**The Method of Farmland Pension System Improvement by Applying Interrupted Time Series Model\*[[1]](#footnote-1)**

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**Abstract**

Korea represents one of the fastest growing countries either in the economic development or in ageing population due to the longer life expectancy and lower birth rate. Recently this ageing population has been, and still is a big social problem, especially in the rural area where the pension system is currently too weak. The Korean government, therefore, developed the Farmland Reverse Mortgage System to solve the issue. This system (FP) is composed of three key factors such as farmland value, change of interest, and net discount ratio. To measure the monthly payment amount of Farmland Reverse Mortgage System, these three factors should be estimated by long term estimation. However, these factors were affected by the external interruptions such as International Monetary Fund and USA subprime mortgage crises. Using Interrupted Time Series Method, this paper analyzed the external effects of International Monetary Fund, USA subprime mortgage crises and both interruptions. The findings show that, comparing with the US subprime mortgage crisis, the International Monetary Fund crisis interruption highly affects the change of farmland value, especially that of interest rate and of net discount ratio. Therefore, the government should take into consideration the domestic and foreign economic circumstances in building the Actuarial Model for the Farmland Reverse Mortgage System, given that the International Monetary Fund and USA subprime mortgage crises affected directly the change of Korean farmland price in the rural areas.

**Keywords**: Actuarial model, Farmland pension, International Monetary Fund, Interrupted time series analysis, Subprime mortgage.

1. **Introduction**

Korea represents one of the fastest growing countries and simultaneously one of the fastest aging due to the lowest birth rates and extension of the average life expectancy in the world. These circumstances generated other social problems such as elderly welfare issue and shortage of working population. For the elderly who retired from their jobs a pension system constitute one of the most important welfare systems. However, Korea, like other developing countries has a weak pension system, which cannot fully cover the living costs of the elderly. Ultimately, the income replacement rate of pension represents 42.1% in Korea, yet the average rate of countries of Organization for Economic Cooperation and Development (OECD) amount to 63.6%. In order to settle these problems, the Korean government introduced, in 2007 in the urban area the housing reverse mortgage, which is called as Housing Pension (HP); and in 2011 in the rural area the farmland reverse mortgage system, which is called as Farmland Pension (FP) (Cho, 2015). This study tries to develop the asset (housing and land) reverse mortgage system which includes housing and land. The asset reverse mortgage system represents a system that liquidates total real estate asset for the monthly living costs which the elderly households own and this liquidated monthly payment is used for the living cost of elderly household.

The reverse mortgage is theoretically simple, its cash flow being just a reverse direction of traditional mortgage system. When a household it is generated, he/she buys a housing using mortgage system. After retirement from his/her job market, he/she gets some monthly payment for the living cost by a reverse mortgage program. In Korea, reverse mortgage can be categorized as a housing pension or farmland pension, depending upon the objectives of application. It actually liquidates the housing or farmland values for the monthly living costs of the elderly (see Eq.1). Therefore, the amount of monthly payment highly depends on the values of housing or farmland. Real estate values are also affected by the taxes, economic recession, and other external facts. International Monetary Fund (IMF) crisis which resulted in the biggest economic crisis in Korea and subprime mortgage (SM) crisis in USA are representative examples of external facts on the changes of real estate prices (Cho and Ma, 2004; Cho, 2015). Eventually the IMF crisis was generated in the 4th quarter in 1997 and subprime mortgage crisis in the 3rd quarter in 2008.

The goals of this paper are to estimate the effects of IMF and SM crises, and both of them, which significantly affected the real estate values, in order to improve the Korean FP system and to develop the asset pension in which HP and FP are integrated. To figure out the external effects of changing rates of farmland value by the IMF and SM crises as well as both interruptions, chapter 2 reviews the reverse mortgage, the time series model (ARIMA) and interrupted time series model (ITSA) on the land value and interest rate changes. Chapter 3 analyzes the characteristics of three different time series data and tests their stationarities. Chapter 4 measures the external effects of IMF and SM crises using ITSA. Lastly, this paper notes some policy alternatives to improve the farmland pension system and to develop the asset pension system for the elderly.

1. **Review of Literature**

*2.1 The Concept of Reverse Mortgage System*

In a conventional mortgage, the homeowner makes a monthly payment to the lender. After each payment, the homeowner's equity increases by the amount of the principal included in the payment. In a reverse mortgage, the homeowner is not required to make monthly payments. If payments are not made, interest is added to the loan's balance. Although the rising loan balance can eventually grow to exceed the value of the home, the borrower is generally not required to repay any additional loan balance in excess of the value of the home (Cho et al., 2008, Cho et al., 2009). The basic concept of a reverse mortgage is a loan available to homeowners who are 65 years old and over that enables them to convert part of the equity of their homes into cash. The loan is called a reverse mortgage because the traditional mortgage payback stream is reversed (Higgins & Folts, 1992; Ha & Cho, 1997; Cho & Ma, 2004; Cho et al., 2008, Cho et al., 2009; Jun, 2008; Lim & Cho, 1999). Instead of making monthly payments to a lender, as with a traditional mortgage, the lender makes payments to the borrower. He or she is not required to pay back the loan until the home is sold or otherwise vacated. As long as the elderly household is living in the home, he/she is not required to make any monthly payments towards the loan balance, but he/she must remain current on his/her property taxes and homeowners insurance (Ma & Cho, 2008; Park & Cho, 2014). The demand on the reverse mortgage has been increased gradually because the “baby boomers” which do not have an appropriate pension system start to retire from their job market in Korea.

*2.2 Actuarial Model of Farmland Pension System*

Some studies developed the actuarial model of HP (Ma & Cho, 2003; Ma, Kim & Lew, 2007) as it is shown in Eq.1. This model is basically composed of three core factors which are interest rate, life expectancy, and land value. Especially, the farmland value and interest rate influence directly the monthly payment amount because FP liquidates the farmland value using the interest rate. Therefore, the forecasting of land value and interest rate might be the core factors (Yeo & Cho, 2010) in estimating the monthly payment of FP. A basic actuarial model is required for estimating the monthly payment amount of elderly households.

To estimate the monthly payment amount, Korean government has utilized the publicly assessed land value. However, this method is considerably arguable because this assessed value by government is relatively lower than appraisal values. It results in the decrease of the monthly payment amount (Park & Cho, 2014). Therefore, this paper uses the real transaction values of farmland provided by Ministry of Land, Infrastructure and Transport (MLIT) and the interest rate of 3 Years National Bond (YNB). Moreover, by this article are estimated the external effects of IMF economic crisis and SM crisis which considerably influence the changing rate of land value and interest rate.

An actuarial model assumes that the present value (PVMIP) of the total payment amount of FP should be the same with the present value (PVEL) of farmland value at the future certain time (N). Under this condition, this study can measure the monthly payment amount. Forecasting the future farmland value is one of the most important factors in estimating the monthly annuity (Ma & Cho, 2004; Ma, Kim, & Cho, 2008; Cho, 2015) along with forecasting an interest rate and mortality rate.

$Eq.1 PVMIP=UP\_{0}+ \sum\_{t=1}^{T(a)}\frac{mip\_{t}∙p\_{a,t}}{(1+i)^{t}}= \sum\_{t=1}^{T(a)}\frac{max⁡((OLB\_{t}- L\_{t})q\_{a+t,}0)∙p\_{a,t}}{\left(1+i\right)^{t}}=PVEL$

Where

*PVMIP - Present value of total projected mortgage insurance premium,*

*PVEL - Present value of expected losses,*

*UP0 – Up-front mortgage insurance premium at t = 0,*

*T(a) – The number or months left for the borrower living until 100 years old,*

*mipt – Projected monthly mortgage insurance premium at t:*

*mipt = (OLB t-1 + PMT) × m, where PMT = The annuity payment (constant monthly payment) and m = Percent of monthly mortgage insurance premium,*

*OLBt – Expected outstanding balance at t:*

*OLBt = (OLBt - 1 + PMT + mipt) (1 + i),*

*Ft – Expected farmland value at t:*

*Ft = F0 × (1 + g)t, where g = average farmland value rising rates,*

*qa+1 – The probability of loan termination at age a + t,*

*pa,t  - Loan survival probability for the borrower at age a living until age a + t,*

*I – Interest rates (discount rates).*

1. **Data and Analysis Methods**
	1. *Data Description*

In this study was used the quarterly data of farmland value increasing rate and interest rates, considering the data availability for IMF and SM crises. The data set of farmland value and interest rate covers from the 2nd quarter of 1995 to the 2nd one of 2014. Total time periods are composed of 77 quarters which are provided by the Korean Appraisal Board. Also in this article was used the quarterly data of 3 year national bond (YNB) supported by the Bank of Korea for the same mentioned period of time, instead of the Company Bond interest rate, because the transaction of farmland does not often occur in the real world and this interest rate is also relatively stable (Cho et al., 2009).

In order to forecast the change rates of farmland values and interest rates, these times series data should be stationary. Figure 1 shows that the increasing rate of farmland value looks stable. However, the change rate of farmland value decreased dramatically during the periods of IMF economic crisis from the 1st quarter in 1998 to the 2nd one in 1999, as well as during SM crisis from the 4th quarter in 2008 to the 4th one in 2009. After each period the farmland values and interest rates are bounced back instantly. Therefore, in this study we are checking the stationarity of land value time series data. And to check the stationarity of time series data we are implementing the unit root tests. Before implementing the unit root test, we drawn the graph on the times series data as it is in Figure 1.

The time series data of land value should be stationary in order to forecast the future land value. For checking the stationarity of time series more specifically, we are implementing the unit root test on the change rates of farmland value. As a result, the null hypothesis is rejected because the absolute value test statistics -4.795 is higher than critical value -3.544 at 1% level as it is shown in <Table 1>.



<Figure 1> Graph of Farmland Value Change and its First Difference during Analysis Period

<Table 1> The ADF Unit Root Test of Farmland Value Time Series Data

|  |  |
| --- | --- |
| Dickey-Fuller test for unit root | Number of obs = 76 |
|  |  | Interpolated Dickey-Fuller |
|  | Test statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
| Z (t) | -4.795 | -3.544 | -2.909 | -2.590 |
| MacKinnon approximate p-value for Z (t) = 0.0001 |

It means that time series data of change of farmland value is stationary even if the farmland value decreased dramatically during the periods of IMF and SM crises (see Figure 1). Therefore, historical mean values can be used in forecasting the future farmland value. However, the time series of interest rates of YBN are continuously decreasing during the analysis period. It might be due to nonstationary time series data. Especially it decreased dramatically during the period of IMF and SM crises. However, its first difference is stable, as it can be seen in< Figure 2>.



<Figure 2> The Graph of Change Rates of 3 Year National Bond and its First Difference

The unit root test should be implemented through the first difference of time series data of interest rate. Its null hypothesis of the first difference is rejected because the absolute value test statistics -6.185 is higher than critical value -3.545 at 1% level as it is shown in Table 2.

<Table 2> The ADF Unit Root Test of 3 Year National Bond

|  |  |
| --- | --- |
| Dickey-Fuller test for unit root | Number of obs = 75 |
|  |  | Interpolated Dickey-Fuller |
|  | Test statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
| Z (t) | -6.185 | -3.545 | -2.910 | -2.590 |
| MacKinnon approximate p-value for Z (t) = 0.0000 |

It means that the null hypothesis is rejected and the first difference of time series data of interest rate is stationary. Therefore, historical means of the first difference of interest rates can be used in forecast the future interest rate.

*3.2 Intervention Time Series Analysis*

In order to estimate the external effects of changing rates of real estate values by IMF and SM crises, we use in this paper the actuarial models of housing and farmland pension systems, the time series model (ARIMA), ordinary least square (OLS) regression, and interrupted time series model (ITSA). Time series is a series of observations on the same dependent variable over time (Box & Tiao, 1970). Interrupted time series is a special type of time series where treatment/intervention occurred at a specific point and the series is broken up by the introduction of the intervention. If the treatment has a causal impact, the post‐intervention series will have a different level or slope with that of the pre‐intervention series.

Before establishing the interrupted time series model we should figure out an autoregressive integrated moving average (ARIMA) model, which is a generalization of an autoregressive moving average (ARMA) model (Box & Tiao, 1970 & 1975). The Box-Jenkins (ARIMA) model is theoretically the most general class of models for forecasting time series. ARIMA (p, d, q) model does not consider completely independent variables. It also supposes that past values of the series plus previous error terms contain information for the purposes of forecasting. The integers refer to the autoregressive (AR), integrated (I) and moving average (MA) parts of the data set respectively. The model takes into account historical data and decomposes it into autoregressive (AR) process, where there is a memory of past events. An integrated process, which accounts for stationarity, makes it easier to forecast. A moving average (MA) of the forecast errors, such that of the longer the historical data, the more accurate the forecasts will be as it learns over time. ARIMA model is applicable only to a stationary data series, where the mean, the variance, and the autocorrelation function remain constant through time (Gathingi, 2014; Lee et al., 2007; Min & Choi, 2014).

Interrupted time series analysis (ITSA) estimates the effect of an intervention when the outcome variable is ordered as a time series, and a number of observations are available in both pre- and post-intervention periods (Yoo et al., 2000). The study design is generally referred to as an interrupted time series because the intervention is expected to "interrupt" the level and/or trend subsequent to its introduction. ITSA is a wrapper program for, by default, Newey, which produces Newey-West standard errors for coefficients estimated by OLS regression, or optionally prais. It estimates treatment effects for either a single treatment group (with pre- and post-intervention observations) or a multiple-group comparison (i.e., the single treatment group is compared with one or more control groups). Additionally, ITSA can estimate treatment effects for multiple treatment periods (Cho, 2015; Linden, 2015).

ITSA can be actually used in diverse fields. Following the process of historical development, Huitema and McKcan (2000) note the design specification of time series intervention model. Yoo et al. (2000) analyze the change of temperature using multiple interrupted models in the City of Daegu. Yun (2002) analyzes the effects of the auction market by the International Monetary Fund (IMF). Wagner et al. (2002) use the ITSA to evaluate the educational, administrative and policy intervention for quality of medication. Sridharan et al. (2003) examine the impact of Virginia’s parole abolition and sentence reform on reported crime rates before and after 1995 when the policy starts to be implemented. Oh (2004) analyze the effects of IMF on the unemployment rate. Kim and Song (2006) estimate the effects of the severe acute respiratory syndrome (SARS). Kim (2010) analyzes the effects of housing market stabilization by the housing policy. Kim & Kim (2011) forecasts KTX passenger demand by the openness of 2nd stage of Gyeongbu line and financial crisis in 2008 using the ITSA. Kim et al. (2012) analyze the effect of intervention variables which may affect the air travel demand for Jeju domestic flights and anticipate the air travel demand for Jeju domestic flights. The air travel demand forecasts for Jeju domestic flights was conducted through ARIMA-Intervention Model selecting five intervention variables such as 2002 World Cup games, SARS, novel swine-origin influenza A, Yeonpyeongdo bombardment and Japan big earthquake.

In previous papers I used the used the ITSA model in forecasting the long term land value (Cho, 2015). However, that paper did not consider IMF crisis which is the biggest interruption on the time series land value and interest rates in the Korean economy. Therefore, in this article it is used the ITSA model to estimates simultaneously the external effects of IMF and SM economic crises before forecasting the change of the long term land value. These solid outcomes which consider the interrupted time series factors will contribute to measure exactly the amount of pension payment. More specifically it was used the ITSA method to measure the external effects of IMF and SM crises interruption factors on the change of farmland using a purse model. When there is only one group under study (no comparison groups), the standard ITSA regression model assumes the following form (Cho, 2015; Linden, 2015).

Eq.2$ Y\_{t}=β\_{0}+β\_{1}T\_{t}+β\_{2}X\_{t}+β\_{3}X\_{t}T\_{t}+ϵ\_{t}$

*Yt* is the aggregated outcome variable measured at each equally-spaced time-point t, *Tt* is the time since the start of the study, *Xt* is a dummy (indicator) variable representing the intervention (pre-intervention periods 0, otherwise 1), and *XtTt* is an interaction term. In the case of a single group study, $β\_{0} $presents the intercept, or starting level of the outcome variable. $β\_{1} $is the slope, or trajectory of the outcome variable until the introduction of the intervention. $β\_{2} $represents the change in the level of the outcome that occurs in the period immediately following the introduction of the intervention (compared to the counterfactual). $β\_{3}$ represents the difference between pre- and post-intervention slopes of the outcome. Thus, we look for significant P-values in $β\_{2} $to indicate an immediate treatment effect, or in $β\_{3}$ to indicate a treatment effect over time (Linden and Adams, 2011; Linden, 2015).

In order to estimate the above two external effects on the change of farmland values; we noted the general intervention models and several forms of intervention responses. There are two common types of intervention variables. One represents an intervention occurring at time T that remains in effect thereafter. That is, the intervention is a step function,

Eq.3 $S\_{t}^{(T)}$=$\left\{\begin{array}{c}0, \\1.\end{array}\right.$ $\genfrac{}{}{0pt}{}{t<T}{t\geq T.}$

The other one represents an intervention taking place at only on time period. Thus, it is a pulse function,

Eq.4 $P\_{t}^{(T)}$=$\left\{\begin{array}{c}0, \\1.\end{array}\right.$ $\genfrac{}{}{0pt}{}{t\ne T}{t=T.}$

The pulse function can be produced by differencing the step function$ S\_{t}^{(T)}$. That is, $P\_{t}^{(T)}$=$S\_{t}^{(T)}$- $S\_{t-1}^{(T)}$= (1-*B*)$ S\_{t}^{(T)}$. Therefore, an intervention model can be represented equally with the step or pulse function. And then the use of a specific form is usually based on the convenience of interpretation (Oh, 2004; Cho, 2015). Figure 1 note the characteristics of purse effects by the IMF and SM crises interventions because the graph bounces back quickly after the interruption shock. In a broad sense, the increase rate of land value index before IMF crisis relatively is high, comparing with that after IMF crisis. However, land value change rate is dramatically decreased during the periods of IMF and SM crises. Accordingly, it is possible to estimates the purse effects of farmland value by IMF crisis in Korea and SM crisis from USA and forecast the change of farmland values to improve the farmland pension system (FP) for the rural elderly.

1. **Effects of Interrupted Time Series Analysis**
	1. *Interruption Effects on the Farmland Value*

The analysis is composed of three different interruption categories. The first factor is farmland value factor which contains IMF crisis (model1), SM crisis (model2), and both interruptions (model3). The second one is interest rate factor which includes IMF crisis (model4), SM crisis (model5), and both interruptions (model6). The third one is net discount ratio factor which is consisted of IMF crisis (model7), SM crisis (model8), and both interruptions (model9). Total number is composed of nine models. At first it analyses the effects of IMF crisis assuming an interruption in ITSA. It evaluates whether the introduction of IMF economic crisis resulted in a shift in the level and trend of increasing of farmland value compared with those of the pre-intervention period. In this paper was specified a single group ITSA. The model1 is estimated using Newey-stand error regression as it is in <Table 3>.

<Table 3> The Interruption Effect of IMF crisis on the Farmland Value Change (Model1)

|  |  |
| --- | --- |
| Regression with Newey-West standard errorsMaximum lag: 1 | Number of obs = 77F (5, 71) = 10.02Prob > F = 0.0000 |
| farmland | Coef. | Newey-West Std. Err. | t | P>|t| | (95% Conf. Interval) |
| dummy1 | -3.499159 | 1.435351 | -2.44 | 0.017 | -6.361167 | -.6371502 |
| dum1qn | .0536483 | .025862 | 2.07 | 0.042 | .0020808 | .1052157 |
| \_t | -.0096364 | .0131517 | -0.73 | 0.466 | -.0358602 | .0165874 |
| \_x11 | .9958899 | .1981648 | 5.03 | 0.000 | .6007606 | 1.391019 |
| \_x\_t11 | -.0112131 | .01362 | -0.82 | 0.413 | -.0383706 | .0159444 |
| \_cons | .464 | .0972158 | 4.77 | 0.000 | .2701572 | .6578428 |
| Post-Intervention Linear Trend: |
| Treated: \_b (\_t) + \_b (\_x\_t11) |
| Linear Trend | Coef.  | Std. Err.  | t | P>|t| | (95% Conf. Interval) |
| Treated | -0.0208 | 0.0035 | -5.8887 | 0.0000 | -0.0279 | -0.0138 |

In the first quarter of the intervention (first quarter in 1997) by IMF economic crisis there appeared to be a dramatic decrease in increasing rate of land value which is -3.499 percent (P <0.017), followed by a significant increase in the quarterly trend of value change (Linden, 2015). Appendix 1 draws a visual display of these results. The first purse intervention was initiated by IMF crisis in the 11th quarter which is the 2nd quarter in 1997. The model1 is estimated using Newey with 1 lag. As shown in Table 3, the starting level of farmland value change was estimated at 0.464, and the increasing rate of farmland value appeared to decrease slightly every quarter to 4th quarter 1997 by -0.009 (P<0.47, CI=-0.036, 0.016). It can also see from the Lincom estimate produced by specifying post-trend, that after the introduction of IMF crisis, farmland value sales deceased quarterly at a rate of -0.021 (P<0.001 CI -0.030, -0.014). Appendix 1 provides a visual display of these results.

At second it analyses the effects of SM crisis assuming an interruption in ITSA. It evaluates whether the introduction of SM crisis resulted in a shift in the level and trend of increasing of farmland value compared with those of the pre-intervention period. In this paper is also specified a single group ITSA. The model2 is estimated using Newey-stand error regression as it is in <Table 4>.

<Table 4> The Interruption Effect of SM crisis on the Land Value Change (Model2)

|  |  |
| --- | --- |
| Regression with Newey-West standard errorsMaximum lag: 1 | Number of obs = 77F (5, 71) = 9.85Prob > F = 0.0000 |
| farmland | Coef. | Newey-West Std. Err. | t | P>|t| | (95% Conf. Interval) |
| dummy1 | -2.820789 | 1.424324 | -1.98 | 0.052 | -5.660811 | -.0192323 |
| dum1qn | .0448175 | .0256499 | 1.75 | 0.085 | -.0063268 | .0959619 |
| \_t | .0020832 | .0052682 | 0.40 | 0.694 | -.0084213 | .0125877 |
| \_x54 | -.5878911 | .2051302 | -2.87 | 0.005 | .996909 | -.1788732 |
| \_x\_t54 | -.0100889 | .0074787 | -1.35 | 0.182 | -.025001 | .0048232 |
| \_cons | .722382 | .1697363 | 4.26 | 0.000 | .3839375 | 1.060827 |
| Post-Intervention Linear Trend: |
| Treated: \_b (\_t) + \_b (\_x\_t54) |
| Linear Trend | Coef.  | Std. Err.  | t | P>|t| | (95% Conf. Interval) |
| Treated | -0.0080 | 0.0055 | -1.4532 | 0.1506 | -0.0190 | -0.0030 |

In the first quarter of the intervention (4th quarter 2008) by SM crisis there appeared to be a significant decrease in increasing rate of interest rate which represent -2.821 percent (P <0.052), followed by a significant increase in the quarterly trend of value change (Linden, 2015). The second purse intervention was initiated by SM crisis in the 4th quarter in 2008 to the 4th one in 2009. The model2 is estimated using Newey with 1 lag. As shown in Table 4, the starting level of interest rate was estimated at 0.722, and the increasing rate of interest rate appeared to decrease significantly every quarter to the 4th quarter 2008 by -0.588 (P<0.005, CI=-0.997, -0.179). It can also be seen from the Lincom estimate produced by specifying post-trend, that after the introduction of SM crisis, interest rate decreased quarterly at a rate of -0.008 (P<0.150, CI -0.019, 0.003). Appendix 2 provides a visual display of these results.

At third it analyses the effects of IMF and SM crises assuming two interruptions in ITSA. It evaluates whether the introduction of IMF and SM crises resulted in a shift in the level and trend of increasing of farmland value compared with those of the pre-intervention period. In this paper is also specified a single group ITSA. The model3 is estimated using Newey-stand error regression as it is in <Table 5>.

<Table 5> The Interruption Effect of Both Interruptions (IMF and SM: Model3)

|  |  |
| --- | --- |
| Regression with Newey-West standard errorsMaximum lag: 1 | Number of obs = 77F (7, 69) = 18.44Prob > F = 0.0000 |
| farmland | Coef. | Newey-West Std. Err. | t | P>|t| | (95% Conf. Interval) |
| dummy1 | -3.497455 | 1.467952 | -2.38 | 0.020 | -6.425939 | -.5689713 |
| dum1qn | .0568489 | .0263618 | 2.16 | 0.035 | .0042585 | .1094394 |
| \_t | -.0096364 | .013341 | -0.72 | 0.473 | -.0362509 | .0169782 |
| \_x11 | -.948232 | .2487591 | 3.81 | 0.000 | .4519712 | 1.444493 |
| \_x\_t11 | -.0085357 | .0152511 | -0.56 | 0.578 | -.0389608 | .0218893 |
| \_x54 |  |  | -1.56 | 0.123 | -.6254937 | .0761742 |
| \_x\_t54 |  |  | 1.11 | 0.270 | -.0078842 | .0277676 |
| \_cons | .722382 | .1697363 | 4.71 | 0.000 | .2672691 | .6607309 |
| Post-Intervention Linear Trend: |
| Treated: \_b (\_t) + \_b (\_x\_t11) + \_b (\_x\_t54) |
| Linear Trend | Coef.  | Std. Err.  | t | P>|t| | (95% Conf. Interval) |
| Treated | -0.0082 | 0.0056 | -1.4639 | 0.1478 | -0.0194 | -0.0030 |

In the first quarter of IMF intervention (1st quarter in 1998) there appeared to be a significant decrease in increasing rate of farmland value which is -3.500 (P <0.020). Both IMF and SM crises are 0.948 and -0.274. As shown in Table 5, it can also be seen from the Lincom estimate produced by specifying post-trend, that after the introductions of IMF and SM crises, farmland value deceased quarterly at a rate of -0.008 (P<0.148, CI -0.019, 0.003). Appendix 3 provides a visual display of these results.

Finally in this paper we are comparing IMF and SM crises and both interruptions with each other as it is shown in <Table 6>.

<Table 6> The Comparison of the Interruption Effects among Models

|  |  |  |  |
| --- | --- | --- | --- |
| Variable  | model1 | model2 | model3 |
| dummy1 | -3.499\*\*\* | -2.821\*\*\* | -3.497\*\*\* |
| dum1qn | 0.054\*\*\* | 0.045\*\*\* | 0.057\*\*\* |
| \_t | -0.010 | 0.004 | -0.010 |
| \_x11 | 0.996\* |  | 0.948 |
| \_x\_t11 | -0.011 |  | -0.009 |
| \_x54 |  | -0.588 | -0.275 |
| \_x\_t54 |  | -0.010 | 0.010 |
| \_cons | 0.464 | 0.722\*\*\* | 0.464 |
| r2 | 0.427 | 0.384 | 0.429 |
| Legend: \* p< .1; \*\*p < .05; \*\*\* p < .01 |

The effect of IMF crisis model (Model 1) has the highest effects on the decreases of farmland value. The second one is SM crisis model. The third one is the effects of both interruptions. In other words by this study we noted that IMF economic crisis highly effects on the change of farmland value. Therefore, we should consider the interruption effects on the change of farmland value in establishing the actuarial model for estimating the month payment amount of farmland reverse mortgage (FP).

* 1. *Interruption Effects on the Interest Rate*

The same method can be applied to the change of interest rates.

<Table 7> The Comparison of the Interruption Effect on the Interest Rates among Models

|  |  |  |  |
| --- | --- | --- | --- |
| Variable  | model4 | model5 | model6 |
| dummy1 | 7.423\*\*\* | 4.311\*\*\* | 7.125\*\*\* |
| dum1qn | -0.126\*\*\* | -0.077\*\*\* | -0.127\*\*\* |
| \_t | -0.198 | -0.175 | -0.198 |
| \_x11 | -3.873\*\*\* |  | -3.533\*\*\* |
| \_x\_t11 | 0.125 |  | 0.107 |
| \_x54 |  | 2.092\*\* | 0.781 |
| \_x\_t54 |  | 0.084 | 0.001 |
| \_cons | 13.423\*\*\* | 11.971\*\*\* | 13.423\*\*\* |
| r2 | 0.906 | 0.849 | 0.908 |
| Legend: \* p< .1; \*\*p < .05; \*\*\* p < .01 |

As shown in Table 7, the starting level of interest rate change was estimated at 13.423 in model 4 (IMF), 11.971 in model 5 (SM), and 13.423 in model 6 (both interruptions). Interest rate is decreased -3.873 (P<0.01) by IMF economic crisis, interest rate is increased 2.092 (P<0.05) by SM crisis, and interest rate is decreased -3.533 (P<0.01) by both interruptions.

* 1. *Interruption Effect on the Net Discount Ratio*

Eq.1 might represent a suitable explanation of long term land value because it is based on the rational expectation for the future. However, this model cannot explain the shorter change of land value since of speculation bubbles, economic recession, policy interruption, time-varying discount rates, and short term fads (Burt, 1986). The change of land value at the future certain time (*N*) depends upon the change rate of land value (gt) and discount rate (rt). The present value model on the land value at the certain time (*n*) can be presented like in equations 3 and 5 (Ma & Cho, 2003; Cho et. al., 2009; Yeo & Cho, 2010; Cho and Yeo, 2015).

Eq. 5. $PV=\frac{FP\_{N}}{\prod\_{t=1}^{N}(1+r\_{t})}=\frac{FP\_{0}\prod\_{t=1}^{N}(1+g\_{t})}{\prod\_{t=1}^{N}(1+r\_{t})}=FP\_{0}\prod\_{t=1}^{N}\frac{(1+g\_{t})}{(1+r\_{t})}$

Where

*PV - The present value at the future certain time (N); PV0 – Level of farmland value at time (0); PVN – Level of farmland value at the future certain time (N); gt – The increasing rate of farmland value at the time period (t); rt – The discount rate at time period (t).*

Eq. 5 forecasts the future farmland value, which change rate of farmland value at the certain time *N* is reflected and this forecasted value is discounted by the cumulated return rate at the time *N*. This method calculates the present value of farmland.

In Eq.5, $\frac{(1+g\_{t})}{(1+r\_{t})}$ is the net discount ratio and it can be presented as $\frac{1}{(1+k\_{t})}$, and $k\_{t}$ is the net discount rate. The net discount ratio is presented in Eq.6.

Eq.6. $\frac{(1+g\_{t})}{(1+r\_{t})}$ = $\frac{1}{(1+k\_{t})}$

In order to forecast the long term farmland value, the previous time series of net discount ratio and net discount rate should be stationary. In that case, the historical mean values of these two values can be utilized in forecasting the future land value.

The same method can be applied to the change of net discount ratio.

Table 8. The Comparison of the Interruption Effect on the Net Discount Ratio among Models

|  |  |  |  |
| --- | --- | --- | --- |
| Variable  | model7 | model8 | model9 |
| dummy1 | -0.376\*\*\* | -0.253\*\*\* | -0.369\*\*\* |
| dum1qn | 0.005\*\*\* | 0.004\* | 0.006\*\*\* |
| \_t | 0.001 | 0.004\*\*\* | 0.001 |
| \_x11 | 0.192\*\*\* |  | 0.171\*\* |
| \_x\_t11 | -0.001 |  | 0.000 |
| \_x54 |  | -0.149\*\* | -0.096 |
| \_x\_t54 |  | -0.001 | 0.003 |
| \_cons | 0.103 | 0.139\*\*\* | 0.103 |
| r2 | 0.516 | 0.456 | 0.532 |
| Legend: \* p< .1; \*\*p < .05; \*\*\* p < .01 |

As shown in Table 8, the starting level of net discount ratio was estimated at 0.103 in model 7 (IMF), 0.139 (P<0.01) in model 8 (SM), and 0.103 in model 9 (both interruptions). Net discount ratio is increased 0.192 (P<0.01) by IMF economic crisis. It means that the increasing rate of interest rate is higher than that of farmland value. Net discount ratio is decreased -0.149 (P<0.05) by SM crisis. Net discount ratio is increased 0.171(P<0.05) by IMF crisis and -0.096 by SM crisis in model 9.

1. **Conclusion**

In this paper we noted the external effects which, using ITSA, have changes on the time series trend. When data are available for multiple time-points in both, the pre- and post-intervention periods, interrupted time-series designs offer a robust quasi-experimental alternative for evaluating treatment effects. For the first time, the purse effects of the IMF and SM crises and both interruptions on farmland value, interest rate, change rate, and net discount ratio were estimated in this study to improving the actuarial model of farmland pension system. To accomplish this, a case study mode was developed and used for all the quarterly value index data of farmland value, interest rate, and net discount ratio which are three key variables in estimating the monthly payment amount of farmland pension model to solve the living cost shortage of elderly farmers in the rural area. These data sets were provided by Ministry of Land, Infrastructure and Transport (MLIT) for a period of 77 quarter from the 2nd quarter 1995 to 2nd quarter 2014 in order to include the IMF economic crisis period which implements the highest effect on the change of farmland value.

Analysis results are composed of three different categories which are the change of farmland value, the interest rate, and the net discount ratio. Each category contains three different models which are IMF crisis, SM crisis, and both interruptions in interruption time series analysis model. Table 6, 7, and 8 show the results of interrupted time series analyses. Especially IMF crisis interruption has highly significant effects on the change of farmland value, that of interest rate, and that of net discount ratio comparing to the SM crisis. More specifically, the change rate of farmland value is stationary and we can therefore use the historical means data of farmland value in forecasting the future farmland value without the differentiation process. However, the increasing rate of interest rate is not stationary and the first difference process is necessary in making the stationary time series data. After that we can use the historical means data for estimating the future interest rate. Based upon the previous analysis, we can conclude that the purse effects of IMF crisis, SM crisis, and both interruptions deteriorate the Korean economic recession. It might results in the less popularity of farmland pension system, because the less increasing rates of farmland values cause less monthly payment amount of FP for the elderly. In the methodological aspect, we should consider the external interruptions, such as public policy or big social incidents which are IMF and SM crises, as well as the accident of Sewolho submersion and so on, to build more robust model for estimating the monthly payment of FP and to promote the demand on the FP.

Hence, the Korean government should focus more on giving some policy priorities. First, the government should consider the domestic and foreign economic circumstances in building the real estate market policy, because the IMF economic crisis in Korea and the SM crisis in the USA affected directly the change of farmland price in the Korean rural areas. Secondly, the ARIMA, ITSA model etc. should be tested in order to figure out the suitable model for the long term forecasting of the three fundamental variables which have been analyzed in this study. Thirdly, until now, the historical mean value of time series data is used in long term forecasting if the time series data is stationary. However, this method cannot consider the external interruption effects on the time series data. Therefore, ITSA model should be used for the solid results which consider the interruption effects such as public policy and any other interruption. This paper also has some limitations. It only focused on a purse interruption model. However, it should be extended to the step interruption model considering the other interruption events including IMF and SM economic crises to get the more reliable results for the long term forecast of farmland values.

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*Appendix*



Appendix 1. The Visual Display of IMF Effects on the Land Value Change



Appendix 2. The Visual Display of SM Effects on the Land Value Change



Appendix 3. The Visual Display of Both Interruption Effects

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