast buildup of short-term debt was a major factor to the Asian financial crises, and also other crisis of the 1990s, such as that of Mexico, Russia and Brazil.

⁵ The Noise-to-signal ratio rule is explained in section (3.2). See Edison (2003) and Kaminsky et al. (1998) for further notes. Edison's study is an expansion of Kaminsky et al.'s study. Edison added 8 more countries to the 20 countries used by Kaminsky et al.

2. Overview of Ethiopian economy and its financial system

Ethiopia is a low-income developing nation that is currently witnessing rapid economic growth. Real GDP growth over the past decade (2001-10) averaged 8.4%.⁶ As IMF (2011) shows, the country's average growth rate was 11% in the six years up to the height of the global financial crisis in 2009. The main drivers of growth have been agriculture and service sectors. In recent years, the nation has also taken advantage of growing exports (especially coffee and horticulture), foreign aid and FDI. Alongside the fast pace of GDP growth, the nation has been confronted with rising petroleum and food prices, and thus inflation.

The financial sector of the country is relatively small, as is the case in most Sub-Saharan African economies. As can be seen in Figure-1(a), Total bank asset as a share of GDP is low, at 25%. The largest bank (Commercial Bank of Ethiopia) is owned by the government, which has great control over interest rate setting and lending. The rest of the banking industry is dominated by few domestic private banks. In fact, the five largest banks accounted for 84% of total bank assets in 2012, see Figure-1(b). Further, foreign exchange transactions are largely dominated by the central bank (National Bank of Ethiopia).

(Figure-1(a-d) here)

The government owns the largest share of bank assets, at 61%. This figure is high, even by African standards, See Figure-1(c) for comparison. In recent years, there have been moves to let the domestic private sector participate in the banking business. Yet, the sector is currently closed to foreign ownership. This makes Ethiopia a special case (Barth et al., 2013). In most other African countries, however, foreign investors own significant percent of bank assets, see Figure-1(d). The capital market is relatively undeveloped. The monetary authorities issue treasury bills of 28 days as well as for 3 and 6 months. No stock markets exist at the moment but there are recent moves towards creating specialised equity markets. One example is the ECX (Ethiopia Commodity Exchange), which currently hosts transactions of agricultural goods. It is a spot exchange set up in Addis Ababa, the nation's capital. Through an open outcry system, a range of spot deals are transacted by traders (Alemu and Meijerink, 2010).

The country's central bank has been the main monetary authority in the economy.⁷ Its domain of operation has, however, seen changes over the years. The central bank, which was previously

⁶ Ethiopia is growing from a very low base. Per-capita income at purchasing power parity in 2011 was \$1108 (World Bank WDI database).

⁷ In the pre world-war-II modern Ethiopian state, an important role has been played by foreign currencies and banks. Some of the foreign currencies that were used and the foreign banks in operation included the following; -Currencies (the Austrian Maria Theresa thaler in the 19th century, Italian lira during the 1936-41 Italian occupation, East African shilling, Egyptian pounds and Indian rupees during the World War II British Presence)

known as the ‘State Bank of Ethiopia’, was acting as both central and commercial bank from its re-establishment in April 1943 to its dissolution towards the end of 1963.⁸ Following the monetary and banking proclamation no. 206 of 1963, the State Bank of Ethiopia split in to a new central bank (National Bank of Ethiopia) and a state-owned commercial bank (Commercial Bank of Ethiopia). The duty of issuing coins, which was previously owned by the Ethiopian treasury, was transferred to the National Bank.

Following the 1974 Marxist revolution, private banks and insurance companies were nationalised. On September 1976, Proclamation No. 99/1976 was passed, giving greater powers to the central bank in terms of control over the financial system (insurance institutions, credit cooperatives and investment banks). This converted the financial system in to a single (exclusively public) banking system. The bank also held a pivotal role in national financial planning. Following the fall of the socialist government in 1991 and the consequent transition to free market economy, a new law (Monetary and Banking Proclamation, No. 93/1994) was passed in January 1994. This brought back the dual (private and public) banking system that was operational before the shift to socialism. Once again, private commercial banks were allowed to operate side by side with state banks.

For much of the pre World War II period, fixed exchange rate systems were used, pegging the Ethiopian currency to the then dominant foreign currency.⁹ In the post World War II period, the US dollar obviously became the anchor currency. The local currency was pegged to the US dollar for nearly half a century from 1945 until the nation adopted a managed floating system in 1994. The peg has been revised periodically over the years.¹⁰ On 1st of May 1993, Ethiopia adopted a dual rate system whereby an official peg continued to be used, parallel to an independent float determined through auctions. In this period, the official rate was periodically adjusted by the central bank according to the evolution of the auction rate. Finally, the two rates were officially unified on July 1995.¹¹ With this brief introduction to the nation’s monetary system and history, we proceed to a discussion of the signals approach.

-Banks (National Bank of Egypt and Société Nationale d'Éthiopie pour le Développement de l'Agriculture et du Commerce in early 20th century, Banca d'Italia during the 1936-41 Italian occupation, Barclays Bank during the World War II British Presence), see Gill, 1991.

⁸ The State Bank of Ethiopia was dissolved following the 1936 Italian invasion and it was re-established in 1943 following the Italian defeat (see Gill, 1991).

⁹ Some instances of the pegs include; 1 Ethiopian talari = 1 Maria Theresa thaler (1905); 16.65 Ethiopian talari = UK£1(1931) ; 5 Ethiopian talari = 1 Italian lira (1936) ; 1 Ethiopian talari = 1.875 East African shillings (1942)

¹⁰ 2.48447 Ethiopian birrs (Ethiopian dollars) = 1.50 Ethiopian talari = US\$1(1945); 2.50 Ethiopian birrs = US\$1(July 1963) ; 2.30263 Ethiopian birrs = US\$1(December 1971) ; 2.07237 Ethiopian birrs = US\$1 (February 1973) ; 5 Ethiopian birrs = US\$1 (October 1992)

¹¹ See NBE (1995) and ARER (1996)

3. Methodology (signals approach)

The aim of the signalling technique is to check if certain key macroeconomic variables are behaving ‘unusually’ in a time period preceding a currency crisis. The approach first constructs a currency crisis index (EMPI), which serves to define periods of currency crisis. It then examines the behaviour of indicator variables in the period prior to the identified crises.

3.1 Crisis definition

Kaminisky et.al (1998), page 15, define a currency crisis as “a situation in which an attack on the currency leads to a sharp depreciation of the currency, a large decline in international reserves, or a combination of the two”.¹² They propose an exchange market pressure index (as a measure of currency crisis) as follows:

Exchange Market Pressure Index (EMPI)

Suppose we denote:

e_t = The exchange rate at time t (birr/USD)

R_t = Foreign reserves of a nation at time t (in USD)

$\sigma_{\delta R}$ = The standard deviation of the rate of change of foreign reserves

$\sigma_{\delta e}$ = The standard deviation of the rate of change of the exchange rate

Then, the index of exchange market pressure EMPI can be given as:

$$EMPI_{i,t} = \delta e_{i,t} - (\sigma_{\delta e} / \sigma_{\delta R}) \delta R_{i,t}, \text{ where } \delta e_t = (e_t - e_{t-1}) / e_{t-1} \text{ and } \delta R_t = (R_t - R_{t-1}) / R_{t-1} \quad (1)$$

As indicated in the above equation, an appreciating exchange rate is positively associated with the EMPI index while international reserve accumulation is, negatively related to the index. If the exchange rate instability is severe, it may develop into a currency crisis, which leads to major depreciation of the local currency. In such circumstances of depreciation, central banks often get involved and increase interest rates and also use their foreign reserves to purchase the local currency. Exchange rate instability and reserve losses are, thus, good proxies of a typical currency crisis.

According to the EMPI, a currency crisis is supposed to happen when the index exceeds m standard deviations beyond its mean. If we designate the mean of the index with μ_{EMPI} and the standard deviation of the index with σ_{EMPI} , $m \in \mathbb{R}^+$, we can formally describe a currency crisis as;

¹² Kaminisky et.al (1998) also state that a ‘crisis’ defined in such a way captures both successful and unsuccessful attacks on the currency of a nation. Further, it also captures speculative currency attacks not only under fixed exchange regimes but also under other exchange rate regimes. See also Dahel (2001), Edison (2003) and Peng and Bajona (2008).

$$CRISIS_{i,t} = \begin{cases} 1, & \text{if } EMPI_{i,t} > \mu EMPI_{i,t} + m\sigma EMPI_{i,t} \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

In this study, the months in which the index is at 1.5 standard deviations or more above its sample mean value are labelled as cases of currency crisis or speculative attacks.¹³ The threshold benchmark of 1.5 standard deviations is also used in various other case studies since it gives good estimation of a currency crisis (see Eichengreen et al., 1997; Feridun, 2007 and Herrera and Garcia, 1999).¹⁴ In cases where the index crosses the threshold multiple times, we will use an exclusion window of 12 months to avoid counting what is essentially one crisis as multiple crises.¹⁵

As an alternative to the mean plus 1.5 standard deviations threshold level, we also use the Self-Exciting Threshold Autoregression or SETAR technique. This method enables us to endogenously determine thresholds.

Self-Exciting Threshold Autoregression (SETAR) technique

SETAR models are nonlinear models that are commonly applied to economic time series data, see Tong (1990). They have been successfully used to track and forecast daily exchange rate movements and explain recessions (see Ades et al., 1999; Kahraman et al., 2012; Montgomery et al., 1998). A single-threshold, dual-regime, first-order lag structure autoregressive SETAR model (2, 1, 1) can be specified as:

¹³ That is $m = 1.5$ in equation (2)

¹⁴ Currency crisis definitions by EMPI depend on the level of the threshold used. Various studies use threshold levels that range from one to three standard deviations from the mean. For instance, Kaminsky et al., 1998; Edison, 2003; Youngblood, 2003 and Eichengreen et al., 1997 used 3, 2.5, 2 and 1.5 standard deviations respectively as thresholds. However, as various studies (Kamin et al., 2001; Lestano and Jacobs, 2007 and Ari, 2008) showed, different thresholds might come up with different crisis dates and different number of cases classified as 'currency crisis'. In this study a threshold level of the mean plus 1.5 standard deviations have been used. Studies such as Eichengreen et al. (1997), Herrera and Garcia (1999) and Feridun (2007) have also used this threshold.

Robustness check for the standard deviations of the EMPI thresholds: When a threshold level of 3 standard deviations is used, only the period Mar – Sept 1993 crisis was identified as crisis episode. At a threshold of 2 standard deviation, the periods Oct 1992 - Sept 1993 and June 1999 crisis were identified. At a threshold of 1.5 standard deviation, the periods Oct 1992 - Sept 1993, Mar – July 1999 and Oct –Dec 2008 were identified. At a threshold of 1 standard deviation, the periods Oct 1992 - Sept 1993, Feb 1997 – Jan 2000 and May - Dec 2008 were identified. If the threshold is too low, there will be more episodes identified as 'crisis'. If the threshold is too high, too few crisis will be identified, i.e. only the most extreme cases. This makes the choice of the thresholds more difficult.

¹⁵ This means that there has to be a minimal gap of one year between two separate incidences of a currency crisis. For further explanation, see Feridun (2007).

$$y_t = \begin{cases} \alpha + \beta y_{t-1} + \lambda_{1t} & \text{if } y_{t-d} \leq \gamma \\ \eta + \rho y_{t-1} + \lambda_{2t} & \text{if } y_{t-d} > \gamma \end{cases} \quad (3)$$

Where,

γ is a threshold level that is estimated over a grid search,

d is a ‘delay’ parameter,

λ_{1t} and λ_{2t} are independent random variables and

α and η are constants.

The threshold (γ) is estimated by means of the maximum-likelihood method, using the Akaike Information Criterion (AIC). In other words, it is chosen through a grid search to maximize the likelihood of an alteration in the behaviour of the time series. Due to this, the method is impervious to a possible blame of ‘arbitrariness’ or subjective selection of thresholds.

3.2 Crisis indicators

In their study, Kaminsky et al. (1998) used 15 core macroeconomic and financial indicators which they consider as having potentially good predictive power for currency crises, namely; real exchange rate, exports, stock prices, ratio of M2 to international reserves, output, excess M1 balances, international reserves, M2 multiplier, ratio of domestic credit to GDP, real interest rate, terms of trade, real interest differential, imports, bank deposits and the ratio of lending rate to deposit rate. Due to lack of data, this study will not include the indicators ‘industrial output’ and ‘stock prices’. Industrial production in Ethiopia is rather low and constitutes only a small share of GDP. Further, the indicator ‘stock prices’ is not relevant as there is no stock market in the country, as of now. The data on the 13 indicators used in this study was gathered from the IMF’s International Financial Statistics (IFS). It constitutes monthly values of the set of indicators.¹⁶ All variables are expressed as percentage changes over the duration of 12 months, except those noted otherwise. The information regarding the indicator variables and their description is given in Table-1.

(Table-1 here)

Similar to the crisis index, the binary signals from individual indicators (1 = warning signal and 0 = none) are defined by a certain threshold level for each indicator variable. Table-2 summarises the explanations regarding the thresholds used for each indicator. Those indicators which tend to rise before the start of a crisis (such as imports, real interest rates and domestic credit) will have an upper threshold. On the contrary, those indicators which tend to decline before the start of a

¹⁶ See table-1 for the list of 13 indicators used in this study. Also see the Appendix in Peng and Bajona (2008) and Kaminsky et al. (1998).

crisis (such as the real exchange rate, exports and bank deposits) will have a lower threshold. The exact percentiles used to calculate the thresholds for the indicator variables are taken from Edison (2003). These values are given in columns 7 and 8 of Table-5. The threshold percentile used for exports, for instance, is 10%. This means that, the indicator will be issuing a signal if its year-on-year growth is below the first decile of all observations.

(Table-2 here)

An indicator issues a warning signal about the likely occurrence of a crisis when it crosses its threshold within a particular period called ‘signalling horizon/window’ of 24 months.¹⁷ A signal will be treated as a ‘good signal’ whenever it appears within the signalling horizon and a ‘false signal’ or ‘noise’ otherwise. Table-3 summarizes the signalling possibilities, which can be used to evaluate the performance of the indicators.

(Table-3 here)

In theory, if an indicator is flawless, it will give only good signals i.e. cell *A* and Cell $D > 0$ and there will be no Type I error (a ‘miss’; cell *C*) or Type II error (a ‘false positive’ signal; cell *B*). Kaminsky et al. (1998) suggest an indicator threshold which will minimize the ratio of false signals to good signals i.e. $(B / B + D) / (A / A + C)$, which they call the ‘noise-to-signal ratio’. This measure will help to assess the effectiveness of the individual indicators. If the noise-to-signal ratio is below one, the indicators will be taken as significant. If the ratio is above one, the indicator will be considered insignificant and, thus, dropped.

3.3 Composite crisis index and probabilities of a currency crisis

Composite index

The main objective behind the use of the composite index is to merge the signals from the particular indicators in a comprehensive manner. Following Kaminsky et al. (1998), we define

¹⁷ The ‘*signalling horizon*’ is a time period just before the start date of the currency crisis over which the behaviour of the indicator variables will be observed for their predictive power. In most studies a 24 month period before the start date of the crisis is used as signalling window (see Kaminsky et al., 1998; Edison, 2003; Peng and Bajona, 2008). This study also uses a 24-month signalling window. However in some studies various ranges of periods have been used. For instance, El-Shazly (2002) used 6-months; Feridun (2007) used 12-months; Brüggemann and Linne (2002) used 18-months.

Robustness check for different signalling windows: With a 6 month signalling window, four indicators were significant out of the 13 indicators used. With a 12 month signalling window, six indicators were significant. With an 18 month signalling window, five indicators were significant. With a 24 month signalling window, six indicators were significant. With a 36 month signalling window, nine indicators were significant. As the signalling window gets wider, more indicators become significant. The N/S ratio of the indicators improved as the signalling window widened.

Note: significant indicator variables will have a noise-to-signal ratio (N/S) of less than 1, the smaller the better.

our composite index as a weighted average of the signals from individual indicators. The signals from the indicators are weighed by the noise-to-signal ratio of the respective indicator. Suppose the signals from indicator j in period t are given as $S_t^j \in \{0, 1\}$ and the noise-to-signal ratio of indicator j is denoted as ω_j , the weighted composite crisis index is given as;

$$K_t = \sum_{j=1}^n (1/\omega_j) S_t^j \quad (4)$$

As the weights are the inverse of the noise-to-signal ratio, this index gives greater weight to better-performing indicators (only those with a ratio below unity). Furthermore, as the index is a positive sum of the signals, there will be a higher probability that a currency crisis will occur if larger number of indicators are signalling.

We should note that there are other ways in which the signals could be combined. One obvious technique would be to take the composite index as a simple sum of the signals. Kaminsky et al. (1998) and Edison (2003), however, show that the weighted composite index performs better.

Probabilities of a currency crisis

The probability of the currency crisis is derived from the composite index. It is calculated by watching how frequently a crisis follows a particular value of the index within 24 months (see also Edison, 2003; Peng and Bajona, 2008; and Kaminsky et al., 1998). We may formally define the conditional probabilities of a currency crisis as;

$$Pr(C_{t,t+24}^n | K_t = j) = \frac{\text{Months with } K=j \text{ and a crisis within 24 months}}{\text{Months with } K=j} \quad (5)$$

(Table-4 here)

4. Results and discussion

Figure-2 and Figure-3 plot the exchange market pressure index (EMPI) for Ethiopia over the period January 1970 to December 2008, for the fixed and float (managed) exchange rate regimes respectively.¹⁸ Using the 1.5 standard deviation rule, we identify one longer crisis episode (October 1992-September 1993) in the fixed exchange period and two brief crisis episodes (March-July 1999 and October-December 2008) in the floating exchange regime.¹⁹ When the

¹⁸ The crisis episodes are identified by the months for which the EMPI is above the dotted threshold line, in figures 1 and 2. The 24 months preceding the onset of the crisis would be the signalling window.

¹⁹ When both time periods are considered together the EMPI captures only the 1992-93 crisis. However, various studies note that the EMPI will not have the same nature under various exchange rate regimes. See Stavarek (2010) and Van Poeck et al. (2007). From equation (1) it is evident that the EMPI will be derived from the

SETAR technique is employed to determine the threshold, more pressure points are identified both for the fixed and floating exchange rate regimes. The pressure points are closer to the 1.5 standard deviation rule in the case of the floating exchange rate regime. For the fixed exchange rate regime, however, the SETAR method labels wide range of periods as pressure points. We have based our analysis on the 1.5 standard deviation rule, as it is more robust.

(Figure-2 and Figure-3 here)

The 1992/93 crisis was clearly grounded in domestic developments. In the early 1990s, the Ethiopian economic and political landscape was dominated by major changes. Following a shift in political power, socialist economic policies that were in place for 17 years were replaced by free market policies, backed by the World Bank and the International Monetary Fund's Structural Adjustment Programmes (SAP).²⁰ The reform program liberalized exchange rate regimes and foreign trade. Discretionary government interference and regulation in setting prices of goods and services were abolished.

Financial market reform opened up commercial banking, micro credit services and insurance for the private sector. Additionally, on 1st of October 1992 the local currency (birr) was devalued from an exchange rate of 2.07 birr/dollar to 5 birr/dollar.²¹ The devaluation was made with the intention of advancing local output and employment; removing the difference among the official and the parallel market rates, and enhancing foreign reserves.²² While still susceptible to changes in climate and foreign aid, the agriculture dominated export sector has, indeed, demonstrated advances after the country gave up the fixed exchange rate policy in 1991 and applied a sequence of macroeconomic adjustment and stabilization plans. In reforming the exchange rate regime, an auction system for foreign exchange was as well introduced in 1993.²³

The 1999 crisis overlaps with the Ethio-Eritrean border clash. Eritrea succeeded from Ethiopia in 1993. Following that, the two nations signed a treaty 'Agreement on Friendship and Cooperation' in 1993. According to Tronvoll (2004), the economy was, possibly, the most

movements in reserves only in the case of fixed exchange rate regime and from a combination of changes in exchange rates and reserves in managed floating system. Currency crisis definitions by EMPI are therefore dependent on the exchange rate regime, apart from other factors.

²⁰ See section 2

²¹ See NBE (1993)

²² Studies conducted around the time of the devaluation, such as Ghura and Grennes (1993); Taye (1992); and Edwards (1989) cited in Taye (1999), show that the official value of the Ethiopian birr since the 1970s was just about half (or less than half) of the unofficial market rates. According to standard economic theory, devaluation brings about an expenditure reduction through reduced import demand and a shift from foreign to domestic good consumption. This will, in turn, improve current account balances.

²³ The auction system (which works with a semi-market mechanism) and the official exchange rate (which works with central bank decree) worked alongside each other from May 1993 to July 1995, when they were unified (see also section-2).

crucial part of that accord. In spite of the importance of the treaty, its implementation was weak and both nations went after divergent economic policies. Just before the eruption of the armed conflict, Eritrea's principal trading partner was Ethiopia, accounting for 67% of its exports (Paulos, 1999). They both used a single currency (birr), and the port of Assab, in Eritrea, was Ethiopia's key export outlet.

Over time, because of the increasing competition from domestic products, the demand for Eritrean goods in Ethiopia diminished. Eritrea laid bigger tariffs on products imported and exported by Ethiopia via the port of Assab to retaliate the new Ethiopian economic policies. Further divergences appeared regarding investment policies and the handling of investors. Eritrea desired to invest without restrictions, while Ethiopia put up confinements, especially in key sectors such as electric power supply, insurance and banking (Tronvoll, 2004). Then in November 1997, Eritrea released its own currency, the Nacfa. Eritrea demanded a one-to-one parity of the Birr with the new currency and that the two currencies would freely circulate in both economies (dual currency union). These propositions were declined by Ethiopia. In January 1998, following the introduction of the Nacfa, Ethiopia also released new notes of Birr. Such economic policies and measures, added with the political unease, hastened the road to war (see Abbink, 1998 and 2003; and Gedamu, 2008). Apart from the direct impact of the currency wars between the two nations, the huge cost of financing the armed conflict and its ripple effects on the overall economy (investment, trade and tourism) may explain the timing of this currency crisis.

Yet, this crisis episode also roughly corresponds to the 1997-99 Asian financial crises. The transmission of financial shocks from the Asian crisis to Sub-Saharan Africa was modest due to the undeveloped nature of financial markets and the small amount of private capital inflows. The main ways through which the effect of the external crisis was felt on the subcontinent was through the decrease in prices of oil, sugar, and gold (among others) and the increase in the prices of other commodities like coffee and tea (Harris, 1999).²⁴ As it took advantage of the price fall in oil (top import item) and the price rise in coffee (top export item), the overall net effect was positive for Ethiopia. It, therefore, seems more plausible that the currency crisis was due to the political and economic conflict with Eritrea, rather than the Asian financial crisis.

²⁴ The African Department of the IMF conducted an assessment of the impacts of the crisis on Sub-Saharan African nations, in October 1998. The 1998 baseline projections showed that, for the oil exporting economies real GDP growth was cut back by 0.3% , and real income by 7.2%; the current account deficit broadened by \$7 billion (10.5% of GDP); the fiscal balance worsened by 7.3 % of GDP; and terms of trade deteriorated by nearly 29%. On the other hand, for oil importers, the impact on real GDP and real income was on average positive. The external current account balance improved by 0.5% of GDP; the total fiscal balance decline was minimal; and the terms of trade fairly rose (See Harris, 1999). In these nations, the positive side of lower petroleum import expenditures has mostly outbalanced the losses from price slumps in other goods. Thus, the net effect on oil-importing economies' external current account balances and terms of trade was beneficial.

The 2008 currency crisis coincides with the zenith of the global financial crisis. Like all other nations, Ethiopia has suffered from this crisis. The economy has experienced shocks through falling foreign direct investment, trade, remittances, loans and aid. Exports of commodities (coffee, horticulture, hides, cereals, cotton, sugarcane etc.) declined following the down turn in global demand. Mishra (2011) estimates that merchandise exports, merchandise imports, service exports, service imports, private financial transfers and foreign direct investment would have been 30%, 34%, 22%, 61%, 55% and 70% higher (respectively) than their actual value if the crisis didn't hit. In another study, Getnet (2010) estimates that gross domestic investment declined to 20.3% of GDP in 2008/09, from about 24% of GDP in the preceding four years. Even overall GDP growth itself declined from 10.8% in 2008 to 8.7% in 2009, though this was still high compared to other developing economies.²⁵ Mishra (2011) attributes the relative resilience of the Ethiopian Economy to two major factors. The first has to do with access to foreign financial aid. Even if Ethiopia is not among the largest recipients of foreign aid, external financing has been recently rising in the form of long term loans from non-traditional lenders such as China.²⁶ The other factor has been the policy response by the government. The policy measures included depreciation of the currency, getting rid of fuel subsidies and reducing domestic borrowing by the private and public sector. While much of the rest of the world engaged in easy monetary and fiscal policies in the aftermath of the crisis, Ethiopia started following tight monetary and fiscal policies. These policies were justified as the domestic imbalance involved excess aggregate demand rather than excess aggregate supply.

Ethiopia's vulnerability to external shocks comes from its overdependence on the export of farm items and raw materials (notably, coffee and gold) whose international prices fluctuate greatly. Considering the country's petroleum imports (which is about 5% of GDP), the rise in fuel prices might significantly affect the balance of trade. Further, vulnerability to external shocks arises from volatilities in financial flows. Even if capital account transactions are small, aid inflows have been relatively big (about 5-7% of GDP) and are very erratic. There is a necessity to keep sufficient amounts of foreign reserve as a buffer against these exogenous shocks. Indeed, the nation had been piling up foreign reserves following the world commodity price surges of the 2000s and IMF's increased support.²⁷ However, this has been partially reversed since 2011 due

²⁵ The five year average GDP growth rate of Ethiopia (between 2004 and 2008) was 11.7% while for all Sub-Saharan Africa (SSA) developing economies it was 5.6%. The growth rate in Ethiopia in 2009 was 8.7% while for SSA it was 2.2% (World Bank WDI database).

²⁶ Even if Ethiopia is characterised by low levels of per-capita income and high incidence of poverty, it is not among the highest recipients of foreign aid in per-capita-aid terms. According to Mishra (2011), the per-capita foreign aid to the nation is well below the average of Sub-Saharan economies at 30 USD per annum.

²⁷ The IMF expanded its financial backing to African nations during the global financial crisis and continues to coordinate vital donor funding. The Exogenous Shocks Facility was expanded in September 2008 to allow for meaningful and speedy assistance to low-income nations that are addressing exogenous shocks. Ethiopia (and other countries like Malawi, Senegal, and Comoros) has accessed the facility in dealing with the global financial

to big monetary injections through public infrastructural projects, rising inflation, devaluation of birr and the subsequent sales of foreign reserve to control domestic liquidity. According to IMF (2012), foreign reserves dwindled to US\$2.3 billion in April 2012, compared to US\$3.5 billion in September 2011. This level of reserve is able to cover just 1.8 months of potential imports (the acceptable minimum is three months of import cover). This trend puts external stability at great risk.

Having determined the periods of currency crises, we will next try to see the evolution of the indicators in the time period under consideration. We are especially interested to see if the 13 indicators we selected can produce signals in the 24 month signalling window before the onset of the crisis.²⁸ Figure-4 displays the evolution of the individual indicators over the period under consideration (January 1970 to December 2008).

(Figure-4 here)

All indicators are given as annual percentage changes except for four indicators, namely;

- excess M1 balances (given in millions of nominal currency),
- deviation of the real exchange rate from trend (given in percentage terms) and
- the three interest rate variables i.e. real interest rate differential, domestic real interest rate, lending-to-deposit rate ratio (which are also given in percentage terms)

For all indicators in figure-4, the three shaded regions represent the 24 month period of signalling window for the three currency crises defined by the EMP index. The broken horizontal line represents the threshold (upper or lower as defined for each indicator). The performance of the 13 indicators in figure-4 and their thresholds are summarized in Table-5.

(Table-5 here)

Columns (2, 3, 4 and 5) of Table-5 sum up the information about the signals in the 24 months signalling window. The sixth column gives the total signals received in the overall period under consideration, i.e. 468 months (Jan 1970 to Dec2008). Columns 7 and 8 show threshold levels as percentiles and values of the indicator.²⁹ Column 9 shows the noise-to-signal ratio for this study while the last three columns show the results from other studies, for the sake of comparison. Taking the first variable in the table (i.e. M2 multiplier), we see that the indicator gave no signals during the 24 month signalling window preceding the 1992-93 crisis. However, the indicator gave 13 and 5 signals in the signalling windows of the 1999 and 2008 crisis respectively.

shock (See IMF, 2009). The funds allocated for Ethiopia under the Exogenous Shocks Facility totaled US\$153.76 million (See IMF, 2012).

²⁹ The percentiles are determined from the overall monthly distribution of each indicator (Jan 1970- Dec 2008).

During the signalling window for the 1992-93 crisis, three out of 13 variables did not issue any signal: the M2 multiplier, real interest rate differential, and domestic real interest rate. The other indicators cross their thresholds for various months and, hence, issue signals, ranging from 1 signal (domestic credit/GDP) to 12 signals (bank deposits and exports). Two indicators, deviation of real exchange rate from trend and lending-deposit rate ratio, remained above the threshold during the whole period of this signalling window i.e. 24 months. During the second signalling window, four indicators made signals ranging from 2 (exports and terms of trade) to 13 (M2 multiplier). During the third and latest signalling window, only 2 of the 13 available indicators made signals. Indicator M2 multiplier crossed its threshold 5 times while indicator Bank deposits crossed its threshold 6 times.

In accordance with the noise-to-signal ratio principle, six indicators (M2 multiplier, bank deposits, exports, terms of trade, deviation of real ER from trend and lending to deposit rate ratio) appear to be significant. Five indicators (M2 multiplier, Domestic credit/GDP, bank deposits, exports, and terms of trade) picked two of the three crises. This follows the small number of indicators signalling the 1999 and 2008 crises. Another observation is on the nature of these indicators. They were all either current account indicators (deviation of the real exchange rate, Exports and terms of trade) or domestic financial sector indicators (M2 multiplier, Bank deposits and Lending-deposit rate ratio).³⁰ None of the Capital account indicators considered in the study (Foreign reserves, M2/ reserves and Real interest rate differential) was a good indicator based on the noise-to-signal ratio rule.

Figure-5 gives the probability of currency crisis for Ethiopia, under the period of consideration. As we can see from figure-5, there have been multiple periods where the probability of the currency crisis has been high.³¹

(Figure-5 here)

The case studies made by Edison (2003) on Mexico and Peng and Bajona (2008) on China also showed that out-of-sample probabilities are irregular and not always consistent. The results sometimes showed high crisis probabilities not only in the pre-crisis periods but also in 'normal' periods where the probabilities should be low. Edison (2003), however, showed that the average crisis probabilities were generally higher in the pre-crisis signalling window compared to rest of the period under study.³² This holds true for this case study also (see figure-5). The average crisis probability in the signalling window (0.27) is higher than the average crisis probability in the normal period (0.18).

³⁰ See table-2 for more information

³¹ see table-4 as to how the probabilities are constructed

³² See Edison, 2003: 32

If we also see the composite index in figure-6, it is clearly elevated during the signalling window of the 1992-93 crises. However, the composite index values in the latter two signalling windows were not exceptionally high. This can be explained by the fact that more indicators signalled in the signalling window of the 1992-93 crisis compared to the signalling windows of the 1999 and 2008 crises.

(Figure-6 here)

In accordance with undeveloped capital markets in Ethiopia and loose integration to the financial world, our study finds local developments having more explanatory power for currency crises than external factors. The first crisis was of domestic origin and was at the crossroads of major economic and political transitions in the country. For this reason, it was easily picked up by more indicators. The second crisis has domestic, regional and international elements. The third crisis has clear external roots and aligns with the time of global financial crisis. The latter two crises were not easily picked by the set of indicators we used. To this end, multilateral surveillance techniques and indicators that are good in tracking external shocks are needed.

5. Conclusion

In this study, we used the signals approach (introduced by Kaminsky et al., 1998) to see as to what extent key macroeconomic indicators have predictive power for currency crisis in Ethiopia, defined by the exchange market pressure index, EMPI. Using this index (and the 1.5 standard deviations above the mean threshold), three crisis episodes were identified; October 1992-September 1993, March-July 1999 and October-December 2008. Relatively more indicators signal the first crisis than to the latter two.³³ Consequently, the composite index and the out-of-sample crisis probabilities were quite high in the period preceding the first crisis. Out of the 13 indicators used, the M2 multiplier, bank deposits, exports, terms of trade, deviation of real ER from trend and lending-deposit rate ratio were significant according to the noise-to-signal ratio rule. Their extreme values were more or less aligned with the signalling windows preceding the crises episodes.

One suggestion that may follow our finding is that, perhaps there is room for more indicators (from both real and financial sectors) that are ‘better’ in capturing international contagion. In an increasingly interconnected world economy, multilateral surveillance techniques are gaining importance.³⁴ If the methodological issues of crisis detection are properly addressed and the set

³⁴ At the moment, early warning exercises are conducted by different monetary institutions, the IMF being the key player (see IMF, 2012b; IMF, 2010; Ghosh et al., 2009). The Financial Stability Board and various central banks are increasingly conducting early warning exercises in recent years, often working with the IMF (see Babecký et al, 2012 and Bussiere and Fratzscher, 2012). The IMF’s early warning exercises (which are conducted semi-annually)

of indicator variables are augmented to reflect international financial contagion, the signals approach may continue to be a useful instrument.³⁵ The technique can be an integral part of an early warning system for different kinds of crises. By analysing past currency crises in a country (or set of countries) and the behaviour of financial indicators in the period before the onset of the crises, the approach derives key lessons. Policy makers, monetary authorities and other stakeholders may use these lessons to take precautionary measures as important financial variables start showing ‘unusual’ behaviour. The signals approach might, therefore, help to design a good financial early warning system and informed macroeconomic policies.

are part of its attempts to increase surveillance of cross-border and cross-sectoral spillovers as well as global economic, fiscal and financial risks. The Early Warning Exercise (EWE) is prepared in collaboration with IMF’s other flagship publications such as Global Financial Stability Report (GFSR), World Economic Outlook (WEO) and Fiscal Monitor. However, IMF’s EWE does not try to anticipate crises. Instead, it attempts to find out the vulnerabilities and triggers that could bring systemic crises.

³⁵ Despite being a useful methodological tool, the signals approach has some weaknesses. One key weakness has to do with the way crisis is defined. In the analysis, first the crisis episodes have to be identified by the exchange market pressure index (EMPI) and then the behaviour of the indicators in the time window is analyzed. However, as witnessed in the literature, there is no concrete way of doing so (See footnote 14 for the robustness check on different standard deviations of the EMPI thresholds).

References

- Abbink, J. (1998), *The Eritrean-Ethiopian Border Conflict*, African Affairs 97(389): 551-564
- _____ (2003) *Ethiopia-Eritrea: Proxy Wars and Prospects of Peace in the Horn of Africa*, Journal of Contemporary African Studies, 21 Vol 3, September
- Ades, A., Masih, R. & Tenegauzer, D. (1999) *A Look Through the Rear View Mirror*, GS-Watch
- Adrian, T. and H. Shin (2009) *Liquidity and Leverage*, Journal of Financial Intermediation
- Alemu, D. and Meijerink, G. (2010), *The Ethiopian Commodity Exchange (ECX): An overview*, Wageningen University, June
- ARER (1996) *Annual Report on Exchange Restrictions-1966*, International Monetary Fund
- Ari, A. (2008) *An Early Warning Signals Approach to the Currency Crises: The Turkish Case*, Université du Sud, France
- Babecký, J., Havránek, T., Matějů, J., Rusnák, M., Šmídková, K. And Vašíček, B. (2012) *Banking, Debt, and Currency Crises Early Warning Indicators For Developed Countries*, European Central Bank, Working Paper Series No. 1485, October
- Barth, J., Capiro, G. and Levine, R. (2013) *Bank regulation and supervision in 180 countries from 1999 to 2011*, NBER working paper series, Working Paper 18733
- Berg, A., and Pattillo, C. (1999), *Predicting Currency Crises: The Indicators Approach and an Alternative*, Journal of International Money and Finance, Vol. 18, pp. 561–86
- Bussiere, M. and Fratzscher, M. (2002) *Towards a New Early Warning System of Financial Crises*, European central bank Working Paper Series, working paper No. 145, May
- Brüggemann, A. and Linne, T. (2002) *Are the Central and Eastern European Transition Countries still vulnerable to a Financial Crisis? Results from the Signals Approach*, IWH-Discussion Papers No.157
- Calomiris, C. and Gorton, G. (1991) *The Origins of Banking panics: Models, Facts, and Bank Regulation*, in: G. Hubbard, ed., *Financial Markets and Financial Crises*, pages 109-173, University of Chicago Press, Chicago
- Dahel, R. (2001) *On the predictability of currency crisis: the use of indicators in the case of Arab countries*, Journal of economic cooperation, March 2001 :57-78
- Dornbusch, R., Goldfajn, I., Valdes, R. (1995) *Currency Crises and Collapses*, Brooking Papers on Economic Activity 2 :219-293
- Edison, H., (2003) *Do Indicators of Financial Crises Work? An Evaluation of an Early Warning System*, International Journal of Finance and Economics 8 :11-53
- Edwards, S. (1989) *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries*, The MIT Press, Cambridge
- Eichengreen, B., Rose, A. and Wyplosz, C. (1997) *Contagious Currency Crises*, NBER Working Paper, No. 5681, July
- El-Shazly, A. (2002) *Financial Distress and Early Warning Signals: A Non-Parametric Approach with Application to Egypt*, Paper Prepared for the Ninth Annual Conference of the Economic Research Forum, UAE, October

- Feridun M. (2007) *Financial Liberalization and Currency Crises: The case of Turkey*, Banks and Bank Systems, Volume 2, Issue 2
- Gedamu, K. (2008) *Ethiopia and Eritrea: The Quest for Peace and Normalization*, Center for Peace Studies, July
- Getnet A. (2010) *Global Financial Crisis Discussion Series, Paper 16: Ethiopia Phase 2*, Overseas Development Institute, January
- Ghosh, A., Ostry, J. and Tamirisa, N. (2009), *Anticipating the Next Crisis, What can early warning systems be expected to deliver?*, in Finance & Development, Volume 46 Number 3:35-37, September
- Ghura, D. and Grennes, T. (1993) *The Real Exchange Rate and Macroeconomic Performance in Sub-Saharan Africa*, Economic Development and Cultural Change, 42:155–174.
- Gill, D. (1991) *The Coinage of Ethiopia, Eritrea and Italian Somalia*, D. Gill publishers, Garden City, New York
- Goldfajn, I. and Valdes, R. (1995) *Balance-of-Payments Crises and Capital Flows: The Role of Liquidity*, MIT, Cambridge
- Gorton, G. (1988) *Banking Panics and Business Cycles*, Oxford Economic Papers, number 40 :751-781
- Harris, E. (1999), *Impact of the Asian Crisis on Sub-Saharan Africa*, in Finance and Development, the International Monetary Fund, Volume 36, Number 1, March
- Herrera, S. and Garcia, C. (1999) *User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries*, World Bank Working Paper, November
- Heun, M. (2004) *Early Warning Systems of Financial Crises - Implementation of a currency crisis model for Uganda*, HfB - Business School of Finance & Management, Frankfurt am Main, Germany
- IMF (1996) *Annual Report on Exchange Restrictions*, International Monetary Fund : 169
- ___ (2009) *Impact of the Global Financial Crisis on Sub-Saharan Africa*, the International Monetary Fund - African Department
- ___ (2010), *The IMF-FSB Early Warning Exercise, Design and Methodological Toolkit*, the International Monetary Fund, September
- ___ (2011) *World Economic Outlook Database*, International Monetary Fund, April
- ___ (2012), *The Federal Democratic Republic of Ethiopia: 2012 Article IV Consultation—Staff Report; Public Information Notice on the Executive Board Discussion; Staff Statement; and Statement by the Executive Director for Ethiopia*, International Monetary Fund, IMF Country Report No. 12/287, October
- ___ (2012b), *The IMF's Financial Surveillance Strategy*, the International Monetary Fund, August
- Kahraman, U., Asar, Y., Basbozkurt, H., Akogul, S., Genc, A. (2012) *Statistical Modeling of Van Region by Using SETAR Model*, Journal of Selcuk University Natural and Applied Science
- Kamin, S., Schindler, J. and Samuel, S. (2001), *The contribution of domestic and external factors to emerging market devaluation crises: An early warning systems approach*, International Finance Discussion Papers, number 711, September
- Kaminsky, G., Lizondo, S., and Reinhart, C. (1998) *Leading Indicators of Currency Crises*, International Monetary Fund Staff Papers 45, :1-48

Kaminsky, G. and Reinhart, C. (1999) *The Twin Crises: The Causes of Banking and Balance-Of-Payments Problems*, The American Economic Review 89 (3) : 473-500

Krugman, P. (1979) *A Model of Balance-of-Payments Crises*, Journal of Money, Credit, and Banking, 11 : 311-325

Lestano, L. and Jacobs, J. (2007) *Dating currency crisis with ad hoc and extreme value-based thresholds: East Asia 1970-2002*, International Journal of Finance and Economics, number 12 :371-388

McKinnon, R. and Pill, H. (1994) *Credible Liberalizations and International Capital Flows: the Overborrowing Syndrome*, Stanford University

Mishra, D. (2011) "Ethiopia: Sustaining Rapid Growth amidst Global Economic Crisis" in *The Great Recession and Developing Countries- Economic Impact and Growth Prospects*, Nabli, M. (Ed.), pp 203-234, The World Bank

Montgomery, A., Zarnowitz, V., Tsay, R.S., Tiao, G. (1998) *Forecasting the US Unemployment Rate*, Journal of the American Statistical Association, 93: 478-493

NBE (1993), *National Bank of Ethiopia bulletin*, number 4, National Bank of Ethiopia, Addis Ababa, Ethiopia, page 32

___ (1995) *National Bank of Ethiopia annual report-1994/1995*, National Bank of Ethiopia, Addis Ababa, Ethiopia

Paulos, M. (1999) *Ethiopia and Eritrea at war: Saga of Triumph and Tragedy at the Dawn of the Millennium*, Horn of Africa XVII, Number 1,2,3,4

Peng, D. and Bajona, C. (2008) *China's Vulnerability to Currency Crisis: A KLR*

Signals Approach, China Economic Review, Volume 19, Issue 2 :138-151, June

Reinhart, C., and K. Rogoff (2008) *This Time is Different: A Panoramic View of Eight Centuries of Financial Crises*, NBER Working Paper 13882

Reinhart, C., and K. Rogoff (2009) *The Aftermath of Financial Crises*, American Economic Review : 466-472

Stavarek, D. (2010) *Exchange market pressure and de facto exchange rate regime in the Euro-candidates*, Romanian Journal of Economic Forecasting, February

Taye, H. (1992) *Is the Ethiopian Currency (birr) Overvalued?* Paper presented for the Second Annual Conference on the Ethiopian Economy, Addis Ababa, Ethiopia

_____ (1999), *The Impact of Devaluation on Macroeconomic Performance: The Case of Ethiopia*, Journal of Policy Modeling, 21(4):481-496

Tong, Howell. (1990) *Non-Linear Time Series: A Dynamical Systems Approach*, Oxford University Press

Tronvoll, K. (2004), *From war to peace - and back to war again? The failure of UMOAU to create sustainable peace between Eritrea and Ethiopia*, in Sorbo, G. and Pausewang, S. (eds) *Prospects for Peace, Security and Human Rights in Africa's Horn*, Bergen, Fgbokfolaget : 48-61.

Van Poeck, A., Vanneste, J. and Veiner, M. (2007) *Exchange Rate Regimes and Exchange Market Pressure in the New EU Member States*, Journal of Common Market Studies, Volume 45, Issue 2, : 459-485

Youngblood, C. (2003) *Leading Indicators of Currency Crises in Ghana*, Trade and Investment Reform Program (TIRP), January

Tables:

Table-1 Description of the Indicator Variables

Indicator Variable	Description	How is the indicator used?
Real exchange rate:	Determined from nominal exchange rate (IFS line 00ae) by adjusting for relative consumer prices (IFS line 64).	The indicator is measured as percentage deviation from its trend
Imports:	IFS line 71_d	12-month percentage change
Exports:	IFS line 70_d	12-month percentage change
Terms of trade:	Global Development Finance & World Development Indicators. Monthly terms of trade was interpolated from annual data.	12-month percentage change
Reserves:	IFS line 1L.d.	12-month percentage change
M2/reserves:	Determined by converting M2 (IFS lines 34 plus 35) from local currency (i.e. birr) into dollars (using line 00ae) and then dividing it by reserves (line 1L.d)	12-month percentage change
Real interest rate differential:	The difference between domestic real interest rate and the real interest rate in the United States.	Percentage difference
M2 multiplier	Given as the ratio of M2 (IFS lines 34 plus 35) to base money (IFS line 14) ³⁶	12-month percentage change
Domestic credit/GDP:	Determined by deflating domestic credit (line 32) by consumer prices and then dividing it by real GDP (line 99b.p.). Monthly real GDP was interpolated from annual data.	12-month percentage change
Domestic real interest rate	Determined by deflating deposit rate (IFS line 60l) by consumer price inflation (IFS line 64)	percentage
Lending-deposit rate ratio	Determined by dividing lending rate (IFS line 60p) by deposit rate (IFS line 60l)	ratio
Excess M1 balances:	Determined by deflating M1 (IFS line 34) by consumer prices (IFS line 64) and then subtracting an estimated demand for money from it. The demand for money, in turn, is estimated from a regression of real M1 balances on real GDP, consumer price inflation, and a linear time trend.	millions of nominal currency -birr
Bank deposits:	Determined by deflating deposits (IFS line 24 plus 25) by consumer prices (IFS line 64).	12-month percentage change

Table-2 Description of Thresholds of the Indicator Variables

Category	Indicator	Tail	Comments
Current account	Real exchange rate	Lower	Large negative shocks to exchange rate (i.e. the overvaluation of the real exchange rate)

³⁶ IFS= International Financial Statistics (International Monetary Fund). See also Appendix in Peng and Bajona (2008), page 20.

indicators ³⁷	Imports	Upper	Rapid rise in Imports (a weak external sector)
	Exports	Lower	Rapid decline in exports (a weak external sector)
	Terms of trade	Lower	Big negative shocks to exchange rate and exports (and, hence, terms of trade) leads to loss of competitiveness of local businesses. This may at times lead to recessions.
Capital account Indicators ³⁸	Foreign reserves	Lower	Sustained Loss of foreign reserve
	M2/ reserves	Upper	Expansionary monetary policy and/or rapid fall in reserves
	Real interest rate differential(Domestic/foreign)	Upper	Large interest rate differential which might lead to reversal of capital flows
Domestic Financial sector Indicators ³⁹	M2 multiplier	Upper	Fast growth of credit
	Domestic credit/GDP	Upper	Domestic credit normally expands before a crisis and then contracts in later date. Since we are interested in events before crisis, we take the upper threshold.
	Domestic real interest rates	Upper	Presence of high real interest rates might show a liquidity crunch in an economy. Further, speculative attacks are often dealt with by rising real interest rates
	Lending/deposit interest rates	Upper	Lending rates normally appear to go up before a crisis. Yet, rising lending rates show the decline in loan quality.
	Excess real M1 balances	Upper	Loose monetary policy (excess liquidity) might lead to a currency crisis
	Bank deposits	Lower	Banks lose their deposits as crisis starts to hit the economy
Real sector ⁴⁰	Industrial production	Lower	A recession (decline in industrial output) often leads financial crises.
	Equity indices	Lower	Burst of asset price bubbles (such as the US housing market bubble in 2007) often lead financial crises

Table-3 The performance of an indicator

	Crisis within 24 months	No crisis within 24 months
Signal issued	A	B (a 'false positive' = Type II error)
No signal issued	C (a 'miss' = Type I error)	D

Note: The table summarizes the possible outcomes of an indicator variable. Cell A represents a good signal while cell B represents a noise or false alarm. Also note that entries C and B would be zero for a perfect indicator (i.e. a perfect indicator only has cell A and D).

Table-4 Composite crisis Index and Crisis probabilities

Value of composite crisis indicator	Probability of crisis
0-0.6	.14
0.6-1.2	.12

³⁷ See table-2 in Heun (2004), page 25; also see Dornbusch et al. (1995)

³⁸ See Edison (2003), Kaminsky and Reinhart (1999)

³⁹ See Edison (2003); McKinnon and Pill (1994); Krugman (1979); Goldfajn and Valdes (1995)

⁴⁰ See Edison (2003), See also Gorton (1988) and Calomiris and Gorton (1991) cited in Heun (2004), page 25

1.2-3	.17
3-5	.25
5-7	.32
7-9	.33
9-10	.43
10-11	.51
11-12	.49
Over 12	.50

Source: Table 9 in Edison (2003)

Table-5 Results from the signals approach

	Number of signals in preceding 24 months			Total signals (Signalling window)	Total signals (Signalling & tranquil periods combined)	Threshold		Noise-to-signal ratio ⁴¹ (Comparison to other studies)			
	1992	1999	2008			Percentile	Value	This Case study	Edison (2003)		Kaminsky et.al (1998) Multi country study
									Mexico case study	Multi country study	
M2 multiplier	0	13	5	18	70	85	14.69	0.53	N/A	.86	.61
Domestic credit/GDP	1	4	0	5	93	80	7.09	3.20	N/A	.75	.62
M2/reserves	3	0	0	3	46	90	107.81	2.60	.1	.52	.48
Bank deposits	12	0	6	18	46	10	-8.06	0.28	10.9	.94	1.2
Exports	12	2	0	14	46	10	-43.29	0.42	1.02	.6	.42
Imports	6	0	0	6	46	90	77.38	1.21	.55	.88	1.16
Terms of Trade	6	2	0	8	46	10	-54.52	0.86	N/A	.93	.77
Reserves	3	0	0	3	46	10	-46.65	2.61	.86	.53	.57
Deviation of Real ER from trend	24	0	0	24	46	10	-47.59	0.17	0	.26	.19

⁴¹ There are 468 months in the dataset (Jan 1970 to Dec 2008). 72 months (24months X 3 crisis) belong to the signalling window. The rest (396 months) are tranquil periods. The total signals received from an indicator in the 3 signalling windows (72 months) are given in column 5 of table-5. The total signals received from an indicator in the whole study period (468 months) are given in column 6 of the table.

Suppose :

A=column 5

B=Column 6 – column 5

C=72-A

D=396-B

Then the 'noise-to-signal ratio' can be given as $(B / B + D) / (A / A + C)$. In the case of indicator 'M2 multiplier' for instance, A=18; B=53 (i.e. 71-18); C=54 (i.e. 72-A) and D=343(i.e. 396-B). Thus, noise-to-signal ratio will be $(53/(53+343)) / (18/(18+54)) \approx 0.54$

(see table-2 and the subsequent explanation in section 3.2 for more clarification)

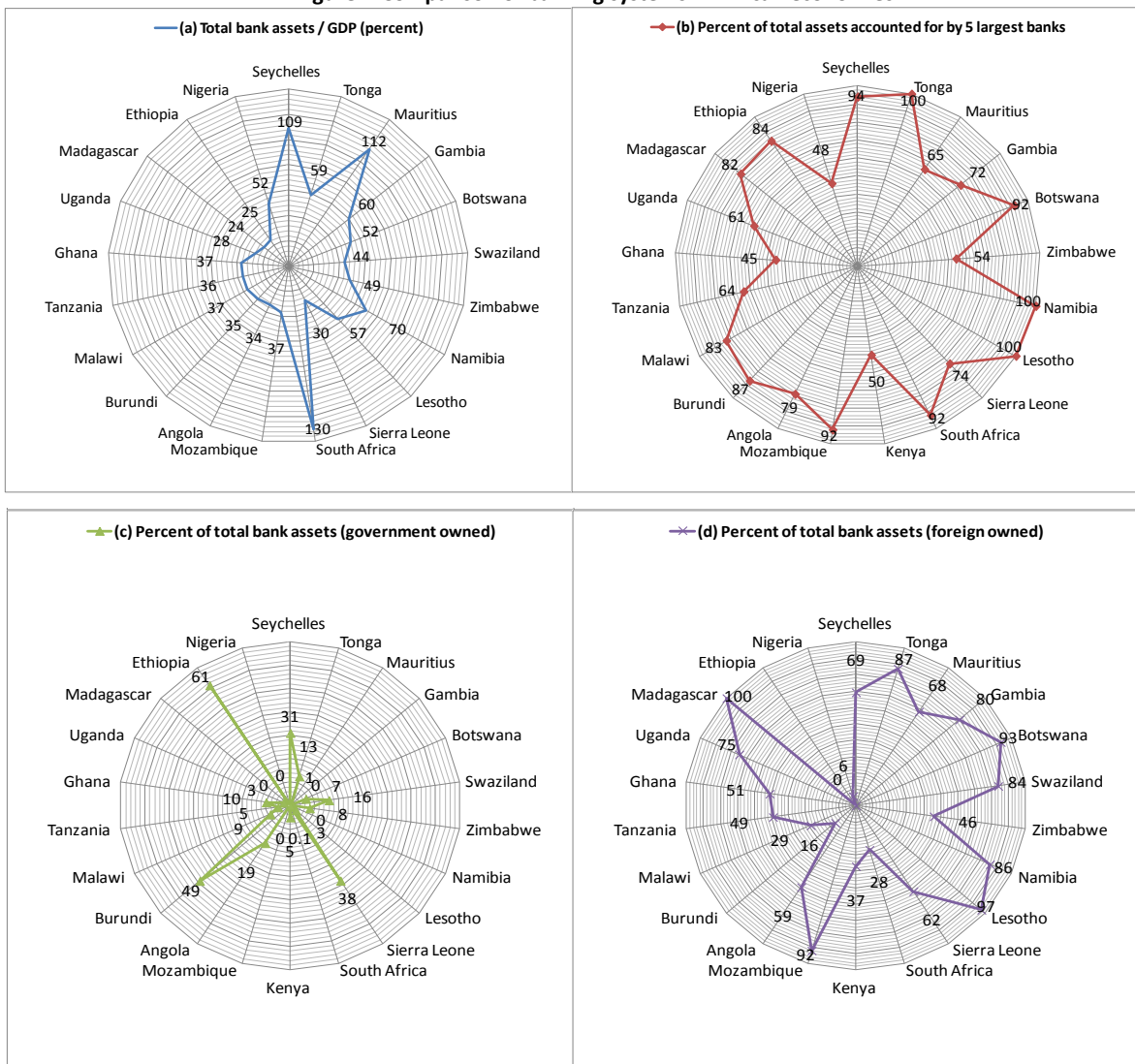
Real interest rate differential	0	0	0	0	46	90	143.63	N/A*	N/A	1	.99
Excess M1 balances	2	0	0	2	46	90	5043.60	4.00	.19	.55	.52
Domestic real interest rate (deflated by cpi)	0	0	0	0	93	80	20.00	N/A*	N/A	.66	.77
Lending-deposit rate ratio	24	0	0	24	93	80	2.41	0.52	3.4	2.7	1.69

N/A= not available

N/A*= not available due to division by zero

Figures:

Figure-1 Comparison of banking systems in African economies



Computation based on World Bank 2012 survey of banking systems in 180 countries (see Barth et al., 2013)

Figure-2 Exchange Market Pressure Index (fixed exchange)

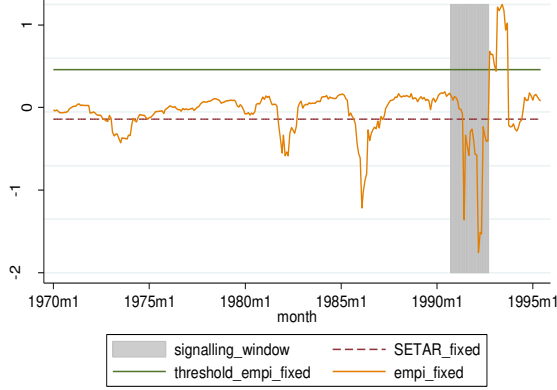


Figure-3 Exchange Market Pressure Index (managed float)

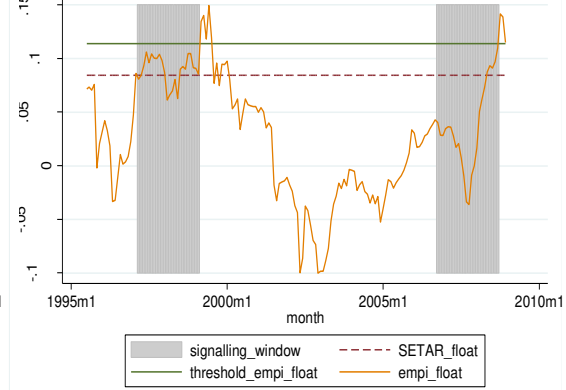
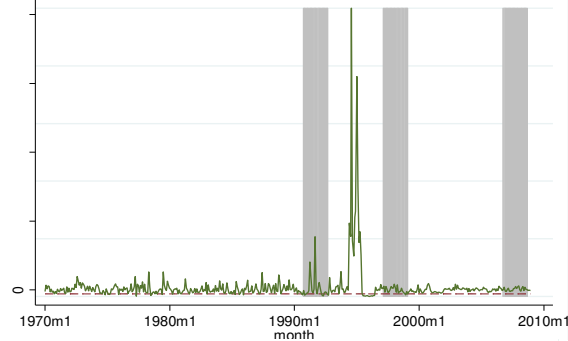


Figure-4 The indicators of vulnerability to currency crisis *

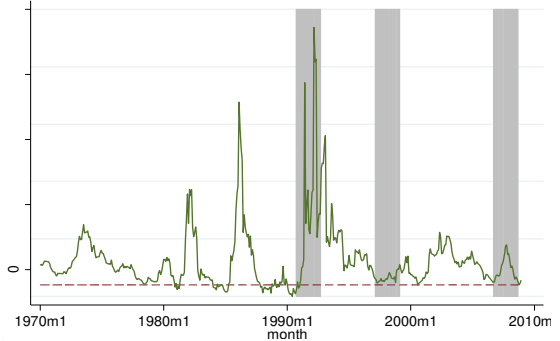


* Note: Shaded regions represent 24-month signalling window and the broken lines represent the threshold lines

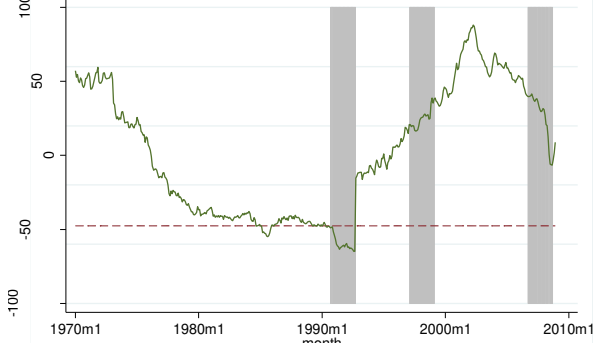
Terms of Trade (12-month percentage change; Lower threshold)



Reserves (12-month percentage change; Lower threshold)



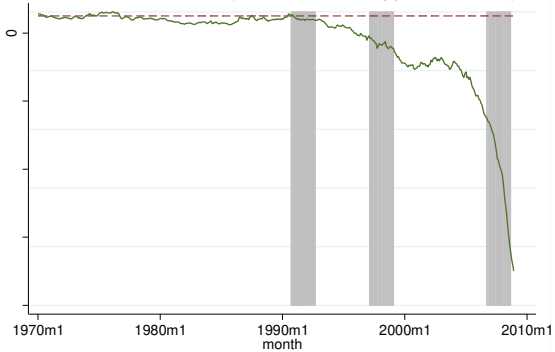
Real exchange rate (Percentage Deviation from trend; Lower threshold)



Real interest rate differential (percentage difference between domestic and US interest rate; Upper threshold)



Excess M1 balance (Millions of birr; Upper threshold)



Real interest rate (Percent; Upper threshold)



Lending-deposit rate ratio (Ratio; Upper threshold)

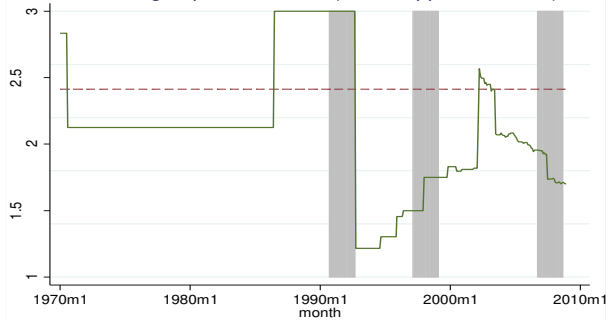


Figure-5 Crisis Probabilities

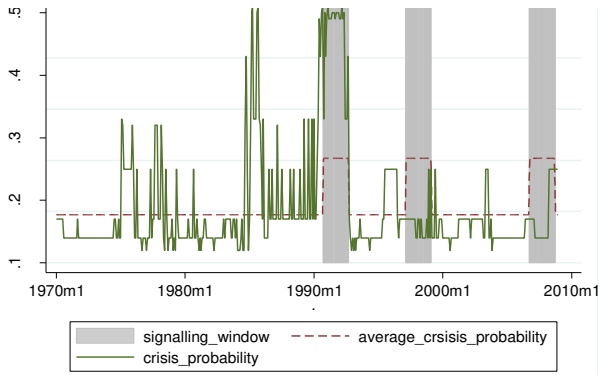


Figure-6 Composite Crisis Index

