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DETERMINANT OF FOOD INFLATION : THE CASE OF INDONESIA

Bambang I. Ismaya[1], Donni F. Anugrah[2]

[1] Department of Economics and Monetary Policy, Bank Indonesia, Jakarta, Indonesia.
Email: bambang_ismaya@bi.go.id
[2] Department of Economics and Monetary Policy, Bank Indonesia, Jakarta, Indonesia.
Email: donni@bi.go.id

ABSTRACT

In this paper, we investigate the determinants of food inflation in Indonesia. Using quarterly data (2008:Q1 to 2017:Q4) and a GMM estimator, we show that backward-looking and forward-looking expectations have a strong impact on food inflation. Additionally, we show that the determinants of general food price inflation, such as food production, agriculture sector output, infrastructure, food import, agriculture sector credit, demand level (M1/consumption), and seasonal event (Eid Mubarak), are highly significant. Backward-looking and forward-looking expectations, domestic oil price, and level of demand have contributed to high food price while factors relating to general food price inflation have reduced food price.

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I. INTRODUCTION

Recently, food price inflation has become one of the main concerns of world stakeholders, including Indonesia. The reasons is simple; first, food price impact consumers (Kornher & Kalkuhl, 2013). Second, food prices have political connotations, triggering government policies and programs.

According to Statistic Indonesia (BPS), the weight in the food stuffs, processed foods, beverages, and tobacco group reached 42.7 % in the CPI basket. Therefore, like other emerging countries, food price shocks play an important role in the dynamics of inflation in Indonesia. Moreover, food price shocks in emerging countries, like Indonesia, are more volatile and persistent, and are propagated strongly into non-food inflation, and thus tend to have stronger and long-lasting effects on inflation.

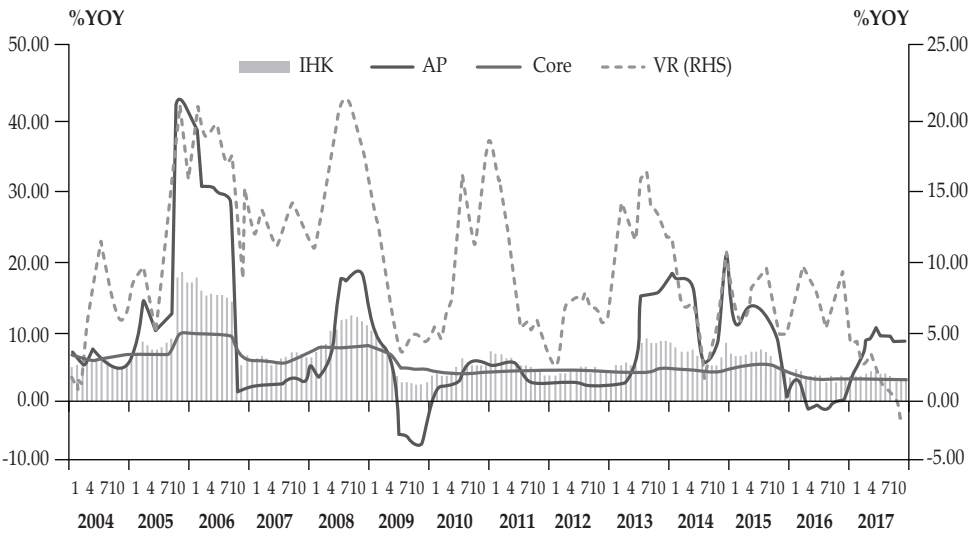

Figure 1. Indonesia Inflation Trend

The policy discussions in Indonesia around food inflation suggest that supply and demand imbalances, lack of infrastructure, climate change, and seasonal events are principal factors of food inflation. However, studies on the determinants of food inflation in Indonesia are still very limited.

This paper aims to investigate the determinants of food inflation, and in particular, rice inflation in Indonesia. This paper addresses the following questions: (1) which type of expectations provide a better explanation of food inflation: backward-looking, forward-looking, or a combination of the two? (2) do government policies, especially the policy in infrastructure, have an impact on food inflation? (3) besides those factors, what other supply-demand factors determine food inflation?

The rest of the paper is arranged as follows. In the next section, we review the literature on the determination of inflation. Section III discusses the data.

Section IV explains the methodology. Section V presents our result using GMM method. At last section (Section VI), we provide conclusions and some policy recommendations.

II. LITERATUR REVIEW

Apart from the natural trend, food price has recently been more volatile (Roache, 2010) which makes food price inflation more of a concern to producers and consumers. That is one of the reasons why food inflation is a popular subject of research. There has been much research done to find the determinants of food inflation.

A supply-shock is generally considered as the main cause of price instability (Subervie, 2008). Kornher & Kalkuhl (2013) find that stock and production (as represent supply side) significantly affect domestic food price. This evidence is also found in Durevall, Loening, & Ayalew Birru (2013). They show that in the short-run, food production affects food inflation, causing large deviations from the long-run price trends. In both studies, food production has a negative correlation with food price inflation.

Food imports is also a factor that has potential to influence food inflation from the supply side. Imports and the stock level tend to exert a stabilizing effect on price. Miranda & Glauber (1995) find that where a chronic supply-demand imbalance exists, imports are driven predominantly by the structural supply-demand imbalance and asymmetry between trade (import), and storage arises. In this example, imports will profoundly determine storage activity but storage itself has little effect on imports. Other studies related with imports and food price inflation are Kornher & Kalkuhl (2013), Joiya & Shahzad (2013), and Abdullah (2011). These studies show that imports positively affect food price inflation and it is also statistically significant. Generally, the importance of production, stocks, and imports depends on the characteristics (such as it been a closed economy, importer of exporter) of a country.

Another potential factor of food price inflation is GDP. The relationship between GDP and inflation is a complex one. Empirical studies have shown that the relationship between GDP and inflation may be positive, negative, or neutral (Rad, 2017). Other studies, such as Adnan and Ali (2014) and Rehman & Khan (2015) find that GDP is negatively correlated with food price inflation in Pakistan. On another hand, Joiya & Shahzad (2013) who analyze the determinants of high food price find that GDP is one of the significant determinants of food price inflation.

Infrastructure is also a potential factor of food price inflation. Fielding (2008) finds that infrastructure is one of the statistically significant factors of inflation. He examines 96 individual products data of 37 Nigerian states and finds that better transport and communication infrastructure, represented by road length, literacy, and linguistic homogeneity, is associated with lower inflation volatility. In another study, Timmer (2000) finds that improvements in agricultural productivity that are stimulated by government investment in rural infrastructure, agricultural research and extension, irrigation, and appropriate price incentives contribute directly to economic growth, poverty alleviation, and price stability.

In several other studies, credit, especially agriculture sector credit, is a potential factor of food price inflation. Besides GDP and trade (export and import), a study by Joiya & Shahzad (2013) finds that credit to agriculture sector causes reduction in food prices. In another study, Khan & Schimmelpfennig (2006) examine the effect of monetary and supply-side factors on inflation in Pakistan. They find that the private sector credit plays a significant role to determining inflation.

In addition to the supply-side factors, demand-side factors also have a statistically significant effect on food price. Khan & Schimmelpfennig (2006) find that money supply is also one of the significant factors affecting inflation, besides private credit. This finding is consistent with Khan & Qasim (2014), who discover that money supply has a statistically significant effect on inflation.

Researchers have also examined the role of oil prices in food inflation. Sujithan, Dovi, & Koliai (2014), for instance, find that oil price is one of five factors that determine inflation. In another study, Irz, Niemi, & Liu (2013) also find that oil price plays a significant but limited role in determining the equilibrium level of food prices in Finland. These findings are consistent with Baek & Koo (2010), who confirm the existence of strong linkages between agricultural and energy markets.

Wimanda, Turner, & Hall (2011) examine the policy implications for the Indonesian economy of the form taken by the price adjustment equation. They found that backward-looking and forward-looking expectations also have significant effects on inflation level. They allow both backward-looking and forward-looking effects on inflation expectations, proxying forward expectations with the realized rate. They also apply a dummy variable to capture 'Eid Mubarak' day, the Islamic festival at the end of the fasting month. They find that backward- and forward-looking inflation expectations is one of the significant factors of CPI inflation in Indonesia.

III. DATA

In this paper, we use quarterly data from 2008 to 2017. This sample is determined by the availability of data. For estimating a general food inflation model, we use GDP agriculture, GDP consumption, domestic retail fuel price (premium), food imports, narrow money (M1), credit agriculture, and M1 to GDP consumption ratio as a proxy of demand. These data are collect from the Central Bank of Indonesia (BI) and Indonesia Central Bureau Statistic (BPS). We also use food production index, obtained from the Food and Agriculture Organization (FAO) as total food production proxy. Most of the variables used in annual growth form (see Table 1).

Table 1.
Data of General Food Price Inflation

Variabel Name	Description	Frequency	Source
cpi_vf	CPI food inflation	Monthly	BPS
gdp_agri	GDP of agriculture sector	Quarterly	BPS
gdp_cons	GDP of consumption	Quarterly	BPS
oil_dom	Domestic retail fuel price (RON 88)	Monthly	BPS
irgt_lnd	Irigated land	Yearly	BPS
food_imp	Food import volume	Monthly	BI
cred_agri	Credit of agriculture sector	Monthly	BI
m1_cons	Narrow money (M1) over GDP consumption	Monthly	BI
food_prod	Food Production Index	Yearly	FAO

For estimating the rice price inflation model, we use more specific data to build the model. We use, for instance, rice production, rice harvested area, rice field productivity, rice import volume, and Oceanic Niño Index (as climate change proxy) besides general variables that also used in general food price inflation model, such as a credit to the agriculture sector and the number of irrigated land (see Table 2).

Table 2.
Data of Rice Inflation Model

Variabel Name	Description	Frequency	Source
price_rice	Price index of domestic rice	Monthly	MA*
hrv_rice	Rice harvested area	Yearly	MA
prod_rice	Rice production	Yearly	MA
pdfty_rice	Rice productivity	Yearly	MA
imp_rice	Rice import volume	Yearly	MT**
cred_agri	Credit of agriculture sector	Monthly	BI
lnd_irgt	Irigated land	Yearly	BPS
clim_ch	Oceanic Niño Index (ONI)	Quarterly	NOAA

* MA : Indonesia Ministry of Agriculture
** MT : Indonesia Ministry of Trade

IV. METHODOLOGY

To analyze the determinants of food inflation in Indonesia, we employ a multivariate framework. Through this framework, we try to assess the importance of the determinants including lagged inflation relative to future inflation. The basic model is as follows:

$$\pi_t = \omega\pi_{t-1} + \gamma\pi_{t+1} + \delta_i(dep_i)_t + \varepsilon_t$$

where π_t is general food price inflation and rice price inflation as an independent variable, $\omega\pi_{t-1}$ is backward-looking inflation expectation, $\delta_i(dep_i)_t$ is forward-looking inflation, is another dependent variable, and ε_t is error term. Besides backward and forward-expectations, in the general food price inflation model, we also use GDP agriculture, credit agriculture, import agriculture, food production, oil domestic oil price (premium), and the ratio of M1 to consumption as a dependent variable. We also use Ramadhan as a dummy variable to capture 'Ramadhan' and 'Eid Mubarak' day, the Muslim festive at the end of the fasting month. In the rice inflation model, besides global variables, such as a credit of agriculture and number of irrigated land, we use specific variables, such as rice harvested area, rice production, rice field productivity, and rice import. We also use Oceanic Nino Index (ONI) as a proxy of climate change.

Since we do not have direct observations of forward-looking inflation expectations, we use the actual value of future inflation, as suggested by McCallum (1976). To allow for the endogeneity of this proxy, following Wimanda et al. (2011), we estimated using the Generalized Method of Moments (GMM) technique (Hall, 1993).

Our hypothesis is GDP agriculture, irrigated land, food production, food import, and dummy 'Ramadhan' are negative and significant. On the other hand, backward and forward-looking expectations, M1/consumption, domestic retail fuel price, and dummy 'Ramadhan' are positive and significant. Based on Wimanda et al. (2011) study, we also expect that backward-looking inflation expectations are more dominant than forward-looking inflation expectations.

V. RESULTS

Some of our data are yearly so to convert the frequency from yearly to quarterly, we interpolate the data by applying a quadratic-match-average method, or quadratic-match-sum depend on a data type. For stock data, we use a quadratic-match-sum approach for conversion, and, for flow data, we use a quadratic-match-average approach.

Table 3 and Table 4 shown the result of GMM estimation for both models, general food price inflation model, and rice price inflation model. We use three variants of each model to find out whether inflation expectations are dominated by a backward-looking component, a forward-looking component, or some combination of the two. From both results, we see that all models have a *p*-value for the *J*-test larger than 0.05, indicating that the instrumental variables are appropriately chosen.

Table 3.
The Determinant of General Food Price Inflation

Variable		VF Inflation Model		
		B	**F**	**B+F**
Constant		9.6122 *	7.8541 *	7.1333 *
cpi_vt	(t-1)	0.6904 *		0.5571 *
cpi_vt	(t-1)		0.4855 *	0.3160 *
gdp_agri	(t-1)	-1.4062 *	-0.6667 *	-1.0792 *
irgt_Ind	(t-1)	-0.4062 *	-0-0560 *	-0.2708 *
food_prod		-0.2617 *	-0.5225 *	-0.1950 *
food_imp		-0.0032	-0.0229 *	-0.0139 *
M1_cons	(t-2)	1.7193	5.6616 *	10.4800 *
oil_dorn		0.1042 *	0.0545 *	0.0822 *
cred_agri	(t-1)	-0.0880 *	0.0418 *	-0.0776 *
R.squared Adjusted		0.5542	0.3957	0.6394
J-Satistic		9.1927	9.3262	8.9291
prob(J-Statictic)		0.9990	0.9981	0.9977

*) significant at 5% confidence
**) significant at 10% confidence

Table 4.
The Determinant of Rice Price Inflation

Variable		Rice Inflation Model		
		B	**F**	**B+F**
Constant		5.1255	0.4770	1.4761 *
cpi_rice	(t-1)	0.8389 *		0.5916 *
cpi_rice	(t-1)		0.9068 *	0.4812 *
rice_prod	(t-1)	-0.4723 *	0.3548 *	-0.0739 *
rice_harv		-0.7100 *	-0.1464 *	-0.2905 *
rice_prodity	(t-1)	0.1442 *	-0.0308	-0.1129 *
cred_agri	(t-1)	-0.1442 *	-0.0051	-0.0670 *
clim_chg	(t-1)	0.9906 *	-0.3143 *	0.2907 *
rice_imp	(t-1)	-0.0001	-0.00236 *	-0.0044 *
m1_cons	(t-3)	9.4216 *	21.0429 *	16.0534 *
irgtd_Ind		-0.0755 *	0.5103 *	0.5561 *
R.squared		0.8222	0.7343	0.8797
R.squared Adjusted		0.7511	0.6235	0.8222
J-Satistic		9.5876	9.3570	9.2131
prob(J-Statictic)		0.9976	0.9967	0.9952

*) significant at 5% confidence
**) significant at 10% confidence

General Food Price Inflation

In general food price inflation model (Table 3) with backward-looking (model B), we find that food imports and M1/consumption are not significant. In model F (general food price inflation model with forward-looking), Ramadhan has the 'wrong' sign. The best model, from the points of view of both statistical fit and consistency with theory, is obtained by including both backward-looking and forward-looking expectations (Model B+ F).

Overall, after comparing models B, F, and B+F, we can see that, on the one hand, Models B+F perform best because they have the highest value of the adjusted R2. On the other hand, Model F appears to be the worst since it has the lowest value of adjusted R2.

More specifically on the best model (model B+F), we find evidence that CPI general food price inflation in Indonesia is significantly determined by both backward-looking and forward-looking expectations, food production, GDP agriculture sector, infrastructure, food import, domestic oil price, credit agriculture sector, M1/consumption, and seasonal event (Ramadhan-Eid). All variables above are statistically significant.

From the best models (B+F), we also identify that macroeconomic factors are important drivers of food price. On general food price inflation model, GDP agriculture statistically significantly causes a reduction in the food price. We see that in the agriculture sector, higher GDP indicates the farmer earns more money by selling his product on the market. The additional income that they get improves their production.

On the other hand, lowering in GDP agriculture leads to food price inflation. This is what also was found in India. Sasmal (2015), for instance, reports that the sectoral imbalance in GDP growth in India has severe consequences on the whole economy. He also finds that the agricultural sector experienced a different growth direction with overall economic growth. The enormous public expenditure of the government every year, mostly on unproductive or less productive heads has further magnified the demand. On the other hand, resource degradation, technological stagnation, lack of infrastructure and fall in public investment have created bottlenecks for increasing agricultural production which in turn drive food price inflation in India. This condition has not happened "yet" in Indonesia, but this is a warning for the government to maintain the balance of development in each sector.

From the model, we also can conclude that general food price inflation in Indonesia mostly driven-by supply-side factor. We see that food production and food import significant cause a reduction in food price.

For a country that relies on domestic production to fulfill their needs, such as Indonesia, maintaining production of high-level performance becomes challenging. Because naturally, there has been a mismatch between the growing demand and the actual production. As we know, agricultural production supply can not immediately adjust itself to the changes in demand. That is why adequate infrastructure, proper technology, and various supporting factors are necessary for higher production.

Moreover, when production is lower than demand, food imports have rolled to fulfill the excess demand then controlled the food prices. This condition is

confirmed by the model, where imports significantly cause a reduction in food price, even less relevant than food production. The level of transmission of international prices to domestic prices depends on a country's dependence on imports of food items and the inputs used in agricultural production. In this case, dependency Indonesia on food import is relatively low. It is because most of food-demand could be fulfilled by domestic production and only a few commodities have a high dependency to import (such as garlic and beef meat).

From the study, we also found that credit in the agricultural sector significantly causes a reduction in food price. When credit to the agricultural sector is increasing, small farmers use those funds to enhance their productivity by using modern machinery, pesticides, tractors, and other productivity tools which will automatically enhance the productivity of farmers and control the food prices. Thus, more credit disbursed to the agricultural sector causes the reduction in food price. Since credit to the agricultural sector is essential in controlling food price, improved access to finance by agribusiness and local farms is also vital. Credit institutions have to be reinforced by government, and farmers require financial products tailored to their specific long-term financial and working capital needs.

For an agriculture-based country like Indonesia, improving infrastructure is critical in controlling inflation. One of the critical infrastructures in agricultural sector is irrigation. In the best food inflation models (B+F), the number of irrigation land as a proxy of irrigation show significant correlation with food price. Irrigation statistically significantly causes a reduction in food price.

Irrigation becomes vital in inflation control because this is one of the primary factors in rice farming. Rice is the primary food of 260 million Indonesian, and the number of rice land that uses irrigation stands at 4.78 million ha or 58.4% of the total paddy fields (BPS, 2017). Another reason why irrigation is an important issue is climate change. In recent years, Indonesian agriculture has been plagued by the El Nina phenomenon, which has resulted in hot temperatures and significant rainfall reductions. In these condition, irrigation is the only one water source for agriculture. These discussions imply the importance of investment in rural areas. The implication is that government must ensure that the agricultural sector remains one of the priorities for investment.

This study also shows that food price inflation is not only driven by supply side but also by the demand side. In the best food inflation models (B+F), we show that M1/consumption as a proxy of demand is statistically significantly causing a rise in food price. Its consistent with the monetarist theory of inflation, which argues that excess money supply drives inflation. In this case, money supply does not affect food prices directly. It is possible that excess money supply affects the exchange rate, and indirectly therefore the inflation rate. This information explains why in the model, this variable is statistically significant at t-2 lags. This fact gives a signal to the central bank to be mind in issuing the monetary policy as it will affect the food price.

Besides money supply, another factor that affects inflation from the demand side is fuel price, especially gasoline RON 88, named 'premium'. In Indonesia, it is the cheapest and most consumed type of gasoline. It follows that if the premium price rose, it will drive inflation in every sector, including food price. It is confirmed by the model that fuel price statistically significantly causes food price rise.

The premium price is set by the government and, therefore, does not float according to market conditions, meaning that the subsequent deficit has to be absorbed by the government's state budget. Since 2004, the government already made 14 adjustments to the premium price; eight of these have been price increments (see Figure 2). From the chart, we see that every time fuel price increases, its followed by rising food inflation. Mostly, fuel price adjustments are transmitted to inflation through rising transportation costs.

Managing subsidized fuel price in Indonesia is a complex one. One characteristic of Indonesia is that a significant portion of its population is clustered just above the poverty line. This means that a relatively minor inflationary shock can potentially push these people below the poverty line. On the other hand, a late response by authorities to raise subsidized fuel prices can thus lead to much higher-than-necessary inflation and push many people into deeper poverty.

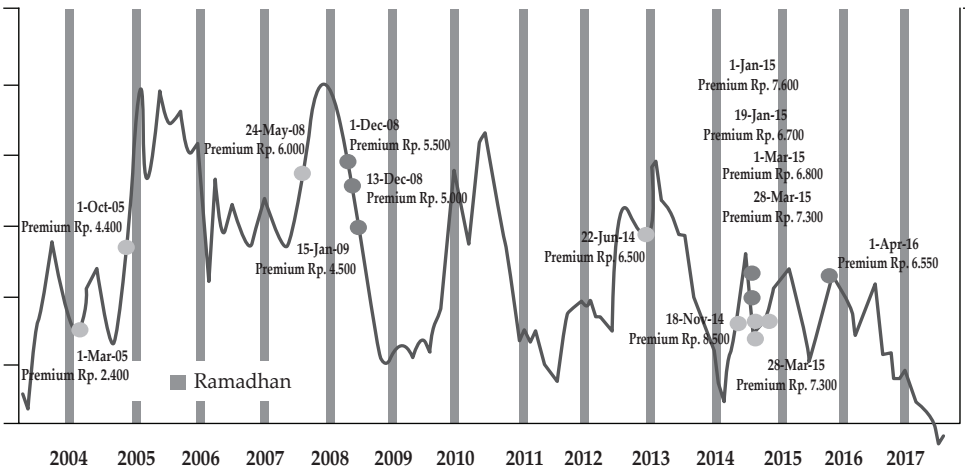

Figure 2. Event Analysis : Premium Price & Ramadhan vs Food Inflation

The last food price determinant is Ramadhan and Eid Mubarak. In the best food inflation models (B+F), we find that the dummy 'Ramadhan' is statistically significantly leading to a rise in food price. This annual event is always driving demand for food. This is unsurprising because Indonesia has the world's largest Muslim population (87% of the total 260 million are Muslims) who celebrate these religions events annually.

Another issue that leads to high food inflation in every Ramadhan and Eid Mubarak period is weak coordination and cooperation between ministries and other (non-ministerial) government institutions. To stabilize food prices, however, it requires good cooperation and coordination among these institutions. In the case of rice, for example, Indonesia's Agriculture Ministry monitors the rice reserves, the Trade Ministry monitors the supply and demand chain, the Transportation Ministry is responsible for the smooth distribution, while Bulog is responsible for market operations (and rice imports). Moreover, it requires smooth cooperation between the public and private sectors as the latter is the primary food supplier.

Rice Price Inflation

On rice inflation model with backward-looking (model B) expectations, we find that rice import are not significant and rice field productivity has the 'wrong' sign. In model F, we find that rice productivity and credit to the agricultural sector are not significant. In that model rice production, rice harvesting area, and climate change (El Nino – El Nina) have the 'wrong' signs. Same with the general food price inflation model, the best model, from the points of view of both statistical fit and consistency with theory, is obtained by including both backward-looking and forward-looking expectations (Model B+ F).

Overall, after comparing models B, F, and B+F, we see that, on the one hand, Models B+F perform best because it has the highest value of the adjusted R2. On the other hand, Model F appears to be the worst since it has the lowest value of adjusted R2.

More specifically on the best model (model B+F), we find that backward-looking and forward-looking expectations, rice production, credit to the agricultural sector, climate (El Nina-El Nino), rice imports, demand level (M1/consumption), rice field productivity, infrastructure (irrigation), and seasonal events (Ramadhan-Eid Mubarak) have a statistically significant correlation with rice price level.

Similar to general food price inflation, we find that backward-looking expectations are more critical (about 0.59) than forward-looking expectations (about 0.48). Besides expectations, we find several identical determinants of food inflation, namely credit to the agricultural sector, money supply (M1/consumption), irrigated land, and Ramadhan. Credit to agriculture and irrigated land statistically significant cause a reduction in rice price, while money supply and Ramadhan have a substantial impact on rice price.

From this study, we also can conclude that rice inflation in Indonesia is mostly driven by supply-side factors. We found that rice production, rice harvested area, rice field productivity, and rice import volume significant cause a reduction in rice price. Harvested area and field productivity have directly impacted the production level, which has a significant impact on domestic rice stock. On the other hand, rice imports have rolled to fulfill the excess demand.

For Indonesia, investments to raise the productivity of domestic rice producers brought greater stability to the rice economy at the macro level, mostly because reliance on the world market was destabilizing to domestic production. Expanded rice production and higher purchasing power in rural areas, stimulated by the productive rice economy, improved the stability of food intake of rural households.

Another factor that significantly affects rice price is climate change. Climate change becomes one of the factors affecting agricultural production, especially 3.4 million non-irrigated lands, which will affect food prices. As we expected, in the best rice inflation models (B+F), El Niño as a proxy for climate change showed a significant effect on rice price inflation.

VI. CONCLUSION AND POLICY RECOMENDATION

This study tries to evaluate the determinants of volatile food inflation and more specifically rice price in Indonesia. By using quarterly data from 2008:Q1 to 2017:Q4, we provide econometric evidence that inflation volatile and food

inflation in Indonesia is significantly determined by both backward-looking and forward-looking expectations, food production, GDP of agricultural sector, infrastructure, food imports, domestic oil price, credit to the agricultural sector, M1/consumption, and seasonal events (Ramadhan-Eid). All variables above are statistically significant.

On the rice inflation model, we find that backward-looking and forward-looking expectations, rice production, credit to the agricultural sector, climate (El Nina-El Nino), rice imports, demand level (M1/consumption), rice field productivity, infrastructure (irrigation), and seasonal events (Ramadhan-Eid Mubarak) have a significant correlation to rice price level.

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