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Abstract:

Economies are susceptible to speculative attacks regardless of whether they use fixed or floating exchange rates. Turkish experience in the last two decades constitutes one of the most prominent examples proving this verdict. It is widely accepted that narrow money (M1) is the most conventional measure of liquidity, excessive growth of which may fuel speculative attacks on the currency. The literature on currency crises clearly lacks a country-specific study that addresses the long-run relationship between this indicator and the speculative pressure in the exchange market. This article aims at filling this gap in the literature using monthly Turkish time series data spanning the period 1984:04- 2006:11. Results of the ADF unit root tests suggest that the series are stationary. Hence, no-cointegration analysis was carried out before the Granger-causality tests. Granger causality tests reveal strong evidence supporting univariate causality running from narrow money (M1) to exchange market pressure. This outcome lends empirical support to the Turkish policy makers' current efforts to maintain a tight control of the money supply.

Key words: Speculative attacks, currency crises, liquidity, M1
Jel codes: F30, E44

I. Introduction

Speculative attacks are defined as large movements in exchange rates, interest rates, and international reserves (Eichengreen at al, 1996). These involve massive selling of domestic currency assets by both domestic and foreign investors. Economies are susceptible to speculative attacks regardless of whether they use fixed or floating exchange rate. Currency crashes around the world in the last decades have shown that if a government chooses to maintain a fixed exchange rate during a speculative attack, they risk the chance of severe financial crises. Speculative attacks take place when speculators consider that a devaluation is imminent (The World Bank, 1999). This consideration leads speculators to demand central bank foreign exchange reserves in exchange for their domestic currency. All too often, the speculators aim to profit from buying reserves at the current exchange rate and selling them after the attack at a higher exchange rate. The central bank is forced to devalue the currency when it runs out of reserves if it has no access to international credit or chooses not to borrow abroad.

Numerous theoretical models have been used to explain the causes and origins of speculative attacks and currency crises. The first generation models (Krugman 1979) emphasize the role of inconsistencies between fiscal, monetary and exchange-rate policies. In these models the presence of inconsistent policies generates a speculative attack against the local currency, and pushes the economy into a crisis. The degree of severity of these inconsistencies will determine the timing of the crisis. The second generation models (Obstfeld, 1986) suggest that even in the presence of consistent macroeconomic policies an economy can suffer a speculative attack. These models emphasize the role of policymaker's preferences, and suggest that the option of abandoning a fixed exchange rate regime may be an ex-ante optimal decision for the policymaker, considering that economic authorities face tradeoffs. The third generation models consist broadly of three different groups such as herd-behavior, contagion, and moral hazard. These models investigate some disputed issues such as moral hazard, herding behavior of portfolio managers, and international contagion effects that appeared through some transmission channels such as trade and financial linkages between countries.

Narrow money (M1) is the most conventional measure of liquidity (Laumas, 1977). High growth of this indicators may indicate excess liquidity which may fuel speculative attacks on the currency (Eichengreen et al. 1995). Besides, it relates with the all three types of crises (Kamin et al. 2001; Lestano and Kuper, 2003). Economies are susceptible to speculative attacks regardless of whether they use fixed or floating exchange rates. Turkish experience in the last two decades constitutes one of the most prominent examples proving this verdict. The literature on currency crises clearly lacks a country-specific study that addresses the long-run relationship between M1 and the speculative pressure in the exchange market. This artice aims at filling this gap in the literature through cointegration and Granger-causality tests using Turkish time series data spanning the period 1984:04- 2006:11. The rest of the article is structured as follows: Section II provides a review of the related literature. Section III provides the theoretical framework. Section IV presents the data and methodology. Section V will discuss the results and the last section will point out the conclusions that emerge from the study.

II. Literature Review

In the currency crisis literature, despite a wealth of empirical studies, only three studies have found that M1 has played a role in the currency crises are Kaminsky *et al.* (1997) Lestano *et al.* (2003), and Jacobs *et al* (2004). Kaminsky *et al.* (1997) build a signals model for twenty countries based on monthly data in the period from 1970 to 1995. The authors use a set of 15 variables capturing external balance, monetary factors, and output and equity movements, whose values are compared in the period of 24 months preceding the crisis with the values recorded in a tranquil period, so indicators are expected to issue signals 2 years ahead of the crisis. They use a crisis index as the weighted average of exchange rate changes and reserve changes. For each variable, an optimal threshold value is estimated, above which the variable gives a signal for a crisis in the coming 24 months. They find that the variables that have most explanatory power based on the noise-to-signal ratio are the deviation of real exchange rates from a deterministic trend, the occurrence of a banking crisis, the export growth rate, the stock price index growth rate, M2/reserves growth rate, output growth, excess M1 balances, growth of international reserves, M2 multiplier growth, and the growth rate of the domestic credit to GDP ratio.

Lestano and Kuper (2003) analyze various types of financial crises examining the significance of a number of leading indicators using a logit model. Results of logit regressions reveal that rates of growth of M1 and M2, bank deposits, GDP per capita and national savings correlate with all types of financial crises. They also find that the ratio of M2 to foreign reserves, the growth of foreign reserves, the domestic real interest rate and inflation play an additional role in banking crises as well as in some types of currency crises.

Likewise, Jacobs et al (2004) estimate a logit model for Malaysia, Indonesia, Philippines, Singapore, South Korea and Thailand for the period between January 1970 and December 2001. The authors build different logit models for different versions of currency crises based on a broad set of indicators which they combine into factors using the factor analysis methodology. As a result of the factor analysis and the logit regressions, they find that the rates of growth of M1 and M2, GDP per capita, national savings, and import growth correlate with all definitions of currency crises. The authors also note that using the first differences of indicators instead of levels improves the predictive power of the model.

There exists a wealth of studies that have found that M1 does not play a role in speculative attacks based on a variety of empirical methods such as signals approach, logit models and probit models (See, *inter alia*, Sachs *et al.* 1996; Goldfjan and Valdes, 1997; Klein and Marion, 1997; Edwards, 1998; Milesi-Ferretti and Razin, 1998; Esquivel and Larrain, 1998; Glick and Moreno, 1999; Caramezza et al. 2000; Geochoco-Bautista 2000; El-Shazly 2002; Krznar 2004). However, the literature clearly lacks a country-specific study that focuses on the long-run relationship between these indicators and the pressure in the exchange market. This is precisely what the next section will seek to address using Turkish time series data.

III. Theoretical Framework

The theoretical foundation of the empirical work carried out in the present article is Krugman's (1979) first generation model. This model is based on several assumptions. Firstly, a small open economy produces and consumes a single consumption good, which is produced in the country and overseas. Purchasing power parity (PPP) holds and the foreign price level is normalized to 1:

$$[(e_t P_t^*)/P_t] = 1 \text{ with } P_t^* = 1 \rightarrow \quad e_t = P_t \qquad (1)$$

where P is the domestic currency price of the good, P^* is the foreign currency price of the good, and e is the exchange rate. Setting the given value of P^* to unity, the domestic price level is equal to the exchange rate. The domestic price level remains constant under a fixed exchange rate system. Secondly, there is perfect foresight and the foreign interest rate is normalized to 0:

$$e_{t+1}^e = e_{t+1} \text{ with } i^*_t = 0 \rightarrow [(e_{t+1} - e_t)/ e_t] = i_t \qquad (2)$$

Thirdly, uncovered interest parity is assumed to hold between domestic and foreign currency assets:

$$i_t = i^*_t + \lambda_t \qquad (3)$$

where i is the domestic interest rate, i^* is the foreign interest rate and λ is the expected rate of depreciation of the domestic currency. Fourthly, there is a lower bound on the level of foreign reserves that the central bank owns:

$$R_t \geq 0 \qquad (4)$$

where R is the foreign exchange reserves of the central bank. Based on these assumptions, Krugman (1979) explains that market participants launch speculative attacks by buying foreign exchange in the face of impending devaluation with the deterioration of economic fundamentals. As a result, the foreign reserves of the central bank decrease all of a sudden, and the currency is devalued or the exchange rate system changes from a fixed exchange rate system to a flexible exchange rate system, which is defined as a currency crisis. The general model is based on the money demand equation:

$$(M^d_t / P_t) = \alpha - \beta i_t \qquad (5)$$

which states that real money demand depends negatively on the expected rate of depreciation and also slips in the normalization that the foreign price level is fixed at unity. Full employment prevails and the level of output is normalized to zero. Real money demand, therefore, can be expressed solely as a function of the nominal interest rate, i. Money market equilibrium requires that:

$$M^s_t / e_t = a - b.i_t \qquad \text{a, b} > 0 \qquad (6)$$

where M is the nominal money stock. Krugman (1979) explains that in the absence of commercial banks we have:

$$M^s_t \equiv R_t + D_t \qquad (7)$$

where R is the central bank's foreign exchange reserves and D is the domestic credit component of the money supply. In addition, investors' behavior is captured by uncovered interest parity condition:

$$[(e^e_{t+1} - e_t)/e_t] = i_t - i^*_t \qquad (8)$$

The money market equilibrium is:

$$M^d_t = M^s_t \rightarrow [(R_t + D_t)/P_t] = \alpha - \beta i_t \qquad (9)$$

which can also be shown as:

$$[(R_t + D_t)/e_t] = \alpha - \beta\ [(e_{t+1} - e_t)/e_t] \qquad (10)$$

where:

$$e_t = \overline{e} \quad \forall t\ \bar{e} \qquad (11)$$

Within this framework, the fixed exchange rate regime is shown as:

$$[(R_t + D_t)/\bar{e}] = \alpha \qquad (12)$$

which defines the conditions under which the fixed exchange rate is viable and determines the level of foreign reserves compatible with a given fixed exchange rate. The exchange rate that would prevail in the market if there were no intervention in the foreign exchange market is called the shadow exchange rate. The assumed source of disequilibrium in the first-generation models comes from a budget deficit that grows at rate μ and monetizes through the growth of domestic credit. The central bank expands the domestic component of money supply at a constant rate indefinitely:

$$D_t = D_{t-1} + \mu \qquad (13)$$

where μ is the rate of growth of domestic credit or the domestic components of the money base. The domestic credit component is assumed to grow at a constant rate μ (e.g., because the government runs a budget deficit which the monetary authority passively monetizes). D(t) is a continuous function of time except when the Central Bank conducts an open market operation.

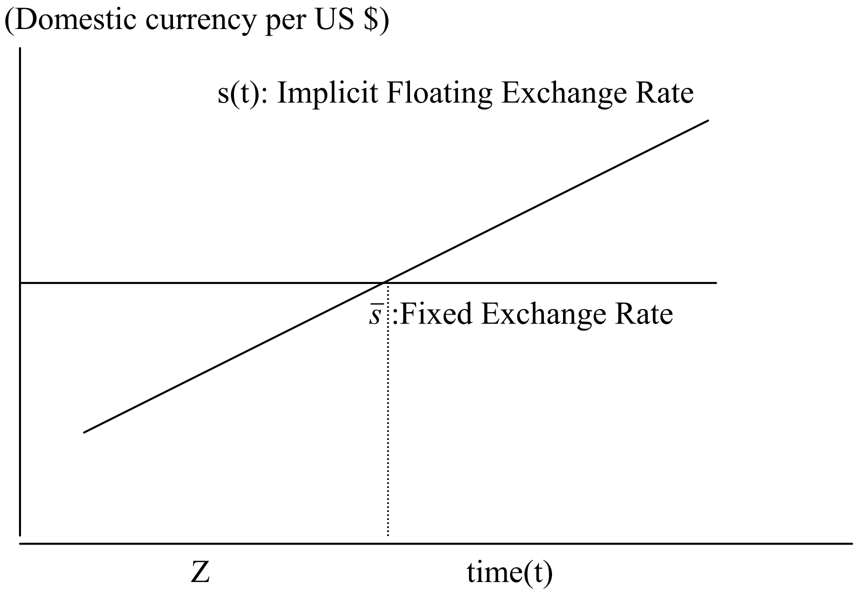
$$dD_t / dt = \mu.D_t \qquad (14)$$

Finally, there is a target level of foreign exchange reserves which the Central Bank will defend i.e., it is prepared to commit the rest of its holding of foreign reserves to the defence of the fixed exchange rate system. In order to defend the peg, the central bank will intervene in the foreign market by selling foreign reserves at the same rate of increase of the domestic credit component of the money supply. As long as the economy is on a fixed exchange rate, D is growing at a rate μ, and foreign reserves fall by μD since:

$$dD_t /dt = - dR_t /dt \qquad (15)$$

In order to maintain the exchange rate at a fixed level under the fixed exchange regime, the central bank must reduce international reserves up to their complete exhaustion. At that point, the previously established exchange rate parity cannot be defended and devaluation takes place. However, even prior to this point, speculators will rightly estimate the developments of the fundamental macroeconomic variables, foresee the forthcoming course of events and start selling domestic currency and buying foreign exchange in order to avoid losses when devaluation takes place. In that way, speculators' rational actions, i.e. exchanging domestic currency with foreign currency, will cause a speculative attack on the domestic currency and a more rapid exhaustion of international reserves, leading to an earlier devaluation. Provided that expectations are rational, the exact point of attack on a currency can be determined. The instant of a speculative attack in Krugman's model is determined by establishing the "shadow exchange rate", i.e. the market exchange rate that would be obtained when the reserves are exhausted, or the market rate at which a central bank can no longer defend the exchange rate. Since domestic credit is growing at a constant rate μ, and since the shadow exchange rate depends on the path of money supply, we have that the shadow exchange rate will depreciate also at the constant rate μ: The attack on the domestic currency will occur at time T at which the shadow exchange rate is equal to the fixed rate. Figure 1 depicts how a country with a fixed exchange rate system is drawn into a currency crisis.

Figure 1 Implicit Floating Exchange Rate and Fixed Exchange Rate



Source: Choi (1999)

In the figure, $\bar{s}$ indicates the current exchange rate level that country currently sustains and s(t) is the exchange rate which would be determined according to the economic fundamentals. As time goes by, the exchange rate level, s(t), can change with the economic fundamentals. It can go upward or downward reflecting the movement of economic fundamentals, and it is called “the implicit floating exchange rate” (Choi, 1999). In case economic fundamentals deteriorate as money expands as a result of an increased fiscal deficit, investors sell domestic currency and buy foreign currency, anticipating capital gains through speculative attack. The central bank is forced to sell foreign reserves to keep the existing exchange rate stable. If the foreign reserves of a central bank decrease to a dangerous level under speculative attack, then it has to devaluate the domestic currency or adopt a floating exchange rate system. When a speculative attack succeeds, investors gain profits as expressed by their foreign currency purchased multiplied by the differential between the implicit floating exchange rate and the previously fixed exchange rate. Economic fundamentals which influence this implicit floating exchange rate include a fiscal deficit, money, real incomes, prices, and the current account position. However, identifying what kind of economic fundamentals influence the implicit floating exchange rate in a particular pre-crisis situation still remains an empirical task. The present article focuses on the role of money (narrow money and quasi money).

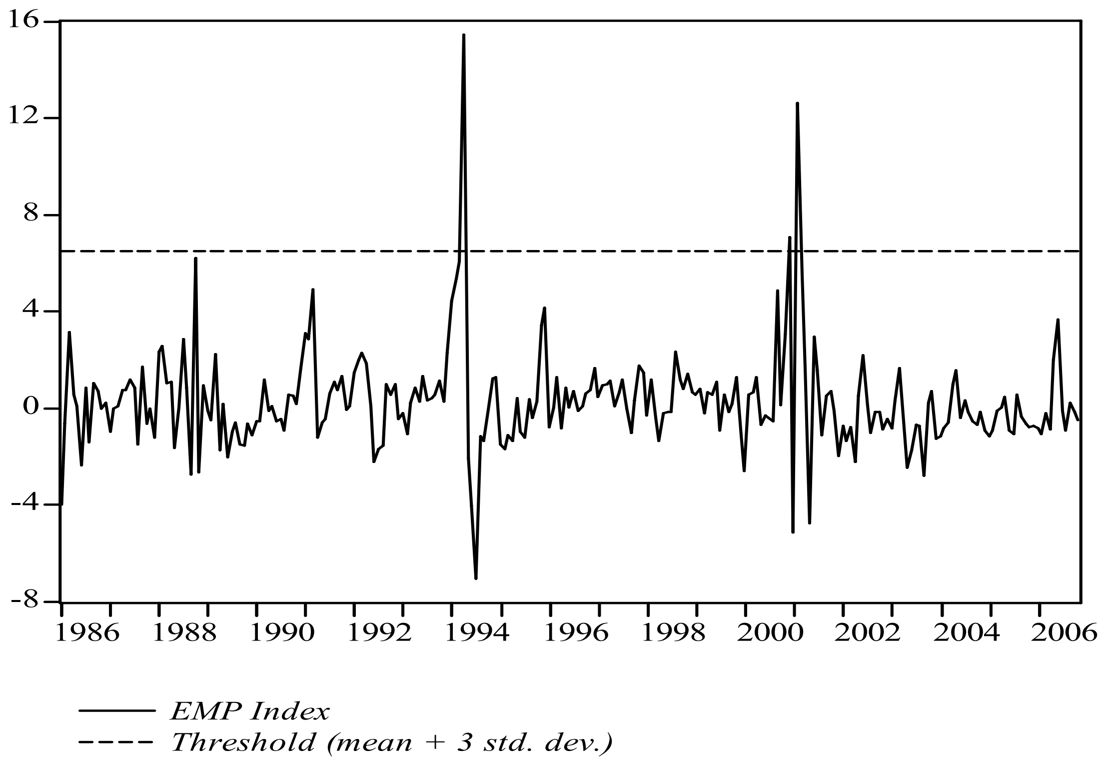
III. Data and Methodology

Data is obtained from the IMF’s online International Financial Statistics database, spans the period 1984:04-2006:11, and is in monthly percent changes. M1 is used in logarithmic returns as their graphical representations indicated exponential growth. Interest rates are the averages of 3-month nominal interest rates. Foreign exchange reserves are the Turkish Central Bank’s gross foreign exchange reserves. Exchange rate is the US dollar-Turkish lira nominal exchange rate. Most studies of currency crises define the currency pressure measure in terms of the bilateral exchange rate against the US dollar. Hence we use US dollar-Turkish lira nominal exchange rate. The reason why these three variables should be considered simultaneously in such index is very well documented by Moreno and Trahan (2000). The authors explain that if a country's exchange rate is floating, or if a peg has collapsed, a sharp depreciation is a clear-cut indicator of a shift in sentiment or speculative pressure against a currency. Nevertheless, if exchange rate stability (or the peg) is maintained, pressure on the exchange rate will be reflected through the action taken by the monetary authorities. If investors want to switch away from a country's assets, the exchange rate will tend to depreciate and, in order to prevent depreciation of the currency, the central bank will either sell foreign reserves to accommodate the increased demand for foreign assets, or allow interest rates to rise (Moreno and Trahan, 2000). Particularly, including interest rates in the index enables us "to seize the full period of the turbulence, which might begin with interest rate increases defending a peg" (Eliasson and Kreuter, 2001). The index of exchange market pressure calculated according to the Equation 16 is shown in Figure 1.

$$EMP = (1/\sigma_e)*(\Delta e/e_{t-1}) + (1/\sigma_r)*(\Delta r/r_{t-1}) - (1/\sigma_{ir})*(\Delta ir/ir_{t-1}) \quad (16)$$

Where σ_e is the standard deviation of the exchange rate, σ_r is the standard deviation of the interest rate and σ_{ir} is the standard deviation of the international reserves. The weights attached to the three components of the index are the inverse of the standard deviation for each series, in order to equalize volatilities of the three components and to avoid any of them dominating the index (Kaminsky et al 1997). A positive value of the index measures the depreciation pressure of the currency, while a negative value of the index measures the appreciation pressure of the currency.

Figure 1 Exchange Market Pressure Index



Source: The author's calculation.

The analysis of the index of speculative pressure identified numerous periods of excessive market volatility. We find that the crisis variable successfully portrays the crisis periods that occurred in Turkey in the sample period using a crisis threshold of mean+3 Standard Deviation. We will test the causal relationships between the selected variables and the calculated EMP index. A practical way for testing for causality was proposed by Granger (1969) and popularized by Sims (1972). Testing causality, in the Granger sense, involves conducting *F*-tests to see whether lagged information on a variable *X* provides any statistically significant information about a variable *Y* in the presence of lagged *Y*. To implement the Granger test, we assume a particular autoregressive lag length *k (or p)* and estimate Equation (4.2) and (4.3) by OLS:

$$X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} X_{t-i} + \sum_{j=1}^{k} b_{1j} Y_{t-j} + \mu_{1t} \tag{17}$$

$$Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} X_{t-i} + \sum_{j=1}^{p} b_{2j} Y_{t-j} + \mu_{2t} \tag{18}$$

F test is carried out for the null hypothesis of no Granger causality:

$$H_0 : b_{i1} = b_{i2} = \cdots = b_{ik} = 0, i = 1,2. \tag{19}$$

where *F* statistic is the Wald statistic for the null hypothesis. If the *F* statistic is greater than a certain critical value for an *F* distribution, then we reject the null hypothesis that *Y* does not Granger-cause *X*, which means Y Granger-causes X. If it is also found that when regressing X on its past values and current and past values of Y, some or all of the current or past values of Y are significant, then we say that there exists feedback between the variables. Unidirectional causality exists when it can be shown that one variable Granger causes the other, but not the other way around. The definition of the Granger causality is based on the hypothesis that *X* and *Y* are stationary or I(0) time series.

IV. Empirical Results

The definition of the Granger causality is based on the hypothesis that *X* and *Y* are stationary or I(0) time series. Therefore, the first necessary condition to perform Granger-causality tests is to study the stationary of the time series under consideration and to establish the order of integration present. Table 1 below presents the results of the unit root test.

Table 1. Augmented Dickey-Fuller Unit Root Test Results

	Test with an intercept		Test with an intercept and trend		Test with no intercept or trend	
	ADF (Levels)	ADF (1st differences)	ADF (Levels)	ADF (1st differences)	ADF (Levels)	ADF (1st differences)
M1	8.048333	0.709563	7.710059	-1.040171	6.015082	1.342023
EMP	-13.87241	-11.68819	-13.87540	-11.66482	-13.69186	-11.71076
CV* (1%)	-3.455887	-3.455887	-3.994453	-3.994453	-2.574134	-2.574134
CV* (5%)	-2.872675	-2.872675	-3.427546	-3.427546	-1.942084	-1.942084

*MacKinnon (1996) one-sided p-values.

The lag length was determined using Schwartz Information Criteria (SIC)

As the calculated ADF statistics are larger than the MacKinnon values in levels, we can reject the null hypothesis of a unit root for M1 and EMP. Hence we conclude that both series are stationry, i.e. I(0). Therefore, there is no need for co-integration analysis and we can proceed to the Granger-causality tests shown in Equation 17 and Equation 18. Table 2 shows the results of these tests.

Table 2. Granger Causality Test Results (Total observations: 262)

	Wald Type F–Statistics						
Null Hypothesis	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7
M1 =/=> EMP	0.28939	3.56556**	4.07633*	3.16775	2.84830**	2.48596**	2.16245**
EMP =/=> M1	0.21056	0.01829	0.70622	1.14418	1.31144	1.19691	1.01966
M2 =/=> EMP	0.23493	0.84054	0.64898	0.53038	0.61878	0.54641	0.51586
EMP =/=> M2	5.48682	1.66095	2.81945**	1.82826	1.48784	1.91706*	1.84532*

** Reject the null hypothesis at the 5% level.
* Reject the null hypothesis at the 10% level.

Granger causality tests reveal strong evidence supporting univariate causality running from narrow money (M1) to exchange market pressure at 2,3,5,6 and 7 year lags.

V. Conclusion

Economies are susceptible to speculative attacks regardless of whether they use fixed or floating exchange rates. Turkish experience in the last two decades constitutes one of the most prominent examples proving this verdict. It is widely accepted that narrow money (M1) and broad money (M2) are the most conventional measures of liquidity, excessive growth of which may fuel speculative attacks on the currency. The literature on currency crises clearly lacks a country-specific study that addresses the long-run relationship between these indicators and the speculative pressure in the exchange market. This artice aims at filling this gap in the literature using monthly Turkish time series data spanning the period 1984:04-2006:11. Results of the ADF unit root tests suggest that the series are stationary. Hence, no-cointegration analysis was carried out before the Granger-causality tests. Granger causality tests reveal strong evidence supporting univariate causality running from narrow money (M1) to exchange market pressure. This outcome lends empirical support to the Turkish policy makers' current efforts to maintain a tight control of the money supply.

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