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Exchange Rate Pass-Through on the Domestic Prices: Evidence from the Turkish Economy

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ABSTRACT

The understanding of the effects of the changes in exchange rates is quite significant for monetary policy implications. Particularly, for developing countries such as Turkey, price instability become a strong factor that makes difficult economic development. Hence, policy implications have crucial roles in the economic activities. The objective of this study is to investigate the pass-through of exchange rate to domestic prices in Turkey for the period of 2010:Q1-2020:Q1. In this context, nominal exchange rate, total import price index, real gross domestic product and consumer price index variables were employed. In the analysis, firstly ADF and KPSS unit root tests are performed. After the variables' order of stationarity is detected, ARDL method is applied. Based on the analysis results obtained, it is found that there is a cointegration relationship between the variables. Exchange rate and import prices have a significant effects on domestic prices for both the long and the short-term. Accordingly the long-term relations, if nominal exchange rate increases by 1%, inflation also increases by 0.61%. In addition, it is concluded that 1% increase in total import price index leads 0.46% increase in inflation.

Keywords: Pass Through Effect, Exchange Rate, Turkey.
JEL Codes: E31, E52, F31.

Döviz Kurunun Yurt İçi Fiyatlar Üzerine Geçiş Etkisi: Türkiye Ekonomisi Üzerine Bir Araştırma

ÖZ

Döviz kurlarındaki değişikliklerin etkilerinin belirlenmesi, para politikası uygulamaları açısından oldukça önemlidir. Özellikle Türkiye gibi gelişmekte olan ülkeler için fiyat istikrarsızlığı, ekonomik kalkınmayı zorlaştıran güçlü bir faktör olarak kabul edilmektedir. Bu nedenle, politika uygulamalarının ekonomik faaliyetlerdeki rolü kritiktir. Bu çalışmanın amacı, 2010: Q1-2020: Q1 dönemi için Türkiye'deki döviz kurunun yurt içi fiyatlar üzerine geçiş etkisinin incelenmesi olmuştur. Bu bağlamda, nominal döviz kuru, toplam ithalat fiyat endeksi, reel gayri safi yurtiçi hasıla ve tüketici fiyat endeksi değişkenleri kullanılmıştır. Analizde öncelikle ADF ve KPSS birim kök testleri uygulanmıştır. Değişkenlerin durağanlık mertebeleri tespit edildikten sonra ARDL yöntemi uygulanmıştır. Elde edilen analiz sonuçlarına göre değişkenler arasında eşbütünleşme ilişkisi olduğu tespit edilmiştir. Döviz kuru ve ithalat fiyatları hem uzun hem de kısa dönemde yurt içi fiyatlar üzerinde önemli etkileri olduğu gözlemlenmiştir. Uzun dönemde, nominal döviz kuru % 1 arttığında, enflasyon da % 0,61 artmaktadır. Ayrıca, toplam ithalat fiyat endeksindeki % 1'lik artışın, enflasyonda % 0,46'lık bir artışa neden olduğu sonucuna ulaşılmıştır.

Anahtar Kelimeler: Geçiş Etkisi, Döviz Kuru, Türkiye.
JEL Kodları: E31, E52, F31.

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1. Introduction

This study investigates the pass through of exchange rate on inflation in Turkey, an emerging market economy. The adverse effects of inflation are well known, and for Turkey, price instability has been argued to be a strong factor in stifling economic development. In this frame, Turkey's experience is not unique in terms of price instability. An understanding of the mechanisms by which inflation is transmitted through the economy is thus of importance, particularly to emerging market economies (Kara and Öğünç, 2012:10).

Turkey's economy has been experienced to inflation rather than struggle against inflation throughout history. In the 2000s, since the stabilization measures were performed, the inflation rate decreased below 40%; however, due to 2001 crisis, it increased to 70% again. Despite the fact that February 21, 2001 crisis essentially is caused by the high rate of increase in the current account deficit, the crisis also affected the inflation in a negative way (Bahar and Erdoğan, 2011: 12). A stabilization program was taken into consideration as a solution to reduce inflation after the 2001 crisis. The stabilization program conducted under the name of Strong Economy Transition Program is the continuation of the Stand-By Agreement signed with the IMF. As a result of the policies implemented in Turkey's economy, at the end of 2004, inflation dropped to 9.3%.

The understanding of the effects of the changes observed in exchange rates is very important for monetary policy implications. In this research study, it has been chosen to examine the external factors, exchange rate and import prices, and internal factors, GDP in Turkey. Since both external and internal factors could affect domestic prices. Turkey's economy is a price-taking open economy, it is considered that external factors has a greater impact on inflation, such as import prices and exchange rate. In literature, the effect of the changes observed in exchange rates on inflation is defined as *pass-through of exchange rate*.

Exchange rate pass-through is defined in different ways. It can be expressed as the percentage change in import prices in local currency resulted from a one-percent change in exchange rate between exporting and importing countries (Goldberg and Knetter, 1996). Another definition is the effect of one unit of change in nominal exchange rate on export and import prices (Menon, 1996: 434).

Exchange rate fluctuations affect economic activities through two channels. Since imported products are part of final consumption, exchange rate fluctuations have a direct impact on domestic prices. On the other hand, imported inputs and intermediate goods also have an indirect effect on the prices of products produced domestically. The increase in exchange rates leads the prices of imported intermediate goods to increase. In this case, it also causes the production costs of the goods produced domestically to increase; therefore, the price of final goods produced in the country increase. In contrast, the rising inflation increase inflation expectations and wage demand and have an increasing effect on inflation again (Arı, 2010: 2835).

The study will not focus on detailed description of the theoretical approaches to explain the notion of inflation; the relative capacities of exchange rate to explain the inflation that Turkey has been experienced will be examined. Hence, the contribution of the study in the literature, is to determine whether there is *pass-through* effect of exchange rates on domestic prices in Turkey for 2010:Q1 and 2020:Q1 period. Moreover, in the literature, the issue of the exchange rate pass-through is generally discussed for the short term. In this research paper, the exchange rate pass-through is evaluated for both short and long term that can be considered as another contribution of the study. In addition to all these, if there is a pass-through from exchange rates to domestic prices or its size is quite important for the CBRT's monetary policy success. More importantly, the CBRT cannot control directly exchange rates. If the exchange rate pass through towards the domestic prices in Turkey is high, maintain price stability become more and more difficult.

2. Literature Review

In the literature, studies that examine the effect of changes in exchange rates on domestic prices (pass-through) can be divided into two groups, and these are the studies that investigate the factors determining the effect of exchange rates on domestic prices and the studies investigating the extent and duration of the pass through effect of exchange rates on inflation (Alptekin etc., 2016). Since the aim of this study is to investigate the influence of exchange rate fluctuations on the extent and duration of the pass through on domestic prices, it is included the second group of studies in the literature. Exchange rate pass-through on inflation in literature is summarized in Table 1.

Table 1: Related Literature

Author/s	**Period/Country**	**Method**	**Results**
MacCarthy (2000)	1976-1998/ USA, Japan, Germany, France, England, Belgium, Netherlands, Sweden and Switzerland	VAR Analysis	The analysis results show that that import prices have a rigid pass through effect. This pass-through effect is greater in the economies that have higher share of imports.
Kara and Öğünç (2005)	1991-2001 and 2001-2004/ Turkey	VAR Analysis	The study suggested that exchange rate pass-through effect reduces after the implementation of floating exchange rate regime.
Kara etc. (2007)	1980-2006/ Turkey	Time-Varying Parameter and Seemingly Unrelated Regressions	Pass-through effect of exchange rate is lower compared to period before the floating exchange rate regime. In addition, it is analysed that there are two most important factors that have impact on inflation, and these are exchange rate regime and inflation targeting strategy.
Korhonen and Wachtel (2006)	1999-2004/ Kazakhstan, Ukraine, Armenia, Georgia, Russia, Kyrgyzstan and Moldova	VAR Analysis	It is stated that pass-through effect is crucial particularly in the countries which have entered to capitalist system recently and have higher degree of import dependency.
Dolores (2009)	2000-2007/ Bulgaria, Estonia, Cyprus, Hungary, the Czech Republic, Lithuania, Poland, Slovakia, Latvia, Romania, Slovenia, Turkey	VAR Analysis	Exchange rate pass-through in developing countries is found to be higher when compared to other Eurozone developed countries. Analysis results show that there is a positive relationship between exchange rate pass-through and inflation.
Prasertnukul etc. (2010)	1990:01-2007:06/ Four Asian Countries	Panel Data Analysis	The study examines how the adoption of inflation-

			targeting influenced exchange rate pass-through and volatility results indicate that inflation targeting caused a decline in exchange rate volatility in all four countries.
Saha and Zhang (2013)	1990-2011/ Australia, China and India	VAR Analysis	In the analysis, impulse responses tests indicated that exchange rates have less effect in the rising domestic prices in China and India.
Alptekin etc. (2016)	2005:01-2015:04/ Turkey	VAR Analysis	In the study, the reaction to producer prices against the shock of one unit in exchange rates is calculated and the effect's completion time is determined. In the study, it is determined that the pass-through effect from exchange rates to consumer prices is inclined to decline.
Karamelikli and Korkmaz (2016)	2003:01- 2015:11/ Turkey	NARDL Method	In the research paper, the effect of exchange rate pass-through on inflation for Turkey is examined. It is found that an increase in the exchange rate increases the consumer price index.
Bozdağlıoğlu and Yılmaz (2017)	1994:01-2014:12/ Turkey	VAR Analysis	Accordingly the study, it is concluded that an increase in nominal exchange rates affects inflation for the selected period of time.
Durgun Kaygısız (2018)	2002-2016 Turkey	VAR Analysis	Variance decomposition results provided that 20% of the change in inflation is caused by the exchange rate.
Benk and Kösekahyaoğlu (2019)	2001:01-2018:12/ Turkey	VAR Analysis and Granger Causality Test	It is stated that there is a mutual causality relationship between exchange rate and inflation.

If the empirical literature summarized in the table above is evaluated, the following conclusions are reached: Pass through effect of exchange rates can varies according to the development level of the countries. In emerging countries this effect is much greater compared to the developed countries. Particularly, in Turkey, the extent and duration of exchange rate pass through is quite remarkable.

3. Model and Data Set

Campa and Goldberg (2005), Berman etc. (2012), Gopinath and Rigobon (2008) and Goldberg and Knetter (1996) theoretical frameworks and following Çiçek and Boz (2013) and Karamelikli and Korkmaz (2016), our basic model formulated as follow:

$$CPI_t = \alpha_1 + \alpha_2 NOMEXCHRATE_t + \alpha_3 IMPORTTOTAL_t + \alpha_4 GDP_t + \mu_t \quad \textbf{(1)}$$

The CBRT has adopted the explicit inflation targeting regime since 2006 and has also chosen the CPI as its target variable. If there is a high pass-through of exchange rates on domestic prices, it becomes difficult to reach the inflation target. Since one of the aims of the study is to evaluate the CBRT monetary policy effectiveness, CPI is employed similar with the literature.

CPI means consumer price index, *NOMEXCHRATE* states nominal exchange rate ($/TL), *IMPORTTOTAL* represents total import price index in US dollars, *GDP* is real gross domestic product. GDP is in Chain Linked Volume by Expenditure Approach (TRY Thousand). The time period of the analysis involves the first quarter of 2010 and the first quarter of 2020. In the analysis, the data is applied between 2010:Q1 and 2020:Q1. CPI and nominal exchange rate data are taken from Central Bank of Republic of Turkey (CBRT). Moreover, the data of import price index of total and real GDP are taken from Turk Stat. In addition, the period of data is quarterly.

4. Method

In this study, ARDL boundary test method is applied to investigate the cointegration relationship between the variables, and also it is examined the casual relationship between inflation, credit growth, government expenditures and real effective exchange rate. In the frame of co-integration tests, such as Engle-Granger (1987) and Johansen (1988) which are frequently used cointegration tests in the literature state that there can be a static combination of two variables that are not stable at levels. These tests require variables to be integrated at the same level. Several advantages of the ARDL bound test model are referred in the literature. One of these advantages is that even though the variables in the model have different stationarity levels, becoming the variables stable at their levels or first differences, ARDL bound test can be applied. Another advantage of this model is that it can give statistically more reliable results than classical cointegration tests since it uses Unrestricted Error Correction Model (UECM). The most important feature of the Unrestricted Error Correction Model is that it contains information about the short- and long-term dynamics of the variables. Furthermore, this method gives healthy results with a low number of observations (Narayan and Narayan, 2004).

5. Empirical Results

In the analysis part of the study, firstly the variables' order of stationarity is analysed, and then the boundary test approach is performed in order to determine whether the cointegration relationship between the series exists. In the scope of ARDL model, both long and short term interactions between the variables are examined.

5.1. Unit Root Test Results

The stationarity of the variables is very important in the analysis of time series. Granger and Newbold (1974) implied that a spurious regression problem may be encountered when working with non-stationary time series. In this case, the result obtained by the regression analysis does not reflect the real relationship (Gujarati, 1999: 726). In the study, the Augmented Dickey-Fuller test (Dickey and Fuller, 1981) and KPSS (Kwiatkowski-Phillips-Schmidt-Shin, 1992) test are used to determine the order of stationarity of the variables.

The Augmented Dickey-Fuller Tests' hypothesis is following:

H_0: Data series are non stationary

H_A: Data series are stationary.

This hypothesis indicates a rejection if p-value is less than 0.05, and hence, not rejection if it is greater than 0.05 at 5% level of significance. More importantly, not rejection for the null hypothesis means unit root for the data, and it is non-stationary; in contrast, rejection means no unit root for the data and it is stationary.

The other unit root test in the analysis is KPSS, Kwiatkowski-Phillips-Schmidt-Shin. The hypothesis for KPSS is the opposite.

The hypothesis:

H_0: Data series are stationary.

H_A: Data series are nonstationary.

This hypothesis refers a rejection if p-value is less than 0.05, and therefore, not rejection if it is greater than 0.05 at 5% level of significance. Particularly, not rejection for the null hypothesis means unit root for the data; on the contrary, rejection implies unit root.

In consequence of the ADF unit root test results, it is observed that LNCPI, LNNOM and LNIMPORT are I(1). On the other hand, LNGDP is equal to I(0). In other words, the unit root test results suggest that LNGDP becomes stable at their level; the LNCPI, LNNOM and LNIMPORT become stable when their first differences are taken.

Table 2: ADF Unit Root Test Results

Variables	**Level**	**1st Difference**	**Decision**
LNCPI	-1.079 [0.920] (c+t)	-5.431 [0.000] (c)	I(1)
LNNOM	-2.111 [0.524] (c+t)	-5.599 [0.000] (c)	I(1)
LNIMPORT	-2.768 [0.217] (c+t)	-2.948 [0.048] (c)	I(1)
LNGDP	-3.379 [0.019] (c)	---	I(0)

The expressions in square brackets indicates probability values; (c+t) denotes constant and trend, (c) means constant.

In addition to ADF test, KPSS unit root test is also applied. And, this test provide that all variables in the study are I(1); the variables are stable at their levels. In the literature, KPSS unit root test is accepted as robust. Hence, it is considered KPPS unit root test results.

Table 3: KPSS Unit Root Test Results

Variables	**Level**	**1st Difference**	**Decision**
LNCPI	0.189	0,080	I(1)
LNNOM	0.221	0.106	I(1)
LNIMPORT	0.555	0.173	I(1)
LNGDP	0.426	0.118	I(1)

5.2.Cointegration Test

In the empirical analysis, it is examined whether there is a cointegration relationship between these series. In the ARDL analysis method, the existence of cointegration is tested with the boundary test approach. The first lag of dependent and independent variables are tested by the F test. After the cointegration relationship between the series is detected, ARDL (Autoregressive-Distributed Lag) models are established to examine long and short term relationships. In ARDL model, the H_0 hypothesis is that there is no co-integration between dependent and independent variables (H_0: $\alpha_6 = \alpha_7 = \alpha_8 = 0$); on the contrary, the H_1 hypothesis is that there is co-integration between them. The calculated F-statistic is compared with the asymptotically derived significance levels in the study. If the calculated F statistic is

smaller than the lower bound, then the null hypothesis cannot be rejected and it is assumed that there is no cointegration. The other case is that the calculated F statistic takes a greater value than the upper limit of the critical values, in which case the null hypothesis that there is no long-run relationship between the variables is rejected. If the calculated F statistic value takes a value between the critical values, it falls into the indeterminate region by another expression, in which case there will be no comment on whether or not there is cointegration. Hence, it is suggested that the use of error terms for cointegration, the application of other cointegration tests according to stationarity ratings of variables. If a long-run relationship is found between the variables after applying the boundary test, then ARDL models are constructed in order to be able to understand both long and short-term relationships among the variables. Some critical values such as Akaike, Schwarz and Hannan-Quinn are employed to determine the lag length of the model, and the lowest value is selected. LM test is then performed to investigate whether the model has autocorrelation problem. Also, the CUSUM and CUSUMSQ tests can be performed to understand if the variables in the ARDL model are stable (Pesaran etc., 2001).

In this study, the lag length is determined as 4 on the basis of Schwarz Information Criterion because it provides the smallest value. After determining the lag length, by using the boundary test approach, the cointegration relationship between the series is investigated. The result of the boundary test is represented in Table 4.

Table 4: Boundary Test Results

k		**%5 Critical Values**	
	F statistic	**Lower Bound**	**Upper Bound**
3	10.609	3.23	4.35

In the table, k indicates the number of independent variables in the equation of Unrestricted Error Correction Model (UECM). Since the value of F statistic is greater than the upper critical value according to the boundary test results, it is found that the variables are cointegrated. As the existence of the Cointegration detected, ARDL model for the data series can be constructed.

5.2.1. ARDL Model

In the table below, ARDL model and diagnostic test results are presented.

Table 5: ARDL (4,3,0,4) Model

Variables	**Coefficient**	**t-statistics**	**p-value**
LNCPI(-1)	0.471	3.267	0.003
LNCPI(-2)	0.091	0.649	0.522
LNCPI(-3)	-0.323	-2.267	0.033
LNCPI(-4)	0.482	4.581	0.000
LNNOM	0.109	5.843	0.000
LNNOM(-1)	0.075	2.596	0.016
LNNOM(-2)	-0.075	-2.352	0.028
LNNOM(-3)	0.060	2.123	0.045
LNIMPORT	0.128	6.079	0.000
LNGDP	-0.117	-2.588	0.016
LNGDP(-1)	0.054	2.689	0.013
LNGDP(-2)	0.049	2.675	0.665
LNGDP(-3)	0.008	0.438	0.003
LNGDP(-4)	0.148	3.315	0.002
C	-1.977	-3.345	

Diagnostic Test Results	
X^2 BG (Breusch-Godfrey)	2.859 [0.080]
X^2 HET Test	0.768 [0.594]
X^2 RAMSEY RESET	0.099 [0.756]

X^2 BG, X^2 HET and X^2 RAMSEY are statistics of autocorrelation, heteroscedasticity and model construction error, respectively.

Based on the diagnostic test analysis, it is found that there is no auto-correlation and heteroscedasticity problems in the series of variables and the selected model is suitable.

5.2.2. Long-Term Relationship

In the table below, the estimation results of ARDL (4,3,0,4) model for the long-term relationship is shown.

Table 6: Long-Term Relationship

Variables	**Coefficient**	**t-statistics**	**p-value**
LNNOM	0.612	16.451	0.000
LNIMPORT	0.463	5.515	0.000
LNGDP	0.513	5.516	0.000
C	-7.109	-3.545	0.001

On the basis of the analysis results, it is found that there is a significant relationship between inflation, nominal exchange rate, import prices and income. The coefficients of nominal exchange rate, total import price index and GDP variables are statistically significant and positive. Therefore, nominal exchange rate, total import prices and GDP have a remarkable effect on inflation in the long run. If nominal exchange rate, import prices and income rises, also inflation rises. 1% increase in nominal exchange rate leads inflation to increase by 0.61%. Furthermore, when total import price index increases by 1%, inflation increases by 0.46% increase. And, if income increases by 1%, inflation increases by 0.51%. Alongside world markets, domestic production (GDP) in case of non-tradable goods, can affect local prices. Therefore, in the present study, we examined GDP in order to reveal how consumer prices arise in domestic product influences.

5.2.3. Short-Term Relationship

The analysis results for the short term indicate that there is a significant relationship between nominal exchange rate, total price index and GDP and inflation in the short term except for LNGDP (-2) period. But, unexpectedly, there is not economically significant relationship between GDP and inflation.

Error correction term's coefficient is found as -0.27. The coefficient is found to be significant and negative as it is expected. It means that in the short-term, 27% of the deviations is corrected for the next term, and the system comes to the equilibrium.

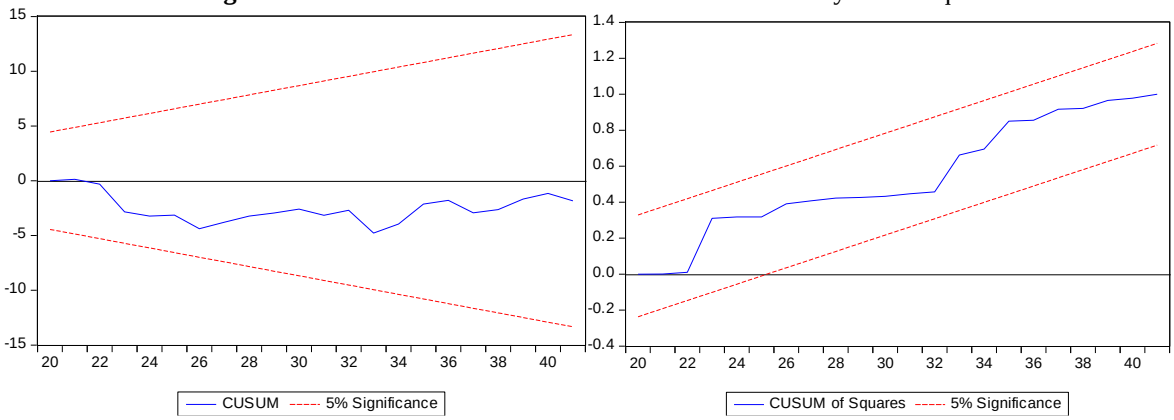
Table 7: Short-Term Relationship

Variables	**Coefficients**	**t-statistics**	**p-values**
D(LNCPI(-1))	-0.250	-1.833	0.080
D(LNCPI(-2))	-0.159	-1.394	0.177
D(LNCPI(-3))	-0.482	-4.581	0.000
D(LNNOM)	0.109	5.843	0.000
D(LNNOM(-1))	0.075	2.352	0.028
D(LNNOM(-2))	-0.060	-2.123	0.045
D(LNIMPORT)	0.128	6.079	0.000
D(LNGDP)	-0.117	-2.588	0.016
D(LNGDP(-1))	-0.049	-2.675	0.013
D(LNGDP(-2))	-0.008	-0.438	0.665
D(LNGDP(-3))	-0.148	-3.315	0.003
ECT(-1)	-0.278	-5.059	**0.000**

5.2.4. CUSUM Tests

Besides the analysis performed, for structural changes, the long term coefficients' stability is analysed performing the Cumulative Sum (CUSUM) tests, which is a general test developed by Brown etc. (1975).

Figure 1: Plot of CUSUM Tests for the Parameters Stability of the Equation



On the basis of the figures, it is concluded the CUSUM test statistics' plot that takes place between 5% significance level critical bounds. It is concluded that the model's predicted parameters are stable for data series employed.

6. Conclusion

The objective of the study is to analyse the pass through of exchange rate on inflation in Turkey, an emerging market economy. The negative effects of inflation are well known, and for Turkey, price instability has been argued to be a strong factor in stifling economic development.

In this research study, it is examined the external factors, exchange rate and import prices, and internal factors, GDP, in Turkey. Since both external and internal factors could affect domestic prices. Turkey's economy is a price-taking open economy, it is considered that external factors has a greater impact on inflation, such as exchange rate and import prices. In the literature, the reflection of the changes of exchange rate on domestic prices is defined as pass through.

Exchange rate fluctuations affect economic activities through two channels, direct and indirect. And, exchange rate fluctuations have a direct impact on domestic prices rates because the imported products are part of final consumption. On the other hand, imported inputs and intermediate goods also have an indirect effect on the prices of products produced domestically.

The movements in exchange rates are quite significant in order to detect the main factors affecting inflation, particularly in the countries that implement inflation targeting regime such as Turkey. The understanding of the effects of the changes observed in exchange rates is very important for monetary policy implications. Also, CBRT cannot control directly exchange rates. Based on the results obtained, it can be concluded that high exchange rate pass-through makes more and more difficult to achieve price stability.

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