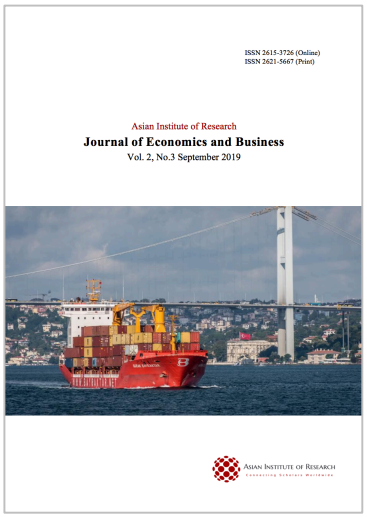

Journal of Economics and Business

Keho, Yaya. (2019), An Econometric Testing of Traditional Import Demand Function for Cote d'Ivoire. In: *Journal of Economics and* Business, Vol.2, No.3, 608-616.

ISSN 2615-3726

DOI: 10.31014/aior.1992.02.03.113

The online version of this article can be found at:
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The Asian Institute of Research
Journal of Economics and Business
Vol.2, No.3, 2019: 608-617
ISSN 2615-3726

DOI: 10.31014/aior.1992.02.03.113

An Econometric Testing of Traditional Import Demand Function for Cote d'Ivoire

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Abstract
This study estimates an aggregate import demand function for Cote d'Ivoire and tests the price homogeneity assumption implied by conventional import models. Estimations are based on annual data for real import, real GDP, domestic and import prices over the period 1980-2017. The empirical results reveal that there exists a long run relationship between imports, income, domestic and import prices. In both the long and short run, imports are positively related to real income and domestic prices, and negatively related to foreign prices. The demand for imports is found to respond much more strongly to changes in domestic price rather than income and import price. The study also shows that the assumption of price homogeneity does not hold, implying that the relative price formulation of import demand function is inappropriate in the case of Cote d'Ivoire.

Keywords: Import Demand, Income, Relative Price, Cote d'Ivoire

JEL Classification: C22, F10, F40, O24

1. Introduction

Since the works by Orcutt (1950), Houthakker and Magee (1969), Leamer and Stern (1970) and Goldstein and Khan (1985), many empirical studies have estimated import demand functions for developed and developing countries (e.g., Mwega, 1993 ; Sinha, 1997; Bahmani-Oskooee and Niroomand, 1998; Tang and Nair, 2002; Chimobi and Ogbonna, 2008; Tang, 2003 ; Dutta and Ahmed, 2004; Tsionas and Christopoulos, 2004 ; Chang *et al*., 2005; Ivohasina and Hamori, 2005; Babatunde and Egwaikhide, 2010; N'Guessan and Yue, 2010; Hye and Mashkoor, 2010; Narayan and Narayan, 2010; Omotor, 2010 ; Fida *et al*., 2011 ; Modeste, 2011 ; Nwogwugwu, 2015 ; Mugableh, 2017). Most of these studies relied on the standard theory of demand that assumes that import demand function is homogeneous of degree zero in income and prices. This hypothesis implies the absence of money illusion and allows the demand for imports to be expressed as a function of real income and relative price. Such a specification imposes the restriction that the influence of the two price variables are equal in magnitude but opposite in sign. One reason for using relative price specification is to avoid the problem of multicolinearity

that may exist between import and domestic prices. However, if this assumption does not hold, the estimates of income and price elasticities may be misleading (Murray and Ginman, 1976). Given its implications, the traditional import demand function should be tested. A general shortcoming with most existing studies is that they assume price homogeneity without testing this restriction.

The main objective of this short study is to estimate the import demand function for Cote d'Ivoire and test the empirical relevance of the price homogeneity assumption. At the methodological level, we employ the ARDL bounds testing approach to cointegration along with other robust estimation methods that account for endogeneity.

The remainder of the paper is organized as follows. Section 2 outlines the econometric methodology employed for the empirical analysis. Section 3 reports the empirical findings of the study. Section 4 concludes the study and provides some policy recommendations.

2. Model, Data and Methodology

2.1 Model Specification

The traditional import demand function is specified as follows :

$$\ln M_t=\beta_0+ \beta_1\ln Y_t+ \beta_2\ln PD_t+ \beta_3\ln PM_t+\mu_t \quad (1)$$

where $\ln M_t$ is the natural logarithm of real imports of goods and services, $\ln Y_t$ is the natural logarithm of nominal income, $\ln PD_t$ is the natural logarithm of the price of domestically produced goods, $\ln PM_t$ is the natural logarithm of the price of imported goods, and μ_t is the error term which is normally distributed with mean zero and constant variance.

Consistent with demand theory, imports are positively related to real income. An increase in domestic income will lead to a greater demand for foreign goods. On the other hand, a positive coefficient is expected on domestic price variable as domestic prices increase, foreign goods become cheaper and import demand increases. The import price is expected to have negative effect on demand for imports because consumers tend to substitute domestic goods for imports when import price increases.

In Eq.(1), we have used two separate price variables instead of the relative import price, as in Rehman (2007). The standard theory of demand assumes that import demand function is homogeneous of degree zero in prices and income, which implies the absence of money illusion (Deaton and Muellbauer, 1980). Therefore, the demand for import can be expressed in terms of real income and relative price. The restricted import demand function is specified as follows :

$$\ln M_t=\gamma_0+ \gamma_1\ln Y_t^*+ \gamma_2\ln RP_t+ +\mu_t \quad (2)$$

where Y^* is real income and RP denotes relative price of imports, which captures the trade-off between imported goods and domestic goods.

Eq.(2) implicitly imposes the restriction that $\beta_1+\beta_2+\beta_3=0$. When the income variable Y enters in Eq.(1) in real terms, then the relative price formulation *i.e*. price homogeneity hypothesis, imposes the restriction that the effects of import price and domestic price are equal in magnitude but opposite in sign, that is : $\beta_2+\beta_3=0$. The relative price formulation implies that domestic and imported goods are substitutes. As mentioned earlier, the basic specification of import demand, given by Eq. (2), is very popular in international trade studies (see, Narayan and Narayan, 2005 N'Guessan and Yue, 2010 ; Chani *et al*., 2011 ; Bathalomew, 2010 ; Zhou and Dube, 2011). If the price homogeneity restriction does not hold, it may lead to inappropriate specification and misleading estimates. Murray and Ginman (1976) argued that the weight assigned to some goods may differ between the import price and the domestic price level, and consumers may react differently to a change in import price from the way they would react to an equal but opposite change in the domestic price. Urbain (1993) also stated that modeling the dynamics of imports demand using relative prices implies identical dynamic response of imports to changes in imports prices and domestic prices. This situation is unlikely to hold, as consumers use different information sets to form their expectations about domestic and imports prices. In addition, domestic prices may be less variable than import

prices. A number of studies postulated price homogeneity whithout providing empirical evidence in support of this restriction. For example, N'Guessan and Yue (2010), Afzal (2001), Chani *et al*. (2011), Bathalomew (2010), Zhou and Dube (2011) and Baek (2015) found nonsignificant effect of relative price on imports. It is clear that if the price homogeneity assumption does not hold, the results from these studies may be questionable.

2.2 Data description

The data set used in this study comprises of real imports (M), income (Y), domestic price index (PD), and import price index (PM). These data were obtained from the 2019 World Development Indicators of World Bank. The sample period spans from 1980 to 2017. Import unit value index (2000=100) was used as a proxy for import price index, GDP deflator (2000=100) was used as a proxy for domestic price index and GDP was used to measure domestic income.

We used the import price index to convert nominal data on imports in constant local currency. Real imports and real GDP were in constant local currency (2000=100). The relative price of imports was calculated as the ratio of import price index to domestic price index. The data are then expressed in natural logarithmic form. This functional form gives elasticity coefficients directly. It also mitigates the problems of outliers, heteroskedasticity and nonnormality. Studies by Doroodian *et al.* (1994), Sinha (1997) and Raijal *et al.* (2000) have performed the Box and Cox (1964) procedure and have shown that the log linear transformation is more effective compared to linear transformation.

The descriptive statistics of the logarithmic transformation of the variables are reported in Table 1. Over the sample period, real imports stood at an average of 28.392 with a standard deviation of 0.410 and a median of 28.486, implying that data was symmetrical. The probability values from the Jarque-Bera statistic suggest that all the variables are normally distributed. The correlation matrix indicates positive relationships among the variables.

Table 1: Descriptive Statistics and Correlation Matrix

Variables	lnM	lnY	lnPD	lnPM
Panel A: Summary statistics				
Mean	28.392	29.476	4.459	4.622
Median	28.486	29.649	4.579	4.605
Maximum	29.081	30.728	5.127	5.369
Minimum	27.205	28.396	3.637	3.871
Std. dev.	0.410	0.706	0.493	0.463
Skewness	-0.618	0.061	-0.211	0.038
Kurtosis	3.253	1.734	1.538	1.786
Jarque-Bera	2.527	2.558	3.665	2.341
Probability	0.282	0.278	0.159	0.310
Panel B: Correlation matrix				
lnM	1.000*			
lnY	0.854*	1.000*		
lnPD	0.846*	0.989*	1.000*	
lnPM	0.575*	0.889*	0.892*	1.000*
Note: M, Y, PD, and PM denote real imports, nominal GDP, domestic price and import price, respectively. (*) indicates statistical significance at the 5% level.				

Figure 1 shows the trends of real imports and real GDP in Cote d' Ivoire over the study period. As can be seen, real GDP shows an upward sloping trend over the sample period. Meanwhile, imports show an upward sloping trend from 1980 to 1985 with an average growth rate of 9.5%. They recorded a sharp decrease from 1985 to 1993 at an annual growth rate of -11.2%. From 1994, imports show an upward trend in line with the devaluation of the country's currency (CFA franc). Beyond 1999, imports remained relatively stable till the year 2005 where they experienced a sharp decrease in the years 2008 and 2011, and then rose from 2012 till 2017. It is worth mentioning that over the period 1999-2011, Cote d'Ivoire experienced economic hardship and social unrest. With the end of

the civil war in 2011, the country embarked on an economic recovery program through the implementation of its National Development Plan coupled with large-scaled structural reforms.

Figure 1 : Trend of real imports and GDP in Cote d'Ivoire over the period 1980-2017.

Table 2 presents the composition of imports by commodity types. Cote d'Ivoire's import basket was dominated by consumer goods up to 2004, though their relative share declined from 46.45 percent in 2002 to 35.86 percent by 2004. During this period, the import of intermediate goods, which was next to consumer goods, averaged 36 percent, while the share of capital goods increased from 17 percent to 28.5 percent. From 2005, the import of intermediate goods dominated aggregate imports up to 2008, with an average of 44 percent, followed by consumer goods which represented 35 percent of imports. From 2010, the import of consumer goods dominated total imports with a share increasing from 39.03 percent in 2010 to 50.7 percent in 2017. On average, 44 percent of Cote d'Ivoire's imports are consumer goods, 31 percent are intermediate goods, and 25 percent are capital goods. These figures clearly show the heavy reliance of the ivorian economy on imported consumer goods to meet the domestic demand of consumers.

Table 2: Structure of imports by commodity types (as share of total imports)

	2002	2004	2006	2008	2010	2012	2014	2016	2017
Consumer goods	46.45	35.86	35.57	39.20	39.03	39.97	39.72	48.23	50.75
Intermediate goods	36.51	35.61	43.72	48.92	35.63	41.60	38.48	29.35	25.26
Capital goods	17.04	28.52	20.70	11.88	25.34	18.43	21.80	22.42	23.99
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: General Administration of Customs, Cote d'Ivoire.

2.3 Econometric Methodology

The empirical analysis involves a series of steps as described below. As a first step, we test for the order of integration of the series using the PP test of Phillips and Perron (1988). In a second step, we test whether there is a long run relationship among the variables. For this purpose, we employ the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration developed by Pesaran *et al.* (2001). This approach has several advantages. The first advantage is that the ARDL bounds test approach is applicable irrespective of whether the underlying regressors are I (0) or I (1). As bounds test does not depend on pre-testing the order of integration of the variables, it eliminates the uncertainty associated with unit root tests in small samples. Secondly, this technique generally provides unbiased estimates of the long run model and valid *t*-statistics even in the presence of endogenous regressors (Inder, 1993; Cheung and Lai, 1993). Mah (2000) argued that the two-step procedure suggested by Engle and Granger (1987) and the multivariate likelihood method of Johansen and Juselius (1990) are not reliable for small sample studies.

To carry out the ARDL cointegration procedure designed by Pesaran *et al*. (2001), Eq.(1) is reformulated into conditional error correction model (ECM) as follows:

(3)

where Δ is the difference operator and $Z_t=(\ln Y_t, \ln PD_t, \ln PM_t)$. The presence of long-run relationship is tested by restricting coefficients of lagged level variables equal to zero. That is, the null hypothesis of no long-run relationship is H_0: $\phi_1=\phi_2=0$. This hypothesis is tested through an *F*-test. The asymptotic critical values are provided by Pesaran *et al*. (2001). The ARDL bounds testing procedure is sensitive to the selection of the lag structure (*m, n*). In this study, maximum lag length on each variable was set to five and the optimal lag structure was selected using the AIC criterion. The model has been tested by the diagnostic tests that are serial correlation, normality test and heteroskedasticity test. The stability test of the model has also been undertaken using the Brown *et al.* (1975) cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ). Once a long-run relationship is identified among the variables, the estimated long run coefficients are the negative values of the coefficients for the lagged explanatory variable divided by the coefficient for the

lagged dependent variable (Bardsen, 1989; Pesaran *et al*., 2001). The short run effects are the estimates of coefficients related to first-differenced variables.

3. Empirical Results

The unit root test of Phillips and Perron (1988) with a constant only, and a constant with trend option was used to test the stationarity of the variables. This was done to ensure that none of the variables were integrated of an order exceeding one. The results are displayed in Table 3. As can be seen from this table, the null hypothesis of unit root cannot be rejected whether or not trend is included in the regression. However, first differencing of all the variables yields rejection of the null hypothesis of unit root under both specifications. Based on these results, we can conclude that all the variables we are working with are integrated of order one. The next step is to test for the existence of long run relationships among the variables.

Table 3: Results of Unit Root Tests

Series	Level		First difference	
	C	C&T	C	C&T
lnM	-1.526	-2.768	-7.678*	-7.635*
lnY	0.087	-2.049	-3.869*	-3.847*
lnPD	-1.073	-1.875	-4.166*	-4.175*
lnPM	-0.745	-3.375	-7.624*	-7.511*

Note: M, Y, PD, and PM denote real imports, nominal GDP, domestic price and import price, respectively. The critical values for model with constant (C) and with constant and trend (C&T) at the 5% level are -2.943 and -3.536, respectively. * indicates the rejection of the null hypothesis at 5% level of significance.

To ascertain the existence of a long-run relationship among the variables, the bounds test is employed under the ARDL approach framework. The results are displayed in Table 4. The calculated F-statistics are compared with the critical values provided by Pesaran *et al*. (2001). The results show that a long-run relationship exists among the variables when imports variable is used as dependent variable. In this case, the computed F-statistic exceeds the upper critical value at 5% level of significance. Furthermore, at the 5% significance level, all diagnostic tests do not exhibit any evidence of violation of the classical linear regression model assumptions. The results also suggest a long run relationship when GDP is the dependent variable. We can therefore conclude that there is at least one long run relationship between the variables.

Table 4: Results of the ARDL Cointegration Test

Model	F_stat.		Diagnostic tests		
			Normality	Heteroskedasticity	Correlation
M=f(Y, PD, PM)	8.295*		0.001 [0.999]	9.397 [0.742]	3.232 [0.198]
Y=f(M, PD, PM)	3.353**		0.602 [0.739]	23.537 [0.132]	1.963 [0.374]
	Critical values (T=38)				
	Lower bounds I(0)	Upper bounds I(1)			
5%	2.45	3.63			
10%	2.01	3.10			

Note: M, Y, PD and PM denote real imports, nominal GDP, domestic price and import price, respectively. Lag length on each variable was selected using the AIC criterion with maximum lag set to 5. Critical values are those of the model with no intercept and trend. Figures in [.] are *p_values*. . * indicates the rejection of the null hypothesis of no cointegration at 5% level of significance.

To crosscheck our results we also carried out the Johansen and Juselius (1990) multivariate trace and maximum eigenvalue cointegration tests. The results provided in Table 5. Trace test statistic shows three cointegration vectors while maximum eigenvalue statistic confirms the presence of one cointegration vector. We can conclude

that both the trace and maximum eigenvalue statistics support the existence of at least one cointegrating relationship between import and its determinants.

Table 5: Results of the Johansen and Juselius Tests for Cointegration

Hypothesis		Trace Test			Max- Eigen Test	
H_0	H_1	Statistic	Prob.		Statistic	Prob.
r=0	r=1	53.152*	0.001		25.964*	0.028
r≤1	r=2	27.188*	0.021		14.324	0.154
r≤2	r=3	12.863*	0.041		10.439	0.068
r≤3	r=4	2.423	0.141		2.423	0.141
Note: *r* indicates the number of cointegrating relations. The Akaike information criterion was used to select the number of lags required in the cointegrating test with a maximum set to 5. * indicates the rejection of the null hypothesis at the 5% level.						

After finding evidence of cointegration between the variables, we further estimate the long run coefficients associated with each independent variable. To that end, we employ the ARDL approach along with the Fully Modified OLS method proposed by Phillips and Hansen (1990) and the Dynamic OLS technique suggested by Stock and Watson (1993). These three estimation methods account for the possible endogeneity among the variables. We also apply the Johansen and Juselius (1990) multivariate method. The results are reported in Table 6.

Table 6: Long run import demand function using nominal income

Regressor	Dependent variable: LnM									
	ARDL		FMOLS			DOLS			Johansen	
	Coef.	t-stat.	Coef.	t-stat.		Coef.	t-stat.		Coef.	t-stat.
lnY	1.087*	106.03	1.112*	69.410		1.092*	82.012		1.081*	76.671
lnPD	0.353*	2.083	-0.132	-0.742		0.031	0.171		0.403*	2.210
lnPM	-1.150*	-6.473	-0.819*	-4.526		-0.853*	-4.301		-1.160*	-5.971
Homogeneity test										
H_0: $\beta_1+\beta_2+\beta_3=0$	5.095* [0.000]		-1.843** [0.074]			3.581* [0.001]			5.944* [0.014]	
Note: The model estimated is: $lnM_t=\beta_0+\beta_1 lnY_t+\beta_2 lnPD_t+\beta_3 lnPM_t+\mu_t$. where M, Y, PD, and PM denote real imports, nominal GDP, domestic price, and import price, respectively. All models were estimated without a constant term. In Johansen method the optimal lag was set to 3 for the level VAR according to the AIC. The restriction $\beta_1+\beta_2+\beta_3=0$ implies that the import demand function is homogeneous of degree zero in income and prices. Figures in [.] are *p_values*. The asterisks * and ** denote statistical significance at the 5% and 10% levels, respectively.										

To check whether the traditional formulation of import demand is appropriate, we test for the hypothesis of homogeneity of degree zero in prices and income. In the ARDL model, the value of the *t*-statistic is 5.095 with *p-value* of 0.000, implying that the restriction can be rejected. The results from the other estimation methods lead to similar conclusion. Further, we estimate the import demand function using real GDP, domestic price, and import price. The results are reported in Table 7. We test the linear restriction on price variables *i.e.* $\beta_2+\beta_3=0$. In all cases, the assumption of price homogeneity should be rejected, implying that the relative price formulation of import demand is not appropriate in the case of Cote d'Ivoire.

Table 7: Long run import demand function with real income

Regressor	Dependent variable: LnM									
	ARDL		FMOLS			DOLS			Johansen	
	Coef.	t-stat.	Coef.	t-stat.		Coef.	t-stat.		Coef.	t-stat.
lnY	0.908*	111.60	0.928*	73.921		0.913*	85.121		0.904*	77.701
lnPD	1.481*	9.213	1.040*	6.304		1.183*	6.734		1.548*	8.626
lnPM	-1.128*	-6.687	-0.810*	-4.762		-0.850*	-4.445		-1.164*	-6.069
Homogeneity test										
H_0: $\beta_2+\beta_3=0$	6.601* [0.000]		2.853* [0.007]			4.629* [0.000]			6.124* [0.013]	

Note: The model estimated is: $lnM_t=\beta_0+ \beta_1 lnY_t+ \beta_2 lnPD_t+ \beta_3 lnPM_t+\mu_t$, where M, Y, PD and PM denote real imports, real GDP, domestic price and import price, respectively. All models were estimated without a constant term. In Johansen method the optimal lag was set to 3 for the level VAR according to the AIC. The restriction $\beta_2+\beta_3=0$ implies that the import demand function is homogeneous in prices. Figures in [.] are *p_values*. The asterisks * denotes statistical significance at the 5% level.

In all models, the long run domestic price elasticity is higher in absolute value than those of real income and import price. This means that import demand responds more much strongly to changes in domestic prices rather than foreign prices and real income. In what follows, we will base our interpretation on the ARDL results. The income level was found to be positively related to import demand, though inelastic in the sense that its elasticity is less than one. Other things remain the same, one percent increase in real income induces growth in import demand by 0.9 percent. The inelastic long run income elasticity implies that imports are regarded as necessary goods in Cote d'Ivoire. The coefficient on domestic price is expectedly positively signed and significant. Thus, one percent increase in domestic price is likely to induce a 1.5 percent increase in imports. The effect of import price is also consistent with *a priori* expectations and statistically significant. Thus, one percent increase in import price induces a 1.2 percent decrease in imports.

The existence of long run relationships between imports and its determinants provides support for the estimation of the short run dynamic model for import demand function. The short run elasticities of import demand with respect to real GDP, domestic and import prices are reported in Table 8. The coefficient on the lagged error term is significant with the expected negative sign, supporting the evidence of a long-run relationship among the variables. The results also show that real income is a major factor influencing short-run import growth. In other words, economic growth is playing a significant role in explaining aggregate import demand for goods and services in Cote d'Ivoire. This finding is consistent with the Keynesian absorption theory. The short run effect of domestic price is positively significant and greater than that of real income. Therefore, in the short run the growth rate of imports is positively affected by growth in domestic price. On the contrary, import price is negatively related to import growth in the short run.

Table 8: Short run import demand function

Regressor	Dependent variable: ΔlnM		
	Coef.	t-stat.	Prob.
ΔlnY	1.043*	3.265	0.002
ΔlnPD	1.365*	6.853	0.000
ΔlnPM	-0.978*	-9.848	0.000
ECT(-1)	-0.289*	-2.181	0.037
Diagnostic tests			
Serial correlation	0.856 [0.651]		
Heteroscedasticity	7.505 [0.111]		
Normality	0.280 [0.869]		

Note: M, Y, PD and PM denote real imports, real GDP, domestic price and import price, respectively. Figures in [.] are *p_values*. The asterisks * denotes statistical significance at the 5% level.

4. Conclusion and policy implications

This study has estimated the import demand function for Cote d'Ivoire based on annual data for the period 1980 to 2017. It used the autogressive distributed lag (ARDL) approach and other estimation methods that account for endogeneity. The results show that there exists a long-run relationship between import demand and domestic income, domestic and import prices. We tested the relevance of the price homogeneity hypothesis postulated in most empirical studies. The empirical results show that, in the case of Cote d'Ivoire, the relative price formulation of the traditional import demand function is not appropriate for estimating income and price elasticities of import demand. Therefore, estimates for policy purpose from earlier studies that did not test the relative price formulation, may be questionable. As far as the size of the estimated elasticities are concerned, the income elasticity in long run was found inelastic. Therefore, imports are treated as necessary goods in Cote d'Ivoire. Furthermore, consumers are more responsive to changes in the price of domestic goods than to the price of imported goods. An increase in domestic price level generates higher imports while an increase in import price reduces imports. This provides additional evidence in favor of controlling inflation rate. In addition, our findings imply that trade policies that aim to lower or remove tariff barriers will lead to a rise in imports. This study is the first of its kind which investigates the relevance of price homogeneity hypothesis in the case of African countries.

Our empirical analysis was conducted using the traditional import demand formulation which relies on income and prices as the main determinants of imports. To increase our knowledge on import demand, study should be carried out testing other influencing factors. Moreover, we have used aggregate GDP as a proxy for income in the import demand function. Using this variable we cannot know whether different components of final expenditure have different import contents. Therefore, it will be informative to disaggregate GDP into different components and estimate the effect of each component on imports. We intend to examine these issues in future researches.

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