

Deflation and Economic Growth in Japan

Komeil Deghani • Ehsan Rajabi • Lee Chin • Junaina Muhammad

Abstract Fear of deflation leads to the hypothesis that deflation can have influential negative impact on growth. This paper aims to examine the relation between deflation and growth slowdown of the Japan economy through threshold effect. By using quarterly time series data from 1965 to 2010, log functional form and OLS threshold regression method, the research found existence of the threshold effect which is significant statistically and strong economically. The threshold point of mild deflation is actual true zero inflation. Below this point, the negative impact of deflation will occur on growth. However this finding is sensitive to period of study. Negative threshold impact of deflation turn to be insignificant if period 1990 to 2010 is taken. In addition, deflation has positive impact on economic growth. These finding which are observed from period with prevalence of deflation is in striking contrast with predication of fear of deflation theory of Keynesians but consistent with Austrian Business Cycle and productivity norm deflation theories. Hence, reasons for fear of danger of deflation in the case of Japan cannot be justified.

Keywords Deflation - Economic growth - Threshold

JEL Classification E31 - F43

1. Introduction

Does deflation have negative impact on growth? Friedman in his works shows that optimal growth will happen under mild deflation Friedman (1969). Selgin and most Austrian economists advocate productivity norm and mild deflation through free banking system (Salerno, 2003; Selgin & Affairs, 1997) As Selgin and Affairs (1997) mentioned, there is expectation of policy makers and economists to prepare themselves for mild deflation goal to achieve better allocation of resource and more growth, since indeed, most of developed countries have

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reached to this goal already (Borio & Filardo, 2004; T. Cargill & Parker, 2003; T. F. Cargill, 2001). Nonetheless, the end of 20th century was witnessed of growing fear of most economists and central bankers around the world about danger of deflation.

Cargill and Parker (2003); DeLong and Sims (1999) warned about danger of deflation. They believed, deflation must be taken into serious consideration even more than inflation, since CPI index has upward bias which means with low level of inflation in developed countries, actually the most important part of the world is in zero inflation which is a critical point to slip into trap of deflation. This fear is also shown in policy meeting in the world. Federal Open Macroeconomic Committee (FOMC) at its meeting in May 2003 warned US about danger of deflation, IMF Report on Deflation (2003) warned Europe especially Germany and Switzerland over the risk of deflation (M. D. Bordo, Lane, & Redish, 2004). Most of the economists had reflected this fear into experience of Japan in 1990th and beginning of 21th century which triggered hot debate between bank of Japan and other economists (e.g. Bernanke, 2000; T. F. Cargill, 2001; T. F. Cargill & Parker, 2004a, 2004b, 2004c; Ito & Mishkin, 2005; Ito & Mishkin, 2006; P. R. Krugman, Dominquez, & Rogoff, 1998). Figure 1 shows Japanese experience of deflation from 1990 to 2010.

Japan experienced bubble and burst from 1985-1990 (Ito & Mishkin, 2006). After that banking system faced crises, and there after Japan fall into stagnation followed by deflation. Hence most of them blamed bank of Japan policies for not being so active that had led Japan into long lasting deflation and stagnation. Figure 2 shows this long run stagnation of Japan specially after 1990.

This study conjectures that if the fear of opponents of deflation in Japan is valid, therefore it must exist not only negative impact of deflation on growth but also negative threshold effect of deflation on growth of Japan. Since as they theorized, there is no symmetric effect between inflation and deflation and low deflation almost have similar effect with high inflation on growth.

Many studies about threshold effect of inflation and growth have reached to this conclusion that low inflation will promote growth and after a rate of high inflation, threshold effect or structural break will appear that will lower growth (Khan & Ssnhadji, 2001; Sarel, 2006). Nevertheless, to the knowledge of this paper, no studies pay much attention to study of threshold effect of deflation on growth, in spite of the worldwide growing fear of deflation specially for the case of Japan. This study aims to fill this gap by examining the existence of threshold effect of deflation on growth during 1965 to 2010 for the Japan economy.

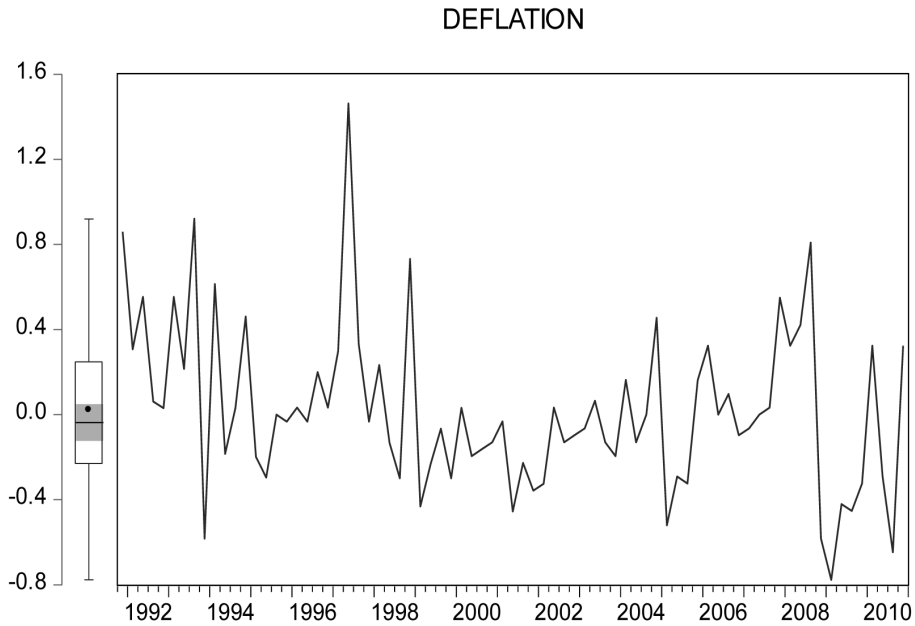
The Figure 3 below illustrates the aim of research better. Point A show optimal point of inflation according to monetarist view. According to this view for sustainable growth economy needs very low level of inflation which range from 2 to 5 percent each year. Above this range growth will be decreased. However, by increasing inflation, economy will reach a point call point B, which after that point, another impact of inflation on growth will be appeared, which cause growth decline more than before. This effect is call threshold effect of inflation on growth. Studies documented this point 12 percent for developed countries and 40 percent for underdeveloped countries. However if prices decrease below point A what will happen on growth? Below point A, growth will decrease as well, however if inflation reaches to Zero then changes to deflation, there is expectation of threshold effect of deflation on growth according to theory of fear of deflation. Searching and documenting this threshold point is new contribution of this research. In addition this study wants to know whether the impact of this threshold point is dependent on period of study or not. For this reason we divide the whole period into two subdivisions, period with low frequency of deflation which is 1965 to 1990 and period with high frequency of deflation which is 1990 to 2010. These subsamples give us better illustration of frequency of deflation than other subsamples such as 1965 to 1985 and 1986 to

2010. Therefore, based on theory of fear deflation we predict that period with high frequency of deflation, negative threshold impact should be significant and greater than period with low frequency of deflation.

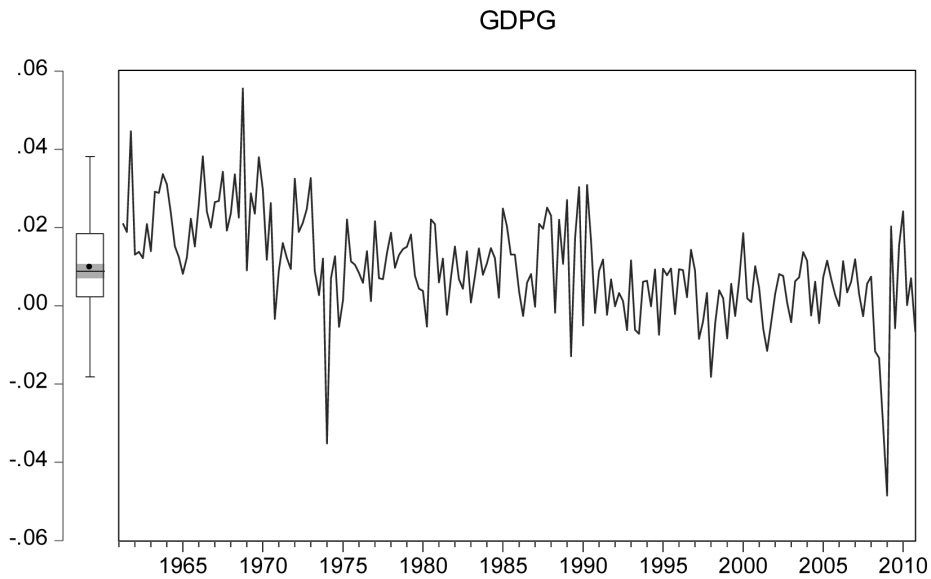
Study chooses Japan for these following reasons, since Japan is the only country which has experienced a relatively long deflation and decline in growth after World War II. As P. Krugman (2000) said: Japan is a leading indicator of “depression economics”. Great importance of the Japanese economy as one of the largest economies in the world implies that malfunction of the Japan economy can lead whole world into depression. That is why Krugman named it leading indicator of “depression economics”.

The rationale for choosing deflation is that, deflation is critical point in economic system which affects many social and economic factors; therefore judgment about deflation is judgment about value and logic of whole system. This strong statement about deflation follows from two contradicting views about deflation in history of economic idea. Based on proponent view of deflation, deflationary monetary system is essential for an economy to conduct its information effectively according to scarcity of resources to the decision makers thus it will enhance division of labor and productivity in long run and will prevent an economy to be trapped into great depression by cluster of market participants’ errors. Hence economy with deflationary monetary system is more stable, more productive than inflationary monetary system. In addition, this kind of system does not need any central planning like central banking, therefore, individuals have control of their money and wealth in their hand. Hence by virtue of these features individuals in deflationary monetary system have more freedom and independence than in inflationary monetary system. Furthermore they can better supervise their government from abusing their power against society since taxation is prime way of getting income in this regime. In overall the only consistent and ethical regime with value of freedom and free individuals is deflationary monetary system. On the other hand, opponent view of deflation claims that modern monetary system cannot stand deflation. Since by advent of deflation, modern economy will be led into downward spiral of depression and deflation which will be ended up not only in bankruptcy of most companies but also government (Fisher). Hence deflation will lead modern economy into great depression, high unemployment, poverty which will tear the fabric of social cooperation and integration. Therefore for sake of freedom of individual and social security it is needed to take certain measures to avoid of this treat as soon as possible. By examining relation of deflation and growth in the case of Japan, the research may be able help policy makers to choose proper view and avoid the wrong one for designing and implementing sound financial system.

The organization of paper will be as follow, related literature to the study will be reviewed in Section 2, theoretical frameworks, model, methodology, data description in Section 3, and result discussions will be explained in Section 4. Finally, the research will be concluded by summary, conclusion, policy implications, limitations of study and area for further study in Section 5.

Fig.1 Deflation of Japan from 1992 to 2010

Source: OECD Economic Outlook, last updated date 12/6/2011. Based on Japan, consumer price index, Index, 2005=100, Adjustment Price Index.

Fig. 2 Growth slowdown from 1960 to 2010

Source: OECD Economic Outlook, last updated date 12/6/2011. Based on Japan, gross domestic product, Constant Prices, JPY, 2000 prices, seasonally adjusted quarterly data.

2. Literature review

The studies which have examined the relation of deflation and growth in other countries except Japan will be reviewed at first and the Japanese experience of deflation will come after. This review has used the new terminology: danger, severe danger and real danger for sake of clarity. As this paper mentioned earlier, danger means long run negative effect on growth, severe means run long negative effect of deflation on whole economy and real means lack of possible economic explanation for positive effect of deflation on growth.

2.1 Worldwide experience of deflation

In order to answer to this question that whether deflation is danger to economy, (M. D. Bordo et al., 2004); M. D. Bordo and Redish (2003) studied the United States, Canada, the U.K. and Germany from 1880-1913, the period which is called classical gold standard. They used panel data regression and sensitivity analyses. They found that not only deflation is not danger but also is good or at best neutral. The exception was Canada in which monetary factor was important in effecting long term output, however this finding was challenged by economic historian (Thornton, 2003).

Thornton (2003) explained that Canada at that time was in the primitive state of development near to barter economy, and money was gold which itself was considered as commodity in national accounting. Discovering mines of gold at that time in Canada had attracted many investors and factory builders, labors which promote economic growth. Therefore, it was not mere money like paper money without any cost of production which stimulates growth, rather it was commodity money such gold that had done this task. Moreover this new gold caused monetization of economy which intensified division of labour and consequently long term growth.

In another study M. Bordo and Filardo (2005) found that deflation will appear in three type good, bad and ugly deflation. Their statistical findings showed that most deflation is not associated with decline in output. Moreover; they found deflation and depression are quite rare in history. They found also that deflation can be dangerous as name it bad and can be severe danger as name it ugly.

In similar study Borio and Filardo (2004) examined relation between deflation and depression with panel data method from 1800 to 2002 on G10 countries. They found that history is full of good deflation with exception of great depression period. Study of Atkeson and Kehoe (2004) admit finding of M. Bordo and Filardo (2005); Borio and Filardo (2004) "*the only episode in which we find evidence of a link between deflations and depression is the Great Depression (1929–3)*". They found that deflation is not necessarily associated with depression since there are many period of deflations with growth and many periods of inflations with depression.

Guerrero and Parker (2006a) challenged the findings of Atkeson and Kehoe (2004) from methodological point of view "*A downside of their procedure is an obvious loss of degrees of freedom in their estimates*". They examine the relation between deflation and depression and found that deflation and depression are less common after Second World War but they happened in quarter of observation before that time. They also found in contrast to Atkeson (2004) that incidence of deflation and depression is not just limited to great depression period, rather OECD countries have experienced deflation; however, as themselves said their finding is not so robust. Furthermore the existence of deflation in OECD countries per se did not prove that

deflation is dangerous or bad. As M. D. Bordo et al. (2004); M. D. Bordo and Redish (2003) have shown, monetary factors are not important. Even for great depression period it is not clear that monetary factors had affected output negatively in long run.

Although Bemanke and James (1991); Bernanke (1994) tend to support monetary factors Cole, Ohanian, and Leung (2005) found that effect of total factor of productivity is more important than deflation in great depression period. They examined the effect of deflation and productivity shocks on output 1929 -1933 with a fully articulated model and panel data regression in 17 countries and show that productivity is the dominant shock, accounting for about 2/3 of the depression, with the monetary shock accounting for about 1/3. The finding of this article is kind of exceptional since most of the other articles had found that monetary shock is more important in era of great depression. Furthermore, it explains that recession in form of decreasing productivity can trigger deflation. These productivity shocks can be stemmed from high regulations such as antitrust regulation, labor union regulations, high tax income and high tariff in period between 1920 to 1940. However, it can be argued that depression or decreasing total supply is not sole factor in bringing deflation, in order to have deflation it is needed that society save more and spend less which is indicated by monetary shock. As Rothbard showed in his book decreasing total supply and total demand will bring deflation to economy.

Guerrero and Parker (2006b) again in another study examined USA history of deflation and depression from (1789-2003). They took the suggestion of Atkeson and Kehoe (2004) and control their study for regime dependency by defining eight dummy variables. The result was that deflations alone do not Granger-cause recessions, but recessions do Granger-cause deflations. By defining interaction term of deflation and recession, they applied another statistical test since effect of deflation on growth is reinforced with recession. This could be interpreted as testing Fisher (1931) hypothesis that debt and deflation jointly have strong negative impact on economy. They found that deflation along with recession has negative effect in growth. However they could not find any long run relation between deflation and depression by means of cointegration test. This was consistent with quantity theory of money. Therefore deflation cannot be danger for economy.

Just few studies, examined the severity of deflation. M. Bordo and Filardo (2005); Borio and Filardo (2004) show that great depression of USA could be ugly deflation. Ugly deflation is near to meaning of severe in this sense that reinforcing spiral of debt deflation along with market mechanism could have damaging effect on economy even to bankruptcy of whole system. Bemanke and James (1991) saw debt-deflation spiral great importance in affecting USA great depression, but M. Bordo and Filardo (2005) has doubted to this conclusion.

This finding leads the research to reality of this danger which means whether deflation is real danger or illusionary danger. In another world, it is understood empirically that deflation could be good for growth, is there any economic theory to support it?

Friedman (1969) proved that optimal growth will happened under mild deflation. Selgin and Affairs (1997) in his study, advocate mild deflation as productivity norm for new monetary policy. According to Selgin and Affairs (1997) Productivity norm is going to reflect itself into mild deflation, allows for changing of relatives price in accordance to scarcity of resources, choices and tastes of public. It means that relative prices signal the true information about scarcity of resources and tastes of consumers which will lead economy to more effective allocation of resource and growth as well. Austrian economists (e.g. Bagus, 2003, 2008; Rothbard, 2004; Salerno, 2003) have this view as well. Moreover, they add that mild deflation brings also stability for economy. In their view mass entrepreneurial error is created through injecting easy credit and paper money by new banking system which makes economy unstable.

The overall review of these empirical researches tends to support that deflation as monetary phenomena cannot effect growth negatively in long run. In other world non-monetary factors are important for effecting output. It remind us the notion of classical economists, Austrian economists like Mises (1953) that money is just medium of exchange not wealth and its quantity is not important. In addition, they have shown deflation is not only danger, but also could be good one, empirically. Nevertheless, there are also period of deflations and depressions, but they are not full proof evidences to conclude deflation causes depression.

2.2 The Japanese experience of deflation

Many studies which are done about Japan blamed deflation and policy of central bank of Japan as main cause of long lasting recession of Japan (e.g. Bernanke, 2000, 2002; T. F. Cargill, 2001; T. F. Cargill & Parker, 2004a; Ito & Mishkin, 2006; Itoh & Shimoi, 2000; P. Krugman, 2000; P. R. Krugman et al., 1998). T. F. Cargill and Parker (2004b) examined association between consumption and deflation by using OLS method and annual data for Japan (1955-2002) and the United States (1929-2002). They found that deflation can lead to decrease in consumption and aggregate demand.

Nevertheless, all economists were not convinced that deflation was responsible for the Japanese stagnation and recession. The Bank of Japan reasoned that nonmonetary factors were primary cause for deflation and recession (T. F. Cargill & Parker, 2004b). Ahearne et al. (2002); Borio and Filardo (2004); Koo (2003); Okina and Shiratsuka (2003) are not convinced that the mild deflation is responsible for output stagnation. Atkeson and Kehoe (2004) Claimed that recession of the Japanese economy cannot be attributed to deflation. Hayashi and Prescott (2002) argued that the economic slowdown in Japan in recent years can be explained by decline in TFP, while the demand-led factors, in their view, are not significant. In contrary, Motonishi and Yoshikawa (1999) hold that negative demand-led factor is the most important cause of the present stagnation of Japan. their finding is reinforced by Fukao, Inui, Kawai, and Miyagawa (2004) which conclude that decline in TFP growth at the macro level from the 1980s to the 1990 was not to be so great, and only could explain 0.20 point of output change. Johnsson (2005) studied the experience of the Japanese deflation from 1990 -2001 with Austrian school view point. He found that there are both productivity driven deflation and demand led deflation in Japan in this period.

In summary, most study about deflation and depression favored the non monetary factors but most fear about deflation in Japan stems from monetary factors. From this contradiction, this study wants to understand how much the reason behind this fear is valid. Hence this review shows that evidence about danger of deflation in general and especially about Japan is mix and needs more study. By searching for threshold effect point, in next section, the research will examine to what extend this fear is reasonable.

3. Data and Methodology

Augmented Dickey-Fuller and Phillips-Perron Unit Root tests will be run by research to check for integrity of data on level, if all variables were stationery on level then OLS regression can be applied on data. Multicollinearity, Misspecification of Model, Serial Correlation and Heteroskedasticity will be checked by appropriate tests and methods. These tests and method are: Adjusted R-squared, AIC, SBC and HQC statistics, Residual normality test, Ramsey Reset

Test, CUSUM of Square Test for checking the misspecification of model, Breusch-Godfrey Serial Correlation LM Test for serial correlation problem, and Breusch-Pagan-Godfrey Heteroskedasticity test for checking Heteroskedasticity.

If the model had one of these problem, the research tries to resolve the problem, and if not the OLS regression is BLUE estimator of β (Asteriou & Hall, 2007). Therefore the model will be run with OLS method after meeting the Classical assumptions of OLS.

3.1 Model specification

For examining the existence of threshold effect during deflation, proxy of these variables should be defined and included in regression line. For doing this task quarterly time series regression from 1965 to 2010 and control variables such as population growth, term of trade growth, initial income

$$dY_t = \alpha + \gamma * Def_t + \beta dX_t + \delta * D_0 * Def_t + \varepsilon_t \quad (1)$$

X is proxy of control variables other than Dummy. $D_i * Def$ is interaction term of Dummy with deflation or inflation. d is proxy of change which this study is used growth instead. t implies that data are time series. Therefore, the model of interest is below model:

$$FDPG_t = \alpha_1 + \alpha_2 Def_t + \alpha_3 d_t * Def_t + \alpha_4 POPG_t + \alpha_5 IGDPG_t + \alpha_6 INING_t + \alpha_7 OPENG_t + \alpha_8 TOFTG_t + \varepsilon_t \quad (2)$$

The Dummy deflation model defined as below:

$D_i = 1$ if $Def \leq 0.00$ percentage inflation

$D_i = 0$ if $Def > 0.00$

GDPG = the growth rate of GDP

Def = price level change which is deflation or inflation. Deflation is measured as decline of price level from previous time period and inflation is measured as increase of price level from previous period.

IGDPG = the growth rate of GDP dedicated to investment

POPG = the growth rate of population.

ININCG = the growth rate of initial income level.

OPENG = the growth rate of openness

TOFTG = the growth rate of term of trade.

The Dummy variable is defined as threshold points for negative impact of true deflation on growth based on researches which are done on Upward CPI Bias. These Dummy are therefore: is defined as deflation less than equal zero percentage point nominal inflation.

Initial income level is defined as GDP per capita from the previous period and openness is measured as proportion of exports plus imports in GDP and term of trade is measured as exports divided by imports and Quarterly CPI index is used for measuring changing of price level.

3.2 Description of data

All variables of this paper are obtained from quarterly seasonally adjusted time series of original variables from 1965 to 2010 with exception of population. The rationale behind choosing

quarterly rather than annual time series for deflation is that unlike inflation, deflation will affect the decision of market participants regarding production much sooner than inflation. For inflation to have real effect on production it needs at least 18 months, in another word it has 18 months' time lags, however for deflation it just needs less than 3 months or 3 months time lags. This is so because decision regarding initiating a new project or expanding an old one due to inflation is much more time consuming than decision regarding cutting of production due to deflation. Hence using quarterly data has much more information for studying deflation than annual data. The original quarterly seasonally adjusted variables are real GDP, export, import, gross fixed capital formation and CPI which all are expressed in 2000 year constant prices in terms of Millions Japanese Yen with exception of CPI which is based on 2005 year in terms of percentage. All of them are from OECD Economic Outlook. Since research deals with changes than absolute terms, therefore different base year is not important. Quarterly data of population more than 15 years is used by this paper which is obtained from Bureau, Ministry of Internal Affairs & Comm., Japan, since it is a better proxy for labor work. All original data are extracted from DataStream, and the variables of growth for this research are obtained with taking the first difference of natural log of this original data. Therefore, all growth rates are in quarterly form, since original data are seasonally adjusted thus growth rate as well.

4. Empirical result

4.1 Stationary test

One of the prerequisites of running OLS Regression is stationarity of data on level. Non-stationary data will lead to spurious regression (Asteriou & Hall, 2007). In Table 2, 3, 4 the paper has done both Augmented Dickey-Fuller and Phillips-Perron tests for whole period between 1965-2010 and 1985 to 2010 periods. The result shows the null hypotheses of having unit root on intercept and trend and intercept can be rejected at 5 percent significance level for all variables of interest except for POPG in second period just for intercept in ADF test. Therefore, data of research are $I(0)$ type and necessary condition of running OLS Regression has met.

Table 2 Unit root test whole period

Series	Level		Level	
	Intercept	Trend and intercept	Intercept	Trend and intercept
GDPG	-3.892 (4) ^a	-5.85 (2) ^a	-10.36 (7) ^a	-11.80 (3) ^a
POPG	-3.03(7) ^b	-3.45(4) ^b	-7.91(12) ^a	-15.86 (10) ^a
IGDPG	-8.10 (2) ^a	-6.45 (2) ^a	-13.29(5) ^a	-13.58(4) ^a
ININCG	-4.07(4) ^a	-6.10 (3) ^a	-10.42(7) ^a	-11.82(4) ^a
TOFTG	-6.65(4) ^a	-6.65(4) ^a	-10.41(5) ^a	-10.39(5) ^a
OPENG	-7.69(4) ^a	-7.73(4) ^a	-11.82(9) ^a	-11.83(9) ^a
DEF	-3.00(4) ^b	-4.36(4) ^a	-4.93(6) ^a	- 7.24(7) ^a

Notes: Figures are the pseudo t -statistics for testing the null hypothesis that the series is nonstationary.

a and b denotes significance at 1% and 5% level. For the series in level (constant with trend) the critical values for rejection are 4.11 and -3.48 at 1% level the lag length is determined by the AIC.

Table 3 Unit root test period 1965-1990

Series	Augmented Dickey-Fuller		Phillips-Perron	
	Level		Level	
	Intercept	Trend and intercept	Intercept	Trend and intercept
GDPG	-3.32 ^a	-3.82 ^b	-8.78 ^a	-9.33 ^a
POPG	-4.16 ^a	-3.41 ^b	-5.80 ^a	-6.50 ^a
IGDPG	-3.62 ^a	-3.63 ^b	-10.52 ^a	-10.51 ^a
ININCG	-3.47 ^b	-3.76 ^b	-8.84 ^a	-9.32 ^a
TOFTG	-4.71 ^a	-4.79 ^a	-7.70 ^a	-7.74 ^a
OPENG	-5.56 ^a	-6.01 ^a	-9.53 ^a	-6.64 ^a
DEF	-2.99 ^b	-3.36 ^c	-4.32 ^a	-4.85 ^a

a and b denotes significance at 1% and 5% level

Table 4 Unit root test period 1990-2010

Series	Augmented Dickey-Fuller		Phillips-Perron	
	Level		Level	
	Intercept	Trend and intercept	Intercept	Trend and intercept
GDPG	-3.77a	-3.89b	-7.57a	-7.73a
POPG	-2.66c	-7.67a	-8.38a	-18.34a
IGDPG	-5.20a	-5.28a	-8.43a	-8.47a
ININCG	-3.53a	-3.63b	-7.84a	-8.02a
TOFTG	-5.47a	-5.45a	-7.41a	-7.37a
OPENG	-4.84a	-4.81a	-7.54a	-7.45a
DEF	-3.08b	-3.70b	-6.45a	-7.61a

a and b denotes significance at 1% and 5% level

Another possible source of biasness of OLS Regression is correlation between independent variables i.e. Multicollinearity (Asteriou & Hall, 2007). Correlation matrix of Table 5 clearly shows that between independent variables of interest there is no correlation. Hence the OLS regression will not suffer from this problem.

Table 5 Correlation Matrix

	GCPI	GIGDPG	GPOP15	GININC	GTOFT	GOPEN
GCPI	1.000000	0.052531	0.425145	0.231410	0.245976	0.150076
GIGDPG	0.052531	1.000000	0.145688	0.336907	-0.373994	0.133910
GPOP15	0.425145	0.145688	1.000000	0.405685	0.087723	0.017940
GININC	0.231410	0.336907	0.405685	1.000000	-0.056372	0.247633
GTOFT	0.245976	-0.373994	0.087723	-0.056372	1.000000	0.163300
GOPEN	0.150076	0.133910	0.017940	0.247633	0.163300	1.000000

Omitted necessary variable is another source of biasness of OLS regression. By including important variables we expect improvement in adjusted R-Squared and decrease in AIC, SBC and HQC statistics (Asteriou & Hall, 2007).

The result in Table 6 shows that Adjusted R-Squared for $D_0 * Def_t$ are higher than model without dummy. The result of AIC, HQC and SBC statistics are also lower for them compared to model without dummy. Furthermore, if dummy interaction variable was not important, the p -value and magnitude of coefficients of our model must not change (Asteriou & Hall, 2007), however the results of Table 6 show that there is significant change of p -value and magnitude of coefficient for $D_0 * Def_t$ as we include $D0*Def$ in regression. This is also consistent with hypothesis of this research which is existence of non-linear relation between deflation and growth. Hence, all statistics suggest us using interaction dummy variable.

Table 6 Statistics for including influential dummy interaction variables

Test	No Dummy	D0*Def
Ad R-Squared	0.4394	0.4564
AIC	-6.4228	-6.4484
SBC	-6.3005	-6.3086
HQC	-6.3733	-6.3918

Misspecification problem is checked with running Residual normality test, Ramsey Reset Test. Misspecification problem will lead to non-normality of residual distribution of model (Asteriou & Hall, 2007). Jarque-Bera statistic on Table 7 shows that, null hypothesis of normality of residual at 5 percent significant level failed to be rejected except for 1964-2010 period, that is because outlier in residuals. Moreover, the results of Ramsey Reset Test for general misspecification show that there is no possibility of rejecting Null Hypotheses of no misspecification problem.

Table 7 shows the results for Breusch-Godfrey Serial Correlation LM Test. The results imply that, null hypotheses of no serial correlation between residuals failed to be rejected. The research does not suffer from Heteroskedasticity problem by using white method in estimation. Hence our model is safe from Autocorrelation and Heteroskedasticity problems.

Table 7 Misspecification tests

Statistics		1964-2010	1985-2010	1990-2010	1964-1990
Residual normality test	JarqueBera	14.36 (0.0007)	3.44 (0.17)	2.82 (0.14)	1.66 (0.45)
Breusch-Godfrey Serial Correlation LM Test		2.1210(0.12)	0.55(0.57)	0.13 (0.87)	3.66 (0.02)
Ramsey Reset Test	t-statistic	0.5291 (0.59)	0.35 (0.68)	0.41 (0.68)	1.58 (0.11)
	F-statistic	0.2799(0.59)	0.12 (0.58)	0.16 (0.68)	2.52 (0.11)

4.2 Interpretation and discussion of results

Table 8 shows the results of OLS Regression with and without interaction Dummies. The overall result shows that coefficients of POPG and IGDGP are significant at one percent level with positive expected sign for both dummy and without dummy models with exception of period 1990-2010 for POPG which is insignificant. Coefficients of Def is not significant in model without dummy, however it turns to be significant at 5 percent significance level when dummy is included in other models, which confirms our justification for including threshold

dummy. In addition, in models with dummy the coefficients of $D0*Def$ are significant at five percent and one percent significance level with exception of period of 1990 -2010 level with positive expected sign for $D0$. Growth.

Table 8 Regression of model with Dummy and without dummy different periods

Variable	Expected sign	Without dummy	1965-2010	1990-2010	1964-1990
C	+	0.0024 (0.0013)	0.0044 (0.0013) ^a	0.0039 (0.0015) ^b	0.0099 (0.0035) ^b
Def	-	-0.2432 (0.1560)	-0.2954 (0.1547) ^b	-0.8715 (0.3708) ^b	-0.3430 (0.1460) ^b
D_i*Def	+	1.4533 (0.6967) ^b	0.9701 (0.8308)	3.5538 (0.8565) ^a
POPG	+	3.1673 (0.6258) ^a	3.0424 (0.5656) ^a	0.6117 (0.6543)	2.7347 (0.9982) ^a
IGDPG	+	0.2899 (0.0419) ^a	0.2731 (0.0431) ^a	0.2791 (0.0493) ^a	0.2419 (0.0466) ^a
ININCG	+	0.0964 (0.0830)	0.0584 (0.0792)	-0.0762 (0.0871)	-0.0270 (0.0788)
OPENG	+	-0.0089 (0.0328)	-0.0086 (0.0287)	0.0545 (0.0296)	-0.0546 (0.0344)
TOFTG	+	0.0979 (0.0290) ^a	0.0869 (0.0280) ^a	0.1762 (0.0335) ^a	0.0301 (0.0234)
S-E of Regression		0.0095	0.009425	0.0064	0.0091
Adj R ²		0.4394	0.4771	0.6474	0.4245

of term of trade is also significant in all models with expected sign with exception of period 1965-1990. Other control variables are not significant in all models. With respect to our objective of this study which is impact of deflation on economic growth of Japan, we limit our analyses to deflation and growth hereafter.

CPI of this study is based on 2005 base year; therefore it is new improved CPI Index which its biasness has decreased substantially. Study of Shiratsuka (2006); Unayama (2004) suggests us to take 0.2 percentage rate as true rate of zero inflation, therefore it can be inferred that 0.00 percentage rate of inflation is already mild deflation that can be good candidate for threshold point. In another word, zero inflation regarding correction of CPI bias is mild deflation. Based on this fact period 1964-2010 which is whole period of study threshold point of deflation have negative impact on economy with power around 1.45 percent. It means that if deflation increases by 100 percent, growth will decrease by around 145 percent. Positive impact of deflation has power around 0.24 percent. Hence the cumulative effect is around 1.21 percent which shows that the negative effect of deflation is huge. Hence study find the existence of threshold effect of deflation on economic growth of Japan, The results for dummies less than zero correspond to strong deflation has no significant difference with above results which for saving the space it is not included in this paper, however it can be interpreted that Japan has not face with strong deflation yet. (The results for dummies less than zero is available on request. However it is soon at this point of study to conclude about huge negative impact of deflation on growth for Japan. Maybe the result is sensitive to period of study.

To check whether the negative effect of deflation is sensitive to time period or not, we divide the whole period into two sub periods. The period between 1965 to 1990 and from 1990 to 2010. The rationale behind this choice is twofold: first 1990 is the ending of Japanese financial crises which thereafter Japan trapped in last long deflation. Second: ending of financial crises

means ending the effect of panic on growth, therefore 1990 to 2010 provide us period with high frequency of deflation without effect of panic.

First surprising result is in second period which is 1990 to 2010, deflation is much more frequent but overall cumulative effect of deflation is around 0.10 percent which is much lower compared to 3.2 percent in first period. In fact, in 1990 to 2010 which is the end of Japan financial crises, the positive and negative effect of deflation converge together, which mean cumulative effect will reach around 0.1 that is near to zero. This finding sounds plausible since Japan economy already passed the effect of panic and error correction effect of deflation is already in work. Hence, if the theory of fear of deflation is valid as Keynesian claim, there is expectation of the existence of huge detrimental impact of deflation on growth in second period which has more frequency of deflation. In contrary study reaches to opposite conclusion, period with more deflation, both threshold point and overall result has lower impact on growth in long term.

Although, overall impact of deflation on growth is negative, this study brings two important questions for further research and explanation. What factors can explain the huge negative impact of deflation on first period and low negative impact of deflation in second period. These results are not consistent with hypotheses of the research that if deflation is danger, it must have powerful negative effect on growth if economy passes through true zero inflation into deflation, since there is not huge decrease in growth in second period. Although the threshold power is 0.97 percent, the cumulative effect is 0.1 percent, which means by 100 percent in increase in deflation, growth will decline by 10 percent. This finding is hold true if we assume that threshold point is significant but table 4-6 shows that even threshold point is not significant in second period, therefore deflation have mere positive impact on growth. In conclusion the fear of most mainstream economists about danger of deflation cannot be justified with these striking findings. Is there any economic explanation for these phenomena?

Expected negative sign of Def for all models and positive sign of interaction dummies imply that deflation has both advantages and disadvantages. Advantages of deflation are increasing purchase power for public, error correction process therefore less unbiased relative prices of goods and services in showing scarcity of resources, preference of public and more saving, therefore more long term investment in future, and disadvantages are increasing real rate of interest, burden of debt and decreasing consumption, therefore decreasing investment in short run. If advantages of deflation is greater than disadvantages of it, thus deflation does not pose a problem for economy. This model shows that the disadvantage of deflation is much more than advantage if we consider whole period and first period. However, disadvantage will decrease and advantage increase in second period until that overall impact of deflation converge to zero and positive even in long run.

These findings are not consistent with prediction of Keynesian economists about danger of deflation although very consistent with Austrian business cycle theory. This theory predicts that after period of high easy credit expansion, such as first period of our study, deflation have detrimental impact on growth, it wipes out all bad investment which has been made in period of high easy credit expansion. They call this process as error correction process. After error correction period of deflation, the good effect of deflation will be appearing which is corresponding with second period of our study. They call this effect, productivity–norm deflation. This productivity norm deflation is at work because, deflation cause, entrepreneurs and households to be guided by prices which are true proxy for scarcity of resources, in another world with not distorted prices. Hence they can allocate resources to their best urgent needs. Therefore we expect from this theory deflation has positive impact on growth even, which is consistent to our finding.

5. Summary and conclusion

This study has reviewed most major literature about the relation of deflation and growth. In spite that, most of this literature has found deflation, as monetary phenomenon like inflation, the growing fear about deflation in Japan, makes deflation a big puzzle: if deflation is neutral or even beneficial why policy makers must be afraid of it. This puzzle, led this research to study the threshold effect of deflation on growth in case of Japan with quarterly time series data from 1965 to 2010 and OLS regression method. The data of study passed all of the necessary and sufficient conditions for running OLS method which makes the OLS regression BLUE. The prediction of study is that if the fear of deflation is the case, then huge negative threshold effect of deflation on growth must exist when economy of Japan passes through true zero inflation into deflation. The study used three periods for examining this threshold effect. One whole period, which is period between 1965 to 2010 and two sub periods, which are 1965 to 1990 and 1990 to 2010 periods. The results are astonishing. In whole period of study, When the Japanese economy passes through true zero inflation into deflation, threshold effect appears with powerful negative effect on growth of Japan which makes deflation as danger for the Japanese economy. However study, does not find the emergence of severe danger in economy by examining other threshold points lower than zero inflation, since in severe danger, capital and labor which are proxied by gross capital formation and population cannot have significant effect on growth but our result shows that these two proxies have significant effect on growth in all dummy variables.

This result is consistent with prediction of study however it is sensitive to chosen period of study. The results of two subdivided periods are not consistent with Keynesian theory of fear of deflation and hence prediction of study. The first period which has much lower frequency of deflation and it is prevailed by inflation, the impact of threshold effect is detrimental and significant however in second period which is prevailed by deflation the threshold effect has much lower impact on growth and it is insignificant as well which make cumulative effect of deflation positive on growth. These finding can be best explain by Austrian Business Cycle Theory and productivity norm deflation. In short, ABCT theory is that after period of easy credit expansion, incidence of deflation will cause detrimental impact on economy as we observe on first period. In Austrian terminology this is error correction process of deflation for freeing economy of bad investments which were undertaken under easy credit expansion period. After error correction period, productivity-norm deflation come into effect in long run, which enhance productivity and growth through signaling true information of scarcity of resources to economic agents as we observe in second period.

The results of this research, however, have limitations and are conditioned on some important assumptions: First: the research has assumed that production function of Japan is kind of Cobb–Douglas with more factors than L and K and further assumed that Cobb–Douglas production function is constant over fifty years. In spite that the model of research has passed misspecification tests successfully, more accurate production function and more control variables can give better and more robust results. Second: The results of the research are based on experience of the Japan economy during 1965 to 2010; therefore generalization of the research results for other countries is not possible and is conditioned to further studies in other countries.

Deflation is not danger for economy per se, huge burden of debt, inflexible relative prices, zero nominal rate of interest and panic, turn deflation to be a danger, however these channels are not long lasting. All of these channels are natural results of economic intervention of government in economy, through central banks and unions. With regard to the results of the re-

search, policy makers and central bankers should avoid of issuing debts with monetary policies that keeps changing price level near true zero inflation rate. In addition, Sustainable policies for decreasing the burden of government debt, decrease the power of labor unions ,and designing a new sound monetary system that prioritizes these goals together should be considered as first national and international preference for avoiding danger of deflation and welcoming its positive effect on economy. All of these policy advises based on assumption that deflation has positive effect on growth which is shown by this research, however , as it mentioned above this research has its limitations, thus to take into account seriously these policy advises further research should be done.

Further studies in proper production function of Japan and upward CPI bias seems to be fruitful for more valid judgment about effect of deflation on growth for economy of Japan, furthermore, study the experience of deflation in other different time spans and different countries can shed more light on the relation of deflation and growth.

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