

The Effects of Monetary Policy on Individual Welfares^{*}

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Monetary policy affects heterogeneously the individual welfare even though its main goals such as income growth and economic stability are well accomplished. This is because macroeconomic policy has different impact on individuals according to their income and other characteristics. Accordingly, monetary policy changes the status of income distribution and poverty. By using Panel System GMM estimation for household and province-level data of Korea from 1997 to 2007, this study investigates short and long-term effects of monetary policy on income distribution as well as poverty. The estimation results are as follows. First, real interest rate and poverty are positively correlated while real interest rate does not have significant effects on income distribution. Second, income growth reduces poverty and improves income distribution. Third, inflation reduces poverty while inflation improves income distribution in the short-term but has no significant effects on income distribution in the long-term. Fourth, long-term effects of monetary policy on poverty gap are greater than short-term effects by 60%. And long-term effects of monetary policy on poverty severity are larger than short-term effects by 53%. But for the Gini coefficient, effects of monetary policy do not last long because the coefficient's auto-correlation term is not significant.

JEL Classification: E0, E4, E5, I3

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1. INTRODUCTION

Monetary policy focuses on stabilization of macro variables such as unemployment and inflation rates. And yet, even though macroscopic measures successfully achieve goals like income growth and economic stability, both individual income and consumption levels might be differently affected. In other words, with average effect of macro changes considered, monetary policy influences the rich and the poor at different levels.

There are many studies on determinants of and trends in poverty and income distribution. However, there are not many studies that analyze poverty and inequality by relating to macroeconomic stabilization policy, especially, monetary policy. Romer and Romer (1999) analyze short-term and long-term effects of monetary policy on poverty and inequality. They used simple regression on the U.S. time-series data for short-term effects and on cross-country panel data for long-term effects. Their study shows that the results of short-term analysis are in contrast to the results of long-term analysis. The fall of interest rate by expansionary monetary policy improves poverty in the short-term while it has no obvious impact on income distribution. However, in the long-term, expansionary monetary policy diminishes the income of the poor and aggravates the inequality.

However, there are some problems in their analysis. First, they use different data set for the short and long-term analysis. Second, they do not consider possible endogeneity of independent variables, especially a lagged dependent variable. By taking into account these problems together, this study aims to precisely understand heterogeneous effects of monetary policy on the welfare of individual economic agents, poverty and income inequality. It is assumed that interest rate reflects the effect of monetary policy. This assumption is based on the fact that the central bank considers interest rate as a key variable for monetary policy. There are other determinants such as inflation rate, provincial GDP, and provincial unemployment rate.

Unlike Romer and Romer (1999), this paper tries to overcome econometric problems and maintains consistency of data in both short-term and long-term

analyses. For example, the person who gets employed through expansionary monetary policy will keep that job for quite a long time. In this case, monetary policy affects poverty and income distribution not only in the short-term but also in the long-term. Second, in consideration of endogeneity and heteroscedasticity of various independent variables, Panel System GMM estimation for the long-term effects is used.

This estimation results indicate several interesting findings. First, real interest rate and poverty have significantly positive relation, while both income growth and inflation rate are negatively correlated to poverty. Second, real interest rate does not have statistically significant effects on the Gini coefficient while income growth and inflation rate decrease the Gini coefficient. Third, current economic hardship continues until the next term but the Gini coefficient has no lasting effects. Fourth, the short-term and long-term effects of monetary policy on poverty are compared. The comparison shows that monetary policy has long-term effects on poverty. For poverty gap, 60% of short-term effects continue in long-term. For poverty severity, it is 53%.

The paper is organized as follows: Section 2 analyzes previous studies on macroeconomic policy, poverty and inequality. Section 3 describes the data used in empirical analysis. Section 4 explains models and estimation methodology. Section 5 provides results of empirical study on how monetary policy influences poverty and inequality. Section 6 concludes with a brief summary.

2. LITERATURE REVIEW

Unlike many studies about trends and causes of poverty and inequality, there are not so many papers on how macroeconomic policy affects microeconomic variables. A research by Romer and Romer (1999) makes empirical attempts to analyze the effect of monetary policy on poverty and inequality. They analyze short-term influence of monetary policy on

poverty and inequality using the U.S. time series data. For examining the long-term effects, cross-country data was used. Their study shows that the results of short-term analysis are in contrast to the results of long-term analysis. The fall of interest rate by monetary policy improves poverty in the short-term. But in the long-term, expansionary monetary policy increases poverty by decreasing the income of the poor with more macroeconomic volatility. Furthermore, it aggravates the income inequality by increasing inflation in the long-term.

They explain the process through which monetary policy influences poverty and inequality as follows. First, in the short-term, monetary policy directly decreases poverty by enlarging average income. Under the assumption of fixed income-distribution, average income growth raises everyone's income and therefore, poverty decreases. Second, monetary policy changes the status of poverty through income distribution. For the low-tech labor force, in particular, monetary policy lowers unemployment rate and increases economically active population and real wage. At the same time, monetary policy drives up the average income and lessens poverty. Third, when prices rise with lower interest rate, poverty may get worse due to diminishing real value of wage and transfer income.

From theoretical point of view, Ferreira *et al.* (1999) explains that a macroeconomic shock can affect poverty through the different sources of household income such as self-employment income, wages, returns on physical assets and the receipt of public transfer. And they categorized those effects into several channels. They explain that macroeconomic shocks can affect the poor households through the changes in relative prices, labor demand, the rate of return on assets, public transfers, and the community environment. And they propose the proactive ways and counter measures to minimize such negative impacts on the poor by explaining the theories.

Easterly and Fischer (2001) analyze the relationship between inflation and poverty by using household data of 38 countries. They conclude that inflation makes the poor worse off and that the poor suffer more from

inflation than the rich do. Also their research findings suggest that inflation aggravates income imbalance.

Furthermore, Agénor (2004) comprehensively analyzes the linkage between macroeconomic adjustment process and poverty. Based on cross-country data, the author analyzes effects of fiscal policy on wage, employment, and poverty. In brief, it shows that poverty is lowered by high levels of per capita income, the fall of real exchange rate, good health care and great openness in industry lower poverty. On the other hand, poverty is heightened by inflation, greater income inequality, and macroeconomic volatility.

Some recent studies have conducted empirical analysis on the relationship between inflation and income inequality. Using national panel data, Crowe (2006) concludes that there is a positive correlation between inflation and income inequality. Similarly Albanesi (2007) analyzes the hypothesis that the cross-country correlation between inflation and income inequality results from distributional conflict. The model used in this analysis presents that inflation and income inequality are positively correlated for the relative vulnerability to inflation of the poor. That is, the poor are likely to hold more currency as a portion of their entire purchases and suffer greater loss from inflation than the rich do.

Given these previous literatures as mentioned above, a conclusion is reached: macroeconomic policy affects poverty and income inequality through income growth, interest rate and inflation.

This research is based on the findings of Romer and Romer (1999) and other previous literature, yet, data and analytic methods are different. First the effects of income growth, interest rate changes and inflation on poverty and inequality are analyzed in the short and long-term separately. The Romer and Romer (1999) classified the effects of monetary policy into short and long-term as well, but different data sets were used for each term. In contrast, this research uses the same microeconomic data for both periods, making it useful to analyze the constant impact of macroeconomic policy on the utility of each economic player. Also previous researches are using

national panel data in estimating short and long-term effect, this study comes up with Korea's provincial panel data and then estimates long-term effects using Panel system GMM. The purpose is to separately examine the short- and long-term effects of monetary policy by reflecting the possibility of the past social welfare levels affecting the present levels.

Also, poverty and inequality are measured on the basis of consumption instead of income level. In the previous literature, as mentioned above, welfare indicators like poverty and inequality were measured based on income. There are still many discussions over which, between income and consumption, is a better social welfare indicator. For instance, Deaton (1997) says that, despite the fact that they both have merits and demerits, consumption is a more stable indicator than income. Taking that into consideration, this research uses consumption in analysis because it is deemed more appropriate under the permanent income hypothesis.

According to the estimation results, the correlation between interest rate and poverty turned out to be positive, which is consistent with that of Romer and Romer (1999). However, income growth and inflation are negatively correlated with poverty, which is contradictory to those of existing studies. And this presumably results from using different type of data and estimation methodology.

3. DATA

In order to measure individual welfare levels¹⁾ such as poverty gap index, poverty severity index and Gini coefficient, the KLIPS (Korean Labor and Income Panel Study) data is used. KLIPS is panel data of extensive surveys

¹⁾ Poverty and inequality as welfare indicators are measured by consumption level which is considered more proper for welfare measurement under Life Cycle and Permanent Income Hypothesis (Deaton, 1997). Since income variable is more fluctuated than consumption variable from the Life Cycle and Permanent Income Hypothesis, the individual welfare indicator based on consumption variable tends to be less sensitive to the measurement timing of welfare indicators.

on the labor market and income activities of households and individuals throughout the country. The 1st wave of KLIPS was launched by the Korea Labor Institute in 1998, and so far, up to the 11th wave of KLIPS is available. Data on income and consumption in 2007 can be found in the 11th wave surveyed in 2008 because the survey questions in KLIPS cover income and spending levels in the previous year. Meanwhile, to analyze the effects of monetary policy on welfare, macro variables based on the database of Bank of Korea and Statistics Korea were used: interest rate, unemployment rate, GDP per capita and inflation rate.

In measuring individual welfare, equivalence scale needs to be considered. In this study, the OECD Oxford index is used to measure consumption and poverty based on adult equivalence index. The Oxford index gives a weight of one unit to the household's first adult, 0.7 to an additional adult and 0.5 to an additional child.

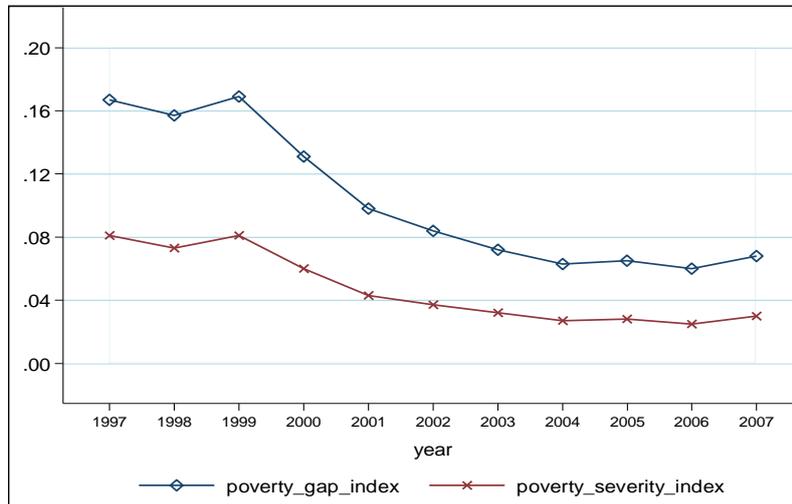
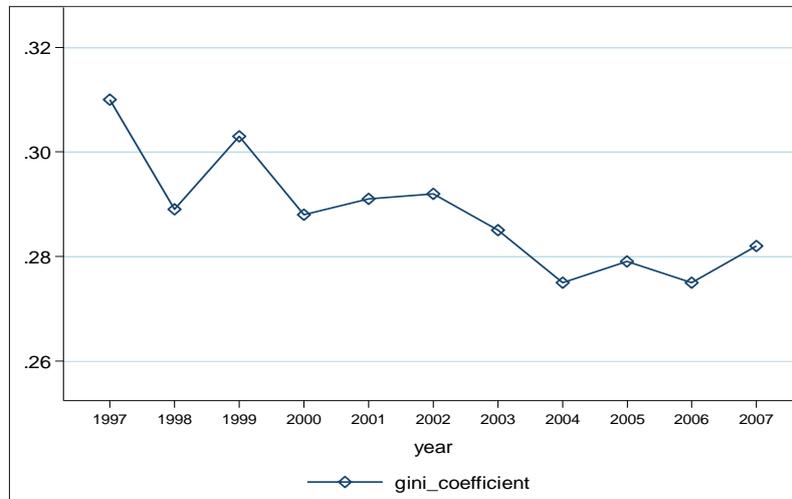
Along with the equivalence scale, welfare indicators as dependent variables are based on adult equivalent per capita consumption to which the OECD equivalence index has been applied. The poverty line is drawn with the minimum cost of living issued by the Ministry of Health, Welfare and Family Affairs. All variables related to income and consumption are converted to real variables by using the consumer price index.

To come up with poverty related index such as provincial poverty gap and poverty severity index, this study used FGT index suggested by Foster *et al.* (1984).²⁾ Figure 1 shows the average of poverty gap index and poverty

²⁾ The FGT poverty index is defined as following equation.

$$FGT(\alpha) = \theta_{\alpha, jt} = \int_0^z \left(\frac{z - c_{ijt}}{z} \right)^\alpha f(c_{ijt}) dc.$$

In the equation above, z is the poverty line, c_{ijt} is i th household consumption in province j at time t and $f(c_{ijt})$ is a probability density function of household consumption. α is a parameter according to which different kinds of poverty index are classified. If $\alpha = 0$, it is the same as counting the number of households in poverty and it is called "head-count ratio". If $\alpha = 1$, it measures the degree of poverty by figuring out

Figure 1 Trend of Poverty Gap and Poverty Severity Index**Figure 2 Trend of Gini Coefficient**

the gap between the poverty line and actual consumption, with equal weight on each individual. It is called “poverty gap index”. If $\alpha = 2$, it measures the degree of poverty by squaring the gap between the poverty line and actual consumption, with larger weight on poorer households. This is called either “poverty severity index” or “poverty gap square”.

severity index from 1997 to 2007. As shown in the graph, since 1997 poverty has continued to decrease in Korea.

Figure 2 shows the average of provincial Gini coefficient³⁾ from 1997 to 2007. Inequality measured with consumption-based Gini coefficient fluctuates with overall decreasing trend.

Recent studies on inequality in Korea show that income inequality has gone worse since 2005. However, it is found that consumption inequality has been improved in 2006 but aggravated in 2007. There are three possible reasons for these different results.⁴⁾

First, different results may have been caused by using data from different sources. Income-based Gini coefficient and by the Statistics Office of Korea, Yoo (2008), Sung (2009) and Kang and Lee (2009) use the Household Income and Expenditure Study. This paper and Kang (2010) use the KLIPS. Second, the Gini coefficients by the statistical Office of Korea and Yoo (2008) and Sung (2009) are calculated in terms of income while those in this research, Kang (2010) and Kang and Lee (2009) is based on household per capita consumption. Third, different ways in applying equivalence process could have led to different findings. Each study either had its own equivalence process or no process at all.

Table 1 and table 2 show provincial poverty gap index and poverty severity index respectively. During the Asian financial crisis of 1997-1998, poverty indexes reached peaks. Other than that, poverty indexes seem to be decreasing in most provinces. South Chungcheong had the highest level of poverty during the Asian financial crisis and the fourth highest poverty level in 2007. Ulsan had the lowest level of poverty during financial crisis and also in 2007, proving the highest level of welfare.

³⁾ The Gini coefficient is taken as an indicator associated with inequality. Gini coefficient is a typical indicator which determines inequality and obtained by the following equation. In the equation, $L(c_{ijt})$ is Lorenz curve measured in consumption quantile.

$$G_{jt} = 1 - 2 \int_0^1 L(c_{ijt}) dc.$$

⁴⁾ See Kang (2010) for details.

Table 1 Poverty Gap Index

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.126	0.093	0.072	0.071	0.050	0.051	0.044	0.038	0.041	0.044	0.049
Busan	0.123	0.170	0.134	0.096	0.082	0.074	0.064	0.064	0.062	0.056	0.055
Daegu	0.142	0.131	0.146	0.131	0.070	0.047	0.050	0.057	0.060	0.041	0.057
Daejeon	0.133	0.128	0.197	0.121	0.055	0.055	0.036	0.034	0.036	0.033	0.041
Incheon	0.159	0.106	0.127	0.115	0.083	0.072	0.054	0.050	0.065	0.052	0.056
Gwangju	0.151	0.176	0.201	0.121	0.108	0.083	0.097	0.081	0.079	0.063	0.090
Ulsan	0.110	0.087	0.084	0.068	0.029	0.019	0.015	0.018	0.017	0.012	0.027
Gyeonggi	0.122	0.106	0.117	0.085	0.062	0.052	0.043	0.041	0.041	0.038	0.033
Gangwon	0.194	0.156	0.221	0.196	0.162	0.106	0.120	0.089	0.084	0.073	0.099
North Chungcheong	0.179	0.165	0.144	0.157	0.117	0.078	0.068	0.061	0.048	0.050	0.050
South Chungcheong	0.289	0.276	0.254	0.221	0.176	0.203	0.158	0.100	0.113	0.110	0.098
North Jeolla	0.206	0.191	0.250	0.168	0.115	0.104	0.091	0.070	0.092	0.111	0.111
South Jeolla	0.237	0.232	0.263	0.190	0.152	0.117	0.102	0.079	0.068	0.069	0.086
North Gyeongsang	0.209	0.208	0.191	0.138	0.130	0.119	0.094	0.109	0.121	0.100	0.115
South Gyeongsang	0.129	0.129	0.130	0.087	0.079	0.074	0.047	0.048	0.052	0.044	0.046

Table 3 shows the provincial Gini coefficient. In every province except for Gangwon, the Gini coefficient is smaller in 2007 than in 1997 in the beginning of the financial crisis, showing improvements in consumption inequality.

From 1997 to 2007, North and South Jeolla, and Seoul had the high Gini coefficient. On the contrary, Ulsan had the lowest Gini coefficient during financial crisis. Given the same period, consumption inequality improved in North Chungcheong (by 22.4%), Seoul (by 15.2%) and Daejeon (by 14.1%). Consumption inequality improved the least in Ulsan (by 0.7%),

Table 2 Poverty Severity Index

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.058	0.034	0.029	0.027	0.020	0.020	0.017	0.014	0.016	0.018	0.020
Busan	0.056	0.075	0.056	0.039	0.034	0.031	0.028	0.028	0.025	0.022	0.023
Daegu	0.066	0.060	0.068	0.059	0.026	0.018	0.020	0.023	0.024	0.016	0.023
Daejeon	0.063	0.055	0.090	0.052	0.024	0.028	0.016	0.016	0.017	0.013	0.018
Incheon	0.078	0.042	0.058	0.045	0.039	0.032	0.025	0.022	0.028	0.021	0.027
Gwangju	0.069	0.081	0.098	0.054	0.054	0.038	0.049	0.041	0.038	0.032	0.044
Ulsan	0.046	0.033	0.031	0.025	0.009	0.008	0.004	0.006	0.005	0.002	0.010
Gyeonggi	0.056	0.045	0.050	0.034	0.026	0.019	0.017	0.016	0.016	0.016	0.013
Gangwon	0.088	0.072	0.113	0.095	0.065	0.043	0.061	0.036	0.035	0.034	0.045
North Chungcheong	0.080	0.070	0.065	0.082	0.057	0.035	0.029	0.025	0.017	0.017	0.019
South Chungcheong	0.158	0.147	0.132	0.109	0.077	0.097	0.077	0.042	0.048	0.043	0.042
North Jeolla	0.104	0.091	0.131	0.085	0.054	0.048	0.040	0.028	0.040	0.054	0.054
South Jeolla	0.125	0.122	0.145	0.089	0.073	0.056	0.042	0.033	0.030	0.026	0.036
North Gyeongsang	0.114	0.113	0.095	0.064	0.057	0.053	0.040	0.051	0.058	0.048	0.054
South Gyeongsang	0.055	0.053	0.058	0.034	0.032	0.031	0.017	0.017	0.019	0.014	0.019

Busan (by 1.7%), Daegu (by 3.6%). But only in Gangwon, consumption inequality is aggravated (by 5.8%).

Table 4 shows summary statistics. There is a total number of 165 observations because the study is based upon panel data in 15 provinces from 1997 to 2007.

Macro variables used in this study as explanatory variables are based on data from of the Bank of Korea and the Statistics Korea. They are provincial per capita GDP, provincial unemployment, national inflation, and interest rate. The above variables were chosen as explanatory variables because, as mentioned in precedent studies, macroeconomic policies can

Table 3 Gini Coefficients

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.346	0.278	0.278	0.290	0.282	0.298	0.294	0.287	0.284	0.296	0.294
Busan	0.294	0.281	0.271	0.286	0.292	0.284	0.284	0.283	0.280	0.287	0.289
Daegu	0.284	0.277	0.263	0.302	0.265	0.260	0.257	0.245	0.256	0.238	0.274
Daejeon	0.301	0.269	0.323	0.279	0.280	0.294	0.259	0.269	0.270	0.271	0.259
Incheon	0.310	0.277	0.297	0.262	0.242	0.263	0.249	0.241	0.267	0.273	0.267
Gwangju	0.316	0.327	0.331	0.285	0.317	0.323	0.324	0.292	0.311	0.280	0.304
Ulsan	0.258	0.219	0.254	0.236	0.259	0.278	0.245	0.226	0.212	0.241	0.257
Gyeonggi	0.304	0.280	0.291	0.269	0.269	0.279	0.282	0.283	0.271	0.268	0.271
Gangwon	0.304	0.273	0.324	0.335	0.315	0.298	0.319	0.296	0.308	0.290	0.322
North Chungcheong	0.308	0.284	0.317	0.315	0.285	0.311	0.271	0.271	0.250	0.257	0.239
South Chungcheong	0.322	0.327	0.320	0.306	0.290	0.279	0.300	0.242	0.281	0.289	0.288
North Jeolla	0.329	0.304	0.348	0.307	0.360	0.302	0.297	0.298	0.345	0.313	0.307
South Jeolla	0.356	0.385	0.345	0.328	0.355	0.351	0.329	0.315	0.298	0.301	0.323
North Gyeongsang	0.323	0.307	0.299	0.263	0.286	0.304	0.298	0.333	0.299	0.285	0.285
South Gyeongsang	0.293	0.244	0.277	0.252	0.268	0.254	0.264	0.246	0.249	0.237	0.258

Table 4 Summary of Statistics

Variable	Obs.	Mean	Standard Deviation	Min.	Max.
Poverty Gap Index	165	0.103	0.059	0.012	0.289
Poverty Severity Index	165	0.047	0.032	0.002	0.158
Gini Coefficient	165	0.288	0.03	0.212	0.385
Call Rate (%)	165	2.843	2.743	-0.595	9.42
Unemployment Rate (%)	164	3.846	1.661	0.7	9.1
Log Provincial Income per Capita	165	6.693	0.266	6.087	7.302
Inflation Rate (%)	165	3.257	1.737	0.065	8.751

Notes: 1) Measuring unit of Provincial GDP per capita is 10,000 won annually. 2) Provincial data of poverty gap index, poverty severity index, Gini coefficient and income per capita are calculated using Korean Labor and Income Panel Study (KLIPS). 3) Call rate, unemployment rate, inflation rate are from the Bank of Korea and the Statistics Korea.

have impact on poverty and inequality, through incurring changes in income growth, interest rate, and inflation. Provincial unemployment rate and provincial per capita GDP are set as variables that reflect income growth. This is different from how other precedent studies used national panel data to measure income levels. Annually, provincial unemployment rate is provided by the Bank of Korea. Provincial per capita GDP is obtained through dividing provincial GDP (issued by the Bank of Korea) by the number of people in the area (issued by the Statistics Korea).

Call rate is used as our explanatory variable because the central bank adjusts nominal call rate to control price changes. In fact, the call rate is equal to nominal call rate minus inflation rate.⁵⁾ The rate is used to estimate pure interest rate effects. Since nominal interest rate can be highly affected by inflation, it is hard to measure pure interest rate effects.

Lastly, inflation rate is calculated by using consumer price index. In fact, inflation rate can be calculated with GDP deflator. However, because this paper concentrates on poverty and inequality related to consumption, it seems more appropriate to use consumption price index.

4. MODEL SPECIFICATION

Assume that income (y) is determined by individual abilities (a) and

⁵⁾ Usually, the following equation is used to come up with real interest rate. This contains the expected inflation rate, which is the expected value of annual inflation rate.

$$\text{Real interest rate} = \frac{1 + \text{Nominal interest rate}}{1 + \text{Expected inflation rate}} - 1.$$

Real interest rate is calculated by subtracting inflation from nominal interest rate. However, call rate is 1-day data in general. To get real interest rate, we need to deduct 1 day inflation rate but the price may not rise during 1 day. Thus, the expected inflation rate is nearly "0" and it might not be improperly called nominal interest as real interest rate in case of using "call rate". Two values are almost same. All the words of profound gratitude go to an anonymous referee who gave useful comments on the above real interest rate equation.

other factors (p) like economic policy, and that consumption (c) is determined by income (y) and time preference (γ). Supposing that income and consumption maximize utility, equation (1) and equation (2) are formed. In equations (1) and (2), i is individual household, j is a province and t is time.

$$y_{ijt} = Y(a_{ijt}, p_{jt}), \quad (1)$$

$$c_{ijt} = C(y_{ijt}, \gamma). \quad (2)$$

Based on poverty and inequality index defined in the previous chapter, FGT poverty index and Gini coefficient are shown in equations (3) and (4) respectively.

$$\theta_{a,jt} = \theta(c_{jt}, p_{jt}), \quad (3)$$

$$G_{jt} = G(c_{jt}, p_{jt}). \quad (4)$$

Among the determinants of poverty and inequality, three control variables which are real interest rate, inflation, and provincial GDP per capita, are considered in equations (3) and (4).

First, real interest rate brings heterogeneous effects on individual economic agents. Individuals determine current and future spending depending on real interest rate, and return of real asset changes due to fluctuating real interest rate. And it is considered to be correlated with monetary policy. Second, inflation affects individual real income or spending when individual wages and income do not fluctuate to the same extent as inflation. Also, in empirical analysis, inflation is included as other factor (p) that controls the gap between real and nominal interest rates. Third, provincial per capita GDP is considered because a change in aggregate demand affects individual income and consumption. Aggregate demand will be affected by monetary policy.

Considering these independent variables for equations (3) and (4), short and long-term model specifications are assumed by equation (5).

$$w_{jt} = \alpha + \delta w_{jt-1} + \beta_1 r_t + \beta_2 GDP_{jt} + \beta_3 \pi_t + u_j + \varepsilon_{jt}, \quad (5)$$

$$E[\varepsilon_{jt}] = 0, \quad E[\varepsilon_{jt}^2] = \sigma_\varepsilon^2, \quad E[\varepsilon_{jt} \varepsilon_{ks}] = 0, \quad \text{if } j \neq k, t \neq s, \quad (6)$$

$$E[u_j] = 0, \quad E[u_j \varepsilon_{jt}] = 0, \quad E[u_j^2] = \sigma_u^2, \quad E[u_j u_k] = 0, \quad \text{if } j \neq k. \quad (7)$$

w_{jt} , a dependent variable for province (j) at time (t), represents the poverty gap index, the poverty severity index and the Gini coefficient.⁶⁾ α is a constant term. w_{jt-1} is the auto-correlation term which is a lagged dependent variable in order to measure long-term effects. r_t and π_t denote interest rate and inflation rate at a period t , respectively. GDP_{jt} is per capita GDP for province (j) at a period (t). u_j is a specific error term for province (j) and ε_{jt} is white noise. $\beta_1, \beta_2, \beta_3$ are parameters that need to be estimated. u_j and ε_{jt} satisfy equations (6) and (7).

Even if error term conditions in equations (6) and (7) are met, estimator is not consistent under fixed and random effects models. It is because of specific errors included in the auto-correlation term. Therefore, for a consistent estimator and an efficient estimate, the Panel System GMM (Blundell and Bond, 1998) is used. $\delta > 0$ indicates that current welfare is related with that of next period.

Several tests need to be done to make sure the equation (5) is consistently estimated by the Panel System GMM with proper instrumental variables. Auto-correlation (AR) test is the first one. AR test examines whether instrumental variables have an appropriate time order. There are order 1 and 2 AR tests. The Panel System GMM is considered proper when order 1

⁶⁾ In this study, headcount index is not included as a dependent variable. Headcount index might be inappropriate for measuring social welfare because it fails to show poverty severity. The index only provides information on the number of households in poverty.

AR test rejects the null hypothesis and order 2 AR test accepts the hypothesis. Second, the Sargan test is over-identification test of instrumental variables. The Panel System GMM is considered appropriate when the test accepts the null hypothesis. With equation (5), short-term effects and long-term effects can be calculated through equations (8) and (9) respectively.

$$\text{(Short run effect)} = \frac{\partial y_t}{\partial x_t} = \beta_x, \quad (8)$$

$$\text{(Long run effect)} = \frac{(\sum_{t=s}^{\infty} \partial y_t)}{\partial x_s} = \frac{\beta_x}{(1-\delta)}. \quad (9)$$

From equation (5), β_1 , β_2 , and β_3 respectively captures the marginal effect of current real interest rate, income growth and inflation on the current welfare, which is the short-term effect in equation (8). But if the coefficient of auto-correlation term (δ) is significantly positive, the welfare in the past can affect the current welfare. Also β_1 , β_2 , and β_3 affect both current and next period of welfare such as poverty and inequality. Thus, the effects of monetary policy on welfare will become accumulated along the infinite geometric sequence with the common ratio δ , which is the long-term effect in equation (9).

5. ESTIMATION RESULTS

The effects of monetary policy on poverty and inequality are studied through empirical analysis. Using the Panel System GMM where auto-correlation term is included, an empirical analysis on short and long-term effects of the monetary policy is conducted.⁷⁾

⁷⁾ When it comes to monetary policy, simultaneous analysis for liquidity, income and price level is often considered. Though we have not focused on such channels for simplicity in this paper, interest rate and other explanatory variables such as GDP and inflation rate can

Tables (5)-(7) show the results of Panel System GMM estimation on short and long-term effects of monetary policy when the poverty gap index, poverty severity index and the Gini coefficient are dependent variables, respectively. Each table presents three types of model: first model includes call rate and unemployment rate as independent variables. Second model includes call rate and log provincial per capita GDP as independent variables. In the third model, call rate, log provincial per capita GDP and inflation rate are included as independent variables.

Auto-correlation terms are included as an independent variable. For every empirical model that includes auto-correlation term, both AR and Sargan tests exhibit whether instrumental variables used in the estimation are appropriate.

Table 5 indicates the estimation results on poverty gap.

First, interest rate, income growth and inflation are shown to be significant as in the short-term. An auto-correlation term which is important in measuring long-term effects has significantly positive effects on current poverty. This means that poverty persists and that present independent variables influence current period's dependent variables until next period.

By applying the results in table 5, short-term and long-term effects of monetary policy on poverty gap can be compared. These short-term and long-term effects are well defined in equations (8) and (9). For call rate, it is 0.0115 in long-term and 0.0072 in short-term. For log provincial per capita GDP, it is -0.0967 in long-term and -0.0603 in short-term. For inflation, it is -0.0062 and -0.0039 in long-term and short-term, respectively. Overall, long-term effects are greater than short-term effects by 60%. This

be interacting in the monetary transmission mechanism. In fact, the correlations between explanatory variables in this study are as follows: -0.6568 between interest rate and GDP, 0.4221 between interest rate and inflation rate, and -0.2565 between GDP and inflation rate. This means that there can be multicollinearity among explanatory variables. However, multicollinearity does not seem to have a decisive impact on this study. Meanwhile, we have tried additional estimations with different model specifications in order to test the robustness of variables. When compared with the original results of the research, the coefficients of interest rate, GDP, and inflation rate had consistency in their signs and statistical significance, and therefore, they are robust. We would express our gratitude to the anonymous referee for this comment on monetary transmission mechanism.

Table 5 Long-term Effects of Monetary Policy on Poverty Gap

	Model (1)	Model (2)	Model (3)
Poverty Gap Index ($t-1$)	0.4994 ^{***} (0.063)	0.3914 ^{***} (0.054)	0.3760 ^{***} (0.067)
Call Rate	0.0036 ^{***} (0.001)	0.0062 ^{***} (0.001)	0.0072 ^{***} (0.001)
Unemployment Rate	0.0101 ^{***} (0.003)		
Log Provincial GDP per Capita		-0.0560 ^{***} (0.013)	-0.0603 ^{***} (0.015)
Inflation Rate			-0.0039 ^{***} (0.001)
Constant Variable	-0.0050 (0.006)	0.4173 ^{***} (0.095)	0.4583 ^{***} (0.109)
AR Test : Order (1)	-3.055 $p=0.002$	-2.806 $p=0.005$	-2.609 $p=0.009$
AR Test : Order (2)	-1.146 $p=0.2517$	0.484 $p=0.629$	0.717 $p=0.473$
Sargan Statistics	62.759 $p=0.169$	63.828 $p=0.147$	59.180 $p=0.260$
Observations	150	150	150
Number of Regions	15	15	15

Notes: 1) Numbers in parentheses are standard deviations. 2) ^{***}, ^{**}, ^{*}: statistically significant at 1%, 5% and 10% level. 3) GMM-type instrumental variables for difference equations use dependent variables before $t-2$. 4) Standard-type instrumental variables for difference equations are differences of independent variables. 5) GMM-type instrumental variables for level equations use difference value of dependent variables before $t-1$. 6) Standard-type instrumental variables for level equations are constant variables.

means that 60% of short-term effects have additional influence on the next period.

All things considered, interest rate and poverty gap have significantly

positive correlation. So it can be said that rising interest rate leads to greater poverty gap. There are two reasons behind this.

First, most poor people are highly likely to be net debtors. To them, higher interest rate may be a burden, causing them to cut back their spending.

Second, other than net debtors, any people in poverty⁸⁾ can face worse situation due to substitution effects of interest rate. When interest rate climbs, opportunity cost of present consumption increases, reducing current spending and enlarging future consumption. Accordingly, poor people will cut back consumption, causing greater poverty gap and poverty severity.

Income growth has significantly negative effects on poverty. When income increases, poverty decreases, which is consistent with the result of Son (2002).⁹⁾ With other variables fixed, it is natural to see that rising income swells consumption. This will lessen poverty gap and raise possibility to get out of poverty.

Inflation and poverty have significantly negative correlation. Theoretically, this may not be apparent because inflation rate does not have direct effects on real variables like real income and real consumption. But inflation is still considered as an indicator of economic cycles. For example, when poor people observe higher inflation and predict the economy will improve, they can surely spend more, at least for the short-term. In this way, inflation improves poverty.

Table 6 indicates short-term and long-term effects of monetary policy on poverty severity. For call rate, it is 0.0058 in long-term and 0.0038 in short-run. For log provincial per capita GDP, it is -0.0518 in long-term and -0.0341 in short-run.

⁸⁾ Kim (2008) shows that low-income people are not classified into net debtor group with the 1st income quintile's average financial assets of 19.17 million won and financial debt of 10.07 million won in 2006. And yet, their financial debt is huge compared to their income. So it can be inferred that they are less likely to clear interest payment.

⁹⁾ Son (2002) investigates on the determinants of poverty by using Korea's FIES (Family Income and Expenditure Survey) between 1990 and 1999. The estimation results present that headcount ratio, poverty gap and severity measured by income or consumption decline when GDP per capita increases. However, poverty increases when unemployment rate decreases.

Table 6 Long-term Effects of Monetary Policy on Poverty Severity

	Model (4)	Model (5)	Model (6)
Poverty Severity Index ($t-1$)	0.4736*** (0.060)	0.3391*** (0.069)	0.3410*** (0.078)
Call Rate	0.0018** (0.001)	0.0032*** (0.001)	0.0038*** (0.001)
Unemployment Rate	0.0057*** (0.002)		
Log Provincial GDP per Capita		-0.0344*** (0.009)	-0.0341*** (0.009)
Inflation Rate			-0.0024*** (0.001)
Constant Variable	-0.0064* (0.004)	0.2510*** (0.062)	0.2552*** (0.068)
AR Test : Order (1)	-2.999 $p=0.003$	-2.865 $p=0.004$	-2.757 $p=0.006$
AR Test : Order (2)	-0.862 $p=0.389$	0.825 $p=0.409$	0.9836 $p=0.325$
Sargan Statistics	59.307 $p=0.257$	60.433 $p=0.225$	54.906 $p=0.402$
Observations	150	150	150
Number of Regions	15	15	15

Notes: 1) Numbers in parentheses are standard deviations. 2) ***, **, * : statistically significant at 1%, 5% and 10% level. 3) GMM-type instrumental variables for difference equations use dependent variables before $t-2$. 4) Standard-type instrumental variables for difference equations are differences of independent variables. 5) GMM-type instrumental variables for level equations use difference value of dependent variables before $t-1$. 6) Standard-type instrumental variables for level equations are constant variables.

For inflation, it is -0.0037 in long-term and -0.0024 in short-run. All things taken together, long-term effects on poverty severity are greater than short-term effects by 53%.

These results indicate empirical analysis on the effects of monetary policy on poverty severity index, which is quite similar to table 5. The results are obvious because poverty gap and poverty severity are closely related. Following effects of monetary policy are observed with table 5 and table 6: First, rising interest rate worsens poverty. Second, income growth reduces poverty. And third, increasing inflation rate reduces poverty as well.

Models (3) and (6) show that raising call rate to control prices can deteriorate poverty. Suppose that the central bank raised call rate by 1% to keep prices down. Even when government holds real interest rate unchanged through economic policy, poverty may grow worse. When real interest grows, or when inflation goes down by less than 1%p, poverty turns for the worse.

Table 7 shows short-term and long-term effects of monetary policy on the Gini coefficient. Auto-correlation term's coefficient is greater than zero but it is statistically insignificant. This is a completely different story from empirical analysis on poverty whose effects persist until the next period. The long-term effects of log provincial per capita GDP and inflation rate are similar to short-term effects.

It can be said that call rate has no significant effects on the Gini coefficient. But income growth has significantly negative effects on the Gini coefficient, making income distribution better. At a significant level of 10%, inflation has negative effects on the Gini coefficient.

This is in contrast to Crowe (2006) and Albanesi (2007) who claim that inflation and income inequality are positively correlated. Such different results could have taken place due to different types of information used. Crowe (2006) and Albanesi (2007) used national panel data while the Korea's provincial panel data is used in this study. For sure, Romer and Romer (1999) did insist that inflation aggravates income distribution by reducing real wage and real transfer income of the poor. However, it is quite different in case of Korea. In Korea, owing to growing use of credit cards and credit loans, people could finance their spending. This caused stable growth in consumption, not deteriorating spending disparities.

Table 7 Long-term Effects of Monetary Policy on Gini Coefficient

	Model (7)	Model (8)	Model (9)
Gini Coefficient ($t-1$)	0.1685* (0.092)	0.0987 (0.113)	0.1443 (0.100)
Call Rate	0.0007 (0.001)	0.0002 (0.001)	0.0008 (0.001)
Unemployment	0.0016 (0.002)		
Log Provincial GDP per Capita		-0.0197* (0.010)	-0.0171* (0.009)
Inflation Rate			-0.0020* (0.001)
Constant Variable	0.2294*** (0.023)	0.3895*** (0.096)	0.3635*** (0.090)
AR Test : Order (1)	-3.072 $p=0.002$	-3.023 $p=0.003$	-3.231 $p=0.001$
AR Test : Order (2)	1.582 $p=0.114$	1.551 $p=0.121$	1.657 $p=0.098$
Sargan Statistics	58.852 $p=0.270$	58.721 $p=0.274$	57.274 $p=0.320$
Observations	150	150	150
Number of Regions	15	15	15

Notes: 1) Numbers in parentheses are standard deviations. 2) ***, **, * : statistically significant at 1%, 5% and 10% level. 3) GMM-type instrumental variables for difference equations use dependent variables before $t-2$. 4) Standard-type instrumental variables for difference equations are differences of independent variables. 5) GMM-type instrumental variables for level equations use difference value of dependent variables in $t-1$. 6) Standard-type instrumental variables for level equations are constant variables.

Table 8 Short-term and Long-term Effects of Monetary Policy on Poverty Gap, Poverty Severity and Consumption Inequality

		Call Rate	Log Provincial GDP per Capita	Inflation Rate
Poverty Gap	Short-term Effects	0.0072	-0.0603	-0.0039
	Long-term Effects	0.0115	-0.0967	-0.0062
Poverty Severity	SE	0.0038	-0.0341	-0.0024
	LE	0.0058	-0.0518	-0.0037
Gini Coefficient*	SE	0.0008	-0.0171	-0.0020
	LE	0.0009	-0.0199	-0.0023

Note: * Results show that for the Gini coefficient, only short-term effects of Log Provincial GDP per capita and inflation are significant, while others are not.

Table 8 summarizes short and long-term effects of monetary policy on poverty and inequality. First, real interest rate has significantly positive effects on poverty while income growth and inflation have significantly negative effects. Second, real interest rate does not have significant effects on the Gini coefficient while income growth and rising inflation have significantly negative effects. Third, poverty persists until the next period while the Gini coefficient does not. Fourth, monetary policy has long-term effects on poverty. For poverty gap and poverty severity, long-term effect is as much as 60% and 53% of short-term effects respectively.

6. CONCLUSION

Using the provincial data of Korea, this study conducts an empirical analysis on effects of monetary policy on individual welfare which can be represented by poverty and inequality. With previous researches, it was examined that macroeconomic policy can influence poverty and consumption inequality through income growth, interest rate changes and inflation.

Furthermore, with provincial Panel Data and dynamic Econometric Analysis of Panel, monetary policy's effects on poverty and inequality are classified into short-term and long-term.

In general, interest rate and poverty are positively correlated, implying that rising interest rate increases poverty rate. This is in line with findings by Romer and Romer (1999). A possible reason behind this is that most poor people are much likely to be net debtors. So a rise in interest rate becomes a burden to net debtors, causing them to decrease their spending. In addition, due to substitution effects of interest rate, growing interest rate can lead to reduction in current spending.

Both income growth and inflation are negatively correlated with poverty. This means that people in poverty base their decision-making on inflation rate. So if they observe inflation and predict the economy will get better, they might actually spend more. Even if inflation does not directly influence poverty, just as Romer and Romer (1998) explains, short-term anticipated inflation can lower unemployment rate, thereby indirectly alleviating poverty. In this case, inflation and poverty are negatively correlated. For the Gini coefficient, Call rate does not have significant effects. Income growth has significantly negative effects on the coefficient and inflation has significantly negative effects at a significance level of 10%.

These results are quite different from the results of previous studies. This may have been caused from use of different types of data or different estimation methodology. During the analysis period, the Korea's provincial consumption-based Gini coefficient tends to decrease. In case of Korea, consumption inequality did not get worse because consumption continued to grow due to increasing household loans and developments in credit market.

Long-term and short-term effects on poverty are compared. For poverty gap, long-term effects after next period were as high as 60% of short-term effects while it was as great as 53% for poverty severity. But the effects on the Gini coefficient did not last long because auto-correlation term was insignificant.

APPENDIX

Table A1 Poverty Gap Index (measured by income data)

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.189	0.140	0.119	0.130	0.103	0.115	0.123	0.104	0.051	0.049	0.054
Busan	0.204	0.204	0.190	0.181	0.141	0.134	0.153	0.144	0.059	0.060	0.059
Daegu	0.214	0.175	0.169	0.165	0.132	0.117	0.118	0.134	0.068	0.062	0.065
Daejeon	0.182	0.186	0.153	0.140	0.109	0.110	0.117	0.091	0.049	0.063	0.063
Incheon	0.198	0.185	0.140	0.163	0.118	0.155	0.132	0.113	0.046	0.077	0.099
Gwangju	0.149	0.192	0.185	0.187	0.140	0.163	0.208	0.160	0.083	0.067	0.100
Ulsan	0.168	0.144	0.095	0.121	0.073	0.090	0.092	0.107	0.028	0.011	0.017
Gyeonggi	0.193	0.152	0.137	0.151	0.112	0.125	0.123	0.111	0.055	0.060	0.054
Gangwon	0.223	0.168	0.186	0.302	0.307	0.291	0.235	0.184	0.111	0.072	0.101
North Chungcheong	0.173	0.173	0.189	0.215	0.161	0.131	0.143	0.100	0.069	0.047	0.055
South Chungcheong	0.281	0.309	0.251	0.225	0.217	0.214	0.172	0.189	0.067	0.076	0.101
North Jeolla	0.220	0.193	0.236	0.214	0.160	0.180	0.172	0.175	0.060	0.074	0.089
South Jeolla	0.214	0.247	0.234	0.199	0.237	0.177	0.178	0.174	0.056	0.046	0.065
North Gyeongsang	0.247	0.246	0.224	0.230	0.173	0.209	0.207	0.202	0.114	0.091	0.093
South Gyeongsang	0.170	0.186	0.158	0.163	0.119	0.117	0.138	0.118	0.043	0.043	0.057

Table A2 Poverty Severity Index (measured by income data)

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.160	0.113	0.095	0.105	0.086	0.092	0.101	0.082	0.028	0.027	0.033
Busan	0.170	0.164	0.155	0.143	0.113	0.105	0.124	0.117	0.029	0.033	0.032
Daegu	0.171	0.128	0.126	0.130	0.095	0.081	0.087	0.097	0.038	0.036	0.037
Daejeon	0.144	0.137	0.108	0.102	0.089	0.089	0.089	0.067	0.030	0.044	0.046
Incheon	0.161	0.139	0.105	0.129	0.093	0.127	0.112	0.087	0.023	0.047	0.073
Gwangju	0.111	0.148	0.148	0.135	0.109	0.130	0.175	0.123	0.048	0.040	0.062
Ulsan	0.144	0.116	0.067	0.105	0.059	0.079	0.081	0.095	0.016	0.004	0.010
Gyeonggi	0.165	0.119	0.106	0.122	0.093	0.105	0.101	0.088	0.035	0.041	0.037
Gangwon	0.181	0.121	0.145	0.261	0.261	0.264	0.203	0.151	0.069	0.039	0.069
North Chungcheong	0.127	0.116	0.144	0.165	0.122	0.102	0.106	0.070	0.045	0.021	0.031
South Chungcheong	0.192	0.226	0.179	0.159	0.165	0.160	0.131	0.144	0.029	0.036	0.059
North Jeolla	0.162	0.139	0.180	0.156	0.124	0.137	0.137	0.134	0.024	0.038	0.059
South Jeolla	0.164	0.176	0.181	0.144	0.189	0.137	0.133	0.133	0.027	0.015	0.034
North Gyeongsang	0.195	0.192	0.166	0.187	0.120	0.154	0.144	0.147	0.074	0.043	0.052
South Gyeongsang	0.129	0.158	0.121	0.135	0.092	0.097	0.111	0.092	0.020	0.019	0.033

Table A3 Gini Coefficients (measured by income data)

Regions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Seoul	0.453	0.435	0.378	0.418	0.421	0.448	0.442	0.427	0.420	0.402	0.405
Busan	0.424	0.429	0.440	0.444	0.424	0.398	0.411	0.422	0.403	0.403	0.376
Daegu	0.423	0.463	0.384	0.396	0.395	0.398	0.395	0.410	0.386	0.401	0.382
Daejeon	0.408	0.445	0.449	0.394	0.397	0.401	0.465	0.389	0.361	0.382	0.352
Incheon	0.437	0.404	0.375	0.381	0.370	0.400	0.418	0.383	0.336	0.399	0.387
Gwangju	0.383	0.413	0.442	0.430	0.405	0.420	0.514	0.435	0.389	0.368	0.391
Ulsan	0.392	0.399	0.371	0.381	0.463	0.358	0.381	0.450	0.337	0.318	0.370
Gyeonggi	0.426	0.416	0.414	0.421	0.413	0.408	0.449	0.440	0.390	0.430	0.390
Gangwon	0.395	0.475	0.443	0.539	0.609	0.522	0.489	0.460	0.408	0.371	0.424
North Chungcheong	0.383	0.402	0.536	0.422	0.401	0.421	0.419	0.417	0.380	0.337	0.351
South Chungcheong	0.460	0.517	0.443	0.467	0.434	0.475	0.471	0.445	0.367	0.374	0.443
North Jeolla	0.438	0.437	0.447	0.471	0.459	0.464	0.440	0.470	0.390	0.375	0.391
South Jeolla	0.460	0.563	0.513	0.510	0.558	0.448	0.515	0.525	0.401	0.427	0.431
North Gyeongsang	0.455	0.425	0.423	0.493	0.436	0.441	0.451	0.474	0.404	0.380	0.371
South Gyeongsang	0.402	0.440	0.393	0.413	0.391	0.384	0.408	0.365	0.356	0.359	0.382

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