Study of Economic Vulnerability and Its Influence on the Economy in Sumatera Island Using the Household Consumption Expenditure Approach

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Abstract. Geopolitics tension, global market volatility, Indonesia economic problem caused uncertainty and instability. Sumatera was one of biggest island that heavily relied on commodities. The readiness of a region to face that risks, shocks and spill over effects from the surrounding region needed to be developed early. Each region had different economic structure so that the policy and strategy that was used to deal with current and future global uncertainties should be different as well. Economic Vulnerability status became important to be analysed. This study aimed to analyse economic vulnerability and the characteristics of its grouping, and analyse the effect of inflation, unemployment rate, foreign investment, and economic vulnerability towards the economy of provinces in Sumatera. The method performed in this study was Cluster Analysis for grouping and creating economic vulnerability variable, Panel Regression Analysis to analyse the effect between variables in general, and GWPR (Geographically Weighted Panel Regression) analysis to analyse spatial effect of regions. The result showed that the variable of economic vulnerability had a negative and significant effect on household consumption expenditures, especially in the Province of Lampung and Sumatera Selatan.

1. Introduction

Global uncertainty that occurred due to the United States recession, China's economic slowdown, and the war between Russia and Ukraine had a significant impact on countries that have high interdependence (Dario, 2022). According to the IMF (2014), impacts that arise from the influence of other regions indirectly either through finance or trade are called spillover effects. As a developed country and a global trading partner, the US economic slowdown and disrupted supply chains for energy and food commodities might have direct or indirect impacts on Indonesia (Vivek, 2001). High inflation in the United States in June 2022 (y-on-y), namely 9.1 percent, caused a decrease in demand for goods (Bureau of Labor Statistics US) including export of goods from Indonesia because the United States is one of Indonesia's main export destinations after China with an export value 2021 amounted to 25.8 billion USD. In addition, in terms of energy and food imports, high international commodity prices had increased the price of raw material imports, resulting an increase in the prices of their derivative

products. This could be seen from the increase in inflation in April 2022 of 0.95 percent, which was the highest monthly inflation since the last 4 years (BPS, 2022). Those shocks and instabilities were risk for countries in short term and long term which called economic vulnerability. In other word, economic vulnerability was the risk for a country to have its development hampered by shocks and instabilities (Patrick, 2011). Thus, it was important give more attention towards economic vulnerability, since every country should be resilient for better situation in facing shocks, unless others might also take disadvantages due to the spill over effect.

Sumatera Island was the second largest contributor to GDP after Java Island with GDP share of 21.7 percent in 2021 and was the largest palm oil producer in Indonesia with palm production share reaching 57.5 percent of total production in Indonesia. It was known that palm oil had great role in Indonesia's GDP as it was one of the dominant contributors towards manufacturing sector and agriculture sector (Kemendagri, 2013), where those two sectors were also sectors with the most dominant share toward Indonesia's GDP, which were 18,34 percent and 12,40 percent in 2022 (BPS, 2023). This made Sumatera Island as one of the most influential islands towards Indonesia's economic situation in general. Little shock in the economic condition in Sumatera could affect the economic condition of the wider area of Indonesia. Thus, the economic condition in Sumatera Island should be far from vulnerability and maintained stably. High geopolitical tensions resulted in world CPO prices touching their highest price in 2022 in April, namely 7104 MYR/T and then fluctuating to their lowest price of 3568 MYR/T in July 2022. Fluctuations in commodity prices have the potential to affect export earnings, production output, investment, absorption labour, taxes, and inflation (Deniz, 2022). Therefore, the regional economy of Sumatera Island had the potential to be hit by a spill over effect and as a result, the price of necessities might increase. So that, according to Patrick (2011), exogenous shocks and related instabilities of economic variables had negative effect on the economic growth and rate of poverty reduction on developing countries. Nevertheless, not all provinces in Sumatera Island had good condition and resilience toward shocks. Then, for those regions which had no resilience to shocks were called vulnerable and they would potentially affect other region. The government should take it as an additional consideration. Therefore, it was required to classify each region by its economic vulnerability so that the government would have a picture which region should be supported while facing shocks and instabilities. This started to indicate the importance of doing study regarding the economic vulnerability over provinces in Sumatera Island and its mapping.

In addition, prices for energy and principal commodity such as food staples were high and unreachable by people with low income. This would have the potential to increase the poverty rate. To support purchasing power, the government had distributed various kinds of subsidies such as energy subsidies, namely fuel, electricity and 3 kg gas, subsidies through the staple food card program, family incentives (Program Keluarga Harapan), pre-employment cards (Prakerja), tax incentives, credit loans, and others. However, this was a short-term solution, regarding the budget constraints. Therefore, the government was taking long-term anticipatory steps by building synergies between Bank Indonesia and the Ministry of Finance to formulate monetary and fiscal policies in order to maintain price stability and support economic growth.

Based on data from the BPS-Statistics of Indonesia (BPS), the province's GRDP (Gross Regional Domestic Product) on Sumatera Island was mostly contributed by household consumption expenditure with an average share of 0.49 percent for the 2017-2022 period. This means that the provincial economy on the island of Sumatera was supported by household consumption expenditure with different levels of consumption in each region. In addition, different levels of welfare will also open gaps or gaps in the economy of a region (Sukirno, 2010)

Even though a high GRDP and GDPGR (Gross Domestic Product Growth Rate) in a region reflects a stronger and growing economy, if the economic growth is not evenly distributed so that creates extreme poverty, the GRDP and GDPGR become less precise when used as a measurement of the welfare level per capita of a region. In addition, inflation has an inconsistent effect on household consumption. If people's purchasing power is high, inflation may not have much effect on changes in household consumption and may even increase for certain goods (Fathudin, 2016). Meanwhile, if

people's purchasing power is low, household consumption will be greatly affected by inflation so that spending will decrease.

Household consumption expenditure as a support for the economy of the provinces on Sumatera Island needed to be maintained in the post-pandemic period, while on the other hand, not all provinces in Sumatera had the same economic resilience. Thus, the application of the same policy to all regions would be inappropriate and inefficient. If household consumption declines, there would be potential for a slowdown in economic growth and even an economic recession. This condition could cause the poverty rate to increase. This was not in line with the target of the President of Indonesia, which was 0 percent of extreme poverty in Indonesia in 2024. Therefore, it was necessary to analyse the factors that influence household consumption in a region so that appropriate follow-up actions can be determined to overcome this, and it was also important to analyse the influence of economic vulnerability status to household consumption. In this study, there were two research questions, which were (i) How were the provinces on Sumatera Island grouped based on economic vulnerability? (ii) How did the status of this grouping affect the regional economy on the island of Sumatera?

Therefore, this study aimed to analyse the grouping of provinces on the island of Sumatera based on economic vulnerability factors and to analyse the effect of the status of these groupings on the regional economy on the island of Sumatera including other factors. This research was expected to be used as consideration in formulating strategies to anticipate the impact of spillover effects both in terms of policy and region.

2. Literature Review

Growth Theory explained about what factor and how a system could give improvement to the economy. One of the Growth Theory was Cobb Douglas function. Output quantity is strongly influenced by production factors, those are capital and labour. Based on the Cobb Douglas production function, it is explained that the increase in production factors, which are capital and labour, is in line with the increase in output produced, so that if the number of workers and capital increases, the product produced will increase. If the produced goods can meet the number of needs, and by working people can earn income, then this will encourage an increase in household consumption (Todaro, 2000). Based on the law of demand, an increase in the price of goods will be responded by a decrease in the quantity of goods purchased. Whereas based on the law of supply, an increase in the price of goods will be responded by an increase in the number of goods sold. If it is connected with the law of supply and demand, then the output is goods sold (supply) and goods purchased (demand), will form the point of intersection, called the market price. Based on classical economic theory, it is explained that the market has an automatic mechanism without external influences in achieving equilibrium, that is, for example, a normal good has a price below the market price, then the quantity of goods demanded will be greater than the goods offered or excess demand occurs. In the end, this scarcity will automatically increase the price of goods until it reaches the equilibrium of the original market price.

On the other hand, Keynesian economic theory explains that the auto-adjustment of the market naturally cannot take place quickly and under certain conditions cannot return to the initial equilibrium without the contribution of a third party, namely the government. Therefore, the government can play a role through monetary and fiscal policies to achieve market balance. Monetary policy is carried out through interest rate instruments while fiscal policy is carried through government spending and taxes. According to classical and Keynesian theory, the function of interest rates on investment has an inverse relationship, for instance the higher the interest rate, the demand for money, and the desire to invest will decrease because saving becomes more attractive, so that an increase in interest rates at a certain level will reduce people's consumption, and vice versa (Nicholas, 2010). If household consumption decreases, it means that the demand for goods decreases. This can result in a decrease in price which the producer will respond with a decrease in production. If transactions decrease, economic growth will be hampered (Fredrich, 2008).

The economic vulnerability of a region is a risky condition that impedes economic growth due to internal and external shocks (Patrick, 2009). Income inequality is a form of economic vulnerability, so

that if exposed to shocks it will have a major impact on the poor to become poorer due to reduced income, increased cost of living, and reduced ability to generate income (World Bank, 2016). According to Patrick (2011) there are two dimensions to measure economic vulnerability, which are shock and exposure. Indicator for shock dimension is trade. Regions with economies that depend on trade will be more easily exposed to external shocks. While indicators of exposure dimensions include: location, size, structure, and environment. An area with a small economic size is characterized by a relatively low GRDP, which has the potential to experience higher growth in percentage terms compared to a region with a large economic size. If this high growth is not matched by a strong structure and a supportive environment, such as high poverty rates and income inequality, this will make an area easily exposed to outside influences. In addition, there are several previous studies related to the topic and methodology used in this research. A summary of these previous studies is presented in Table 1.

Table 1. Previous Studies.

Number	Author	Title	Summary
1.	Budhi Fatanza Wiratama, et al (2021)	Kajian Kerentanan Ekonomi Indonesia terhadap Pandemi COVID-19	The purpose of this study is to create an Economic Vulnerability index and map priority provinces. The results show that EV has a negative effect on GDP growth in the 2nd quarter of 2020, EV is formed from exposure and shock
2.	Zerlita Fahdha Pusdiktasari, et al (2021)	Pengelompokkan Provinsi di Indonesia dengan Ekonomi Terdampak Covid-19 Menggunakan Analisis Cluster	The purpose of this study is to analyze the grouping of provinces whose economies are at risk of being affected by Covid-19 based on the unemployment rate, the percentage of poor people, the UMR, and the hotel occupancy rate. The method used is cluster analysis using hierarchical methods. The result characteristics of the at-risk groups are the high percentage of poor people, low minimum wage, high unemployment rate, and high hotel occupancy rate.
3.	Daru Yudanto, et al (2020)	Pengaruh Pendapatan Perkapita dan Inflasi serta Suku Bunga Terhadap Konsumsi Rumah Tangga Makanan dan Non Makanan serta Pengaruhnya terhadap Kesejahteraan Masyarakat	The purpose of this study was to analyze the effect of per capita income, inflation, and interest rates on food and non-food household consumption and their effect on the welfare of the people of East Kalimantan. The method used is path analysis. The results showed that inflation had a negative and significant effect on household consumption. However, it is not significant in the indirect effect on HDI

Based on the theory and previous research above, an overview of the relationship between theories was collected, for instance, the economy of a region is affected by changes in prices and factors of production. Price stability will encourage economic growth by increasing production factors. In addition, there are economic vulnerability factors that also affect the economy of a region in the face of external influences. This research was built based on theories related to research problems and linked measurable variables to answer research questions and provide quantitative evidence. Based on these theories, the variables used in this study and their relationship were the effect of differences in Economic Vulnerability between regions as measured through the variables Economic Capacity, Economic Growth, Economic Inequality, and Poverty, on Household Consumption together with Inflation, Unemployment, and Investment. The framework for this research is shown in Figure 1. The research hypothesis was based on this framework, namely the variables Economic Capacity, Economic Growth, Economic Inequality, and Poverty can classify regions properly based on Economic Vulnerability. Then,

Economic Vulnerability, Inflation, Unemployment, and Investment jointly affect Household Consumption.
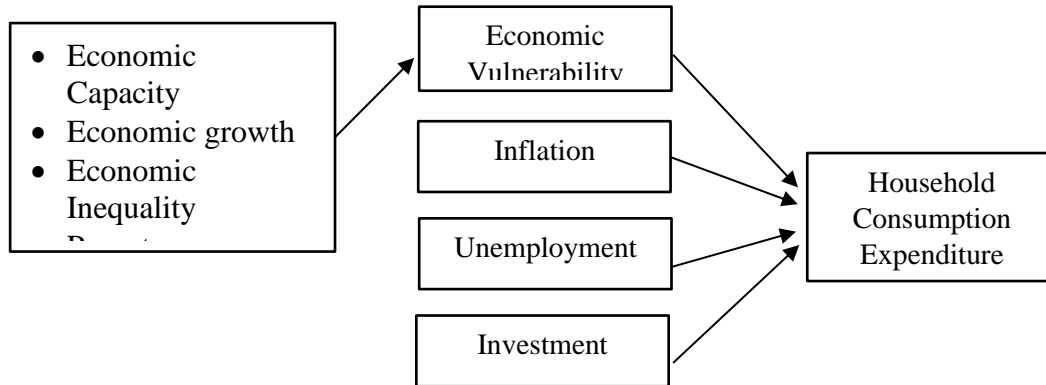
Figure 1. Research Framework

3. Methodology

The data used as variable definitions were secondary data sourced from the BPS-Statistics Indonesia and the BPS-Statistics of provinces in all over Sumatera. The variables included in this study were EV (Economic Vulnerability) (X_1) in binary form, which were 1 (Vulnerable Groups) and 0 (Not Vulnerable Groups) as measured by doing clustering towards GRDP (Gross Regional Domestic Product) (V_1) in million rupiah, GDPGR (Gross Domestic Product Growth Rate) (V_2) in percent, Gini Ratio (V_3) in points, and P2 (Poverty Severity) (V_4) in percent, which was done based on theories of previous studies (Table 1). Then Inflation (X_2) in percent, TPT (Open Unemployment Rate) (X_3) in percent, Realization of Foreign Investment in Indonesia (X_4) in million USD, and Household Consumption Expenditure (Y_1) in million rupiah which part of GDP component or aggregate number of household expenditure in a year. The scope of this study were all ten provinces on the island of Sumatera, namely Aceh, Sumatera Utara, Riau, Sumatera Barat, Jambi, Bengkulu, Sumatera Selatan, Lampung, Kepulauan Bangka Belitung, and Kepulauan Riau on an annual basis in the 2010 - 2021 period, This research used that period because there were many event happened and it consisted of various shocks and stable economic condition as in line with the aim of the research. But there was also limitation of data availability. So that, the data used in this study was a panel with total of 120 objects and 9 variables. Table 2 below is the table containing 20 data.

Table 2. Research Data

Year	Province	Household Consumption Expenditure	Foreign Investment	Inflation	Open Unemployment (TPT)	Ev	Latitude	Longitude
2011	ACEH	56612415,12	22,5	3,43	9	1	4,6951350	96,7493993
2012	ACEH	58580993,67	172,3	0,22	9,06	1	4,6951350	96,7493993
2013	ACEH	60397296,12	94,2	7,31	10,12	1	4,6951350	96,7493993
2014	ACEH	62326263,9	31,1	8,09	9,02	1	4,6951350	96,7493993
2015	ACEH	64201370,35	21,2	1,53	9,93	1	4,6951350	96,7493993
2016	ACEH	66335056,95	134,5	3,95	7,57	1	4,6951350	96,7493993
2017	ACEH	68571837,95	23,2	4,25	6,57	1	4,6951350	96,7493993
2018	ACEH	71037725,02	71,2	1,84	6,34	1	4,6951350	96,7493993

Year	Province	Household Consumption Expenditure	Foreign Investment	Inflation	Open Unemployment (TPT)	Ev	Latitude	Longitude
2019	ACEH	73746376,37	137,5	1,69	6,17	1	4,6951350	96,7493993
2020	ACEH	73271449,57	51,1	3,54	6,59	0	4,6951350	96,7493993
2021	ACEH	74123833,18	203,3	2,22	6,3	1	4,6951350	96,7493993
2011	SUMATERA UTARA	186197958,8	753,7	3,67	8,18	0	2,1153547	99,5450974
2012	SUMATERA UTARA	195133161,5	645,3	3,86	6,28	1	2,1153547	99,5450974
2013	SUMATERA UTARA	204962973,3	887,5	10,18	6,45	0	2,1153547	99,5450974
2014	SUMATERA UTARA	215720143,1	550,8	8,17	6,23	0	2,1153547	99,5450974
2015	SUMATERA UTARA	225907466,2	1246,1	3,24	6,71	0	2,1153547	99,5450974
2016	SUMATERA UTARA	237147363,3	1014,7	6,34	5,84	0	2,1153547	99,5450974
2017	SUMATERA UTARA	249298155,7	1514,9	3,2	5,6	0	2,1153547	99,5450974
2018	SUMATERA UTARA	263925548,7	1227,6	1,23	5,55	0	2,1153547	99,5450974
2019	SUMATERA UTARA	275126715,7	379,5	2,33	5,39	0	2,1153547	99,5450974
2020	SUMATERA UTARA	267334077,8	974,8	1,96	6,91	0	2,1153547	99,5450974

The analysis technique used in this research was descriptive analysis and inferential analysis. Descriptive analysis was carried out by displaying graphs and statistics. Meanwhile, inferential analysis used the Cluster Analysis method to group regions based on certain characteristics. In addition, panel regression analysis was performed using the CEM (Common Effect Model), FEM (Fix Effect Model), and REM (Random Effect Model) methods to analyse the factors that influenced variable Y_1. Then the analysis was continued with GWRP (Geographical Weighted Panel Regression) regression to get the best regional-based model. As final result, the models produced in this analysis were ten models, for ten provinces on the island of Sumatera. The model equation is presented in equation (1)-(10).

$$Y_{1(ACEH)} = \beta_0(p_{(ACEH)}) + \beta_1 X_{1(t)}(p_{(ACEH)}) + \beta_2 X_{2(t)}(p_{(ACEH)}) + \beta_3 X_{3(t)}(p_{(ACEH)}) + \beta_4 X_{4(t)}(p_{(ACEH)}) \tag{1}$$

$$Y_{1(SUMUT)} = \beta_0(p_{(SUMUT)}) + \beta_1 X_{1(t)}(p_{(SUMUT)}) + \beta_2 X_{2(t)}(p_{(SUMUT)}) + \beta_3 X_{3(t)}(p_{(SUMUT)}) + \beta_4 X_{4(t)}(p_{(SUMUT)}) \tag{2}$$

$$Y_{1(SUMBAR)} = \beta_0(p_{(SUMBAR)}) + \beta_1 X_{1(t)}(p_{(SUMBAR)}) + \beta_2 X_{2(t)}(p_{(SUMBAR)}) + \beta_3 X_{3(t)}(p_{(SUMBAR)}) + \beta_4 X_{4(t)}(p_{(SUMBAR)}) \tag{3}$$

$$Y_{1(RIAU)} = \beta_0(p_{(RIAU)}) + \beta_1 X_{1(t)}(p_{(RIAU)}) + \beta_2 X_{2(t)}(p_{(RIAU)}) + \beta_3 X_{3(t)}(p_{(RIAU)}) + \beta_4 X_{4(t)}(p_{(RIAU)}) \tag{4}$$

$$Y_{1(JAMBI)} = \beta_0(p_{(JAMBI)}) + \beta_1 X_{1(t)}(p_{(JAMBI)}) + \beta_2 X_{2(t)}(p_{(JAMBI)}) + \beta_3 X_{3(t)}(p_{(JAMBI)}) + \beta_4 X_{4(t)}(p_{(JAMBI)}) \tag{5}$$

$$Y_{1(SUMSEL)} = \beta_0(p_{(SUMSEL)}) + \beta_1 X_{1(t)}(p_{(SUMSEL)}) + \beta_2 X_{2(t)}(p_{(SUMSEL)}) + \beta_3 X_{3(t)}(p_{(SUMSEL)}) + \beta_4 X_{4(t)}(p_{(SUMSEL)}) \tag{6}$$

$$Y_{1(BENGKULU)} = \beta_0(p_{(BENGKULU)}) + \beta_1 X_{1(t)}(p_{(BENGKULU)}) + \beta_2 X_{2(t)}(p_{(BENGKULU)}) + \beta_3 X_{3(t)}(p_{(BENGKULU)}) + \beta_4 X_{4(t)}(p_{(BENGKULU)}) \tag{7}$$

$$Y_{1(LAMPUNG)} = \beta_0\big(p_{(LAMPUNG)}\big) + \beta_1 X_{1(t)}\big(p_{(LAMPUNG)}\big) + \beta_2 X_{2(t)}\big(p_{(LAMPUNG)}\big) + \beta_3 X_{3(t)}\big(p_{(LAMPUNG)}\big) + \beta_4 X_{4(t)}\big(p_{(LAMPUNG)}\big) \tag{8}$$

$$Y_{1(BABEL)} = \beta_0\big(p_{(BABEL)}\big) + \beta_1 X_{1(t)}\big(p_{(BABEL)}\big) + \beta_2 X_{2(t)}\big(p_{(BABEL)}\big) + \beta_3 X_{3(t)}\big(p_{(BABEL)}\big) + \beta_4 X_{4(t)}\big(p_{(BABEL)}\big) \tag{9}$$

$$Y_{1(KEPRI)} = \beta_0\big(p_{(KEPRI)}\big) + \beta_1 X_{1(t)}\big(p_{(KEPRI)}\big) + \beta_2 X_{2(t)}\big(p_{(KEPRI)}\big) + \beta_3 X_{3(t)}\big(p_{(KEPRI)}\big) + \beta_4 X_{4(t)}\big(p_{(KEPRI)}\big) \tag{10}$$

with

Y_{1it} = Household Consumption expenditure (million rupiah), the ith province, and t period

p_i = geographic location of the ith province (coordinate)

X_{1it} = Economic Vulnerability (binery 1 and 0), the ith province, and t period

X_{2it} = Inflation (percent), the ith province, and t period

X_{3it} = Open Unemployment Rate, the ith province, and t period

X_{4it} = Realisation of Foreign Investment in Indonesia, the ith province, and t period

β_0 = intercept

β_1 = parametric estimation of Economic Vulnerability

β_2 = parametric estimation of Inflation

β_3 = parametric estimation of Open Unemployment Rate

β_4 = parametric estimation of Realisation of Foreign Investment

ϵ_i = the ith province residual

Last, the goodness of fit test, the general significance test for spatial variables, the spatial non-autocorrelation test, and the normality test are performed. The goodness of fit test is used to ensure that the GWPR model is better than the global model without spatial influence. Then the general significance test can provide an overview of which variables have a spatial influence. In addition, a spatial heterogeneity test was carried out to ensure that the GWPR model could remove the symptoms of cross-sectional correlation in the residuals.

4. Results and Analysis

4.1. Descriptive Analysis

Most provinces on Sumatera Island have economic growth that is always around the national figure, one of which is Sumatera Utara Province with an average 2011-2021 GRDP growth of 4.7 percent while the 2011-2021 average National GDP growth is 4. 6 percent. However, there are provinces with economic growth far below the national average, one of which is Riau Province with an average 2011-2021 GRDP growth of 2.45 percent.
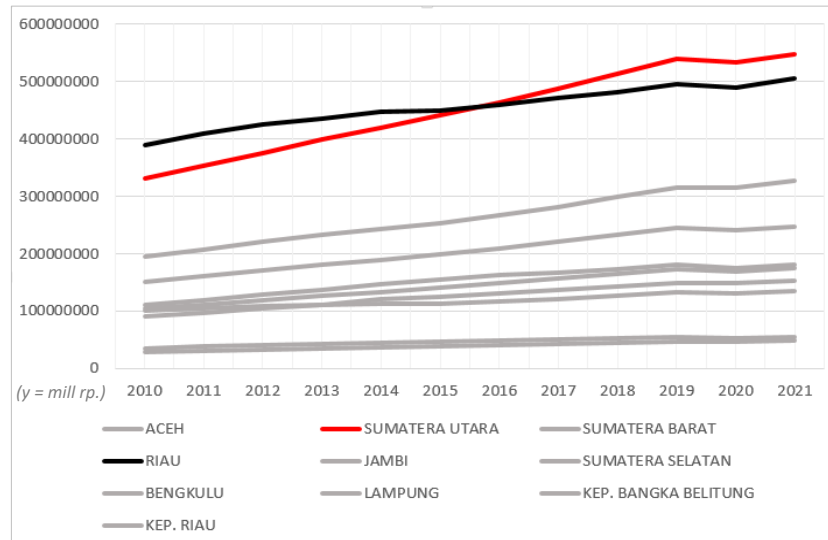
Figure 2. Series of GRDP of All Provinces in Sumatera Island 2010-2021 (million rupiahs)

In fact, during the 2011-2021 period the Provinces of Riau and Sumatera Utara had nearly the same GRDP values and were the highest on the island of Sumatera (Figure 2). However, when compared on a net export basis, Riau Province was superior (Figure 3), while in terms of household consumption expenditure, Sumatera Utara Province appeared to be superior (Figure 4).
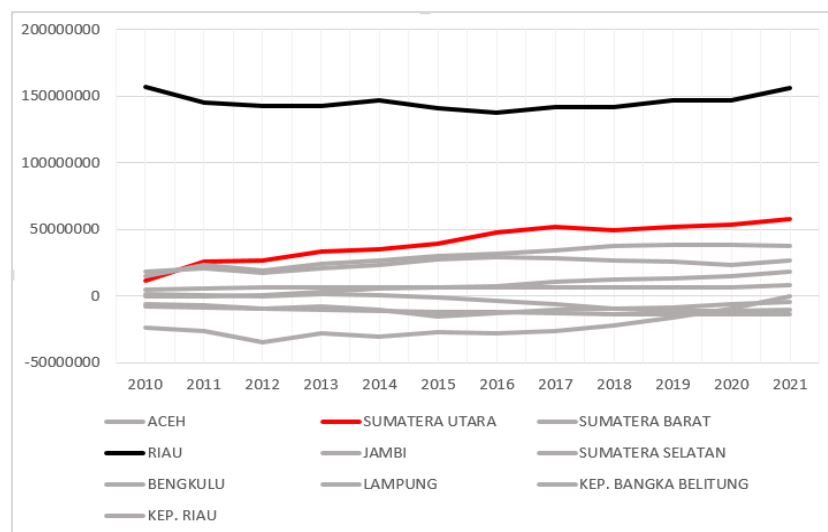

Figure 3. Net Exports at Constant Prices 2010-2011 (million rupiahs)
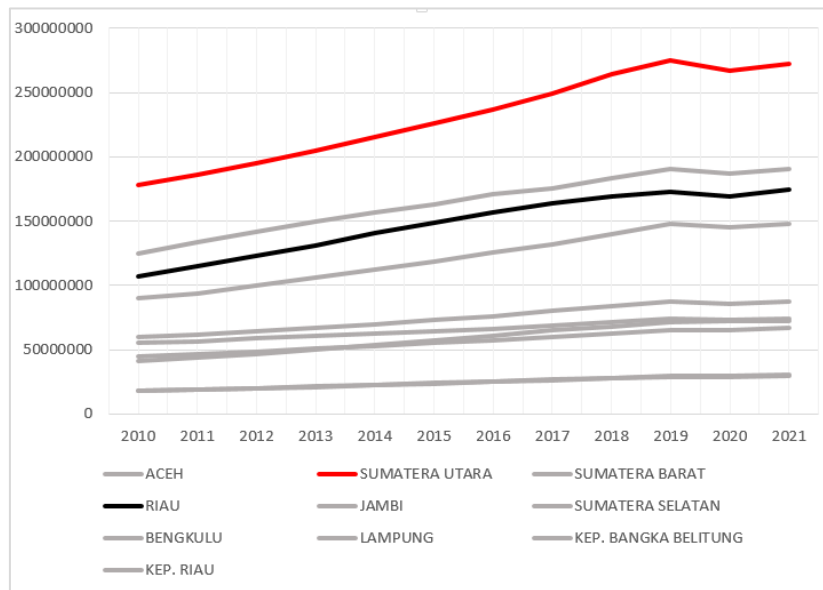
Figure 4. GRDP at Constant Prices According to Consumption
Expenditure Household 2010-2021 (million rupiahs)

Based on the graph in Figure 5, it can be seen that the Provinces of Riau and Sumatera Utara had relatively the same GDP Growth Rate (GDPGR) for 2020, but the highest increase in the percentage of poor people in 2020 compared to 2019 occurred in Sumatera Utara Province, while the lowest increase in the percentage of poor people occurred in the Province of Riau. The paired pattern by comparing the same GDPGR but different growth in the percentage of poor people also occurs in the Provinces of the Kepulauan Riau and the Kepulauan Bangka Belitung and the Provinces of Sumatera Barat and Lampung. So, from this phenomenon it can be indicated that there were differences in the characteristics of economic resilience in dealing with shocks in the provinces on the island of Sumatera.
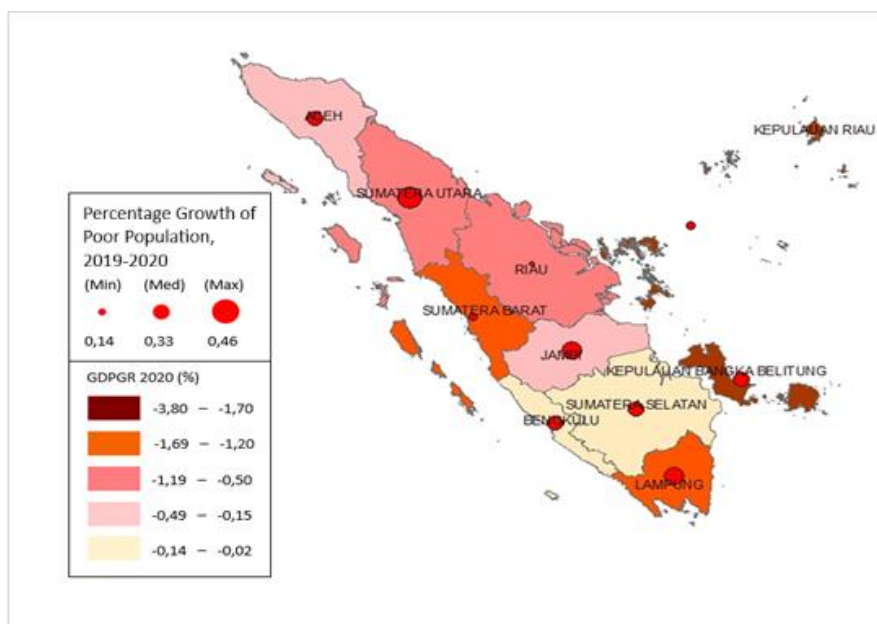
Figure 5. Comparison of Poor Population Growth in 2020 (percent)
with GDP GrowthRate (GDPGR) in 2020 (percent)

Figure 6 shows the condition of the province in Sumatera entering economic recovery, including increasing household consumption, decreasing TPT, and increasing inflation. In Riau Province, there was a high increase in household consumption, a large decrease in TPT, and low inflation. A relatively similar pattern also occured in the provinces of Sumatera Utara, Sumatera Barat, Sumatera Selatan and Jambi. In contrast, the Kepulauan Bangka Belitung Province got relatively low increase in household consumption, a slight decrease in TPT, and relatively high inflation. This pattern also occured in Kepulauan Riau, Aceh, Lampung and Bengkulu Provinces. Based on this phenomenon it was indicated that there was a relationship between household consumption, TPT and inflation.
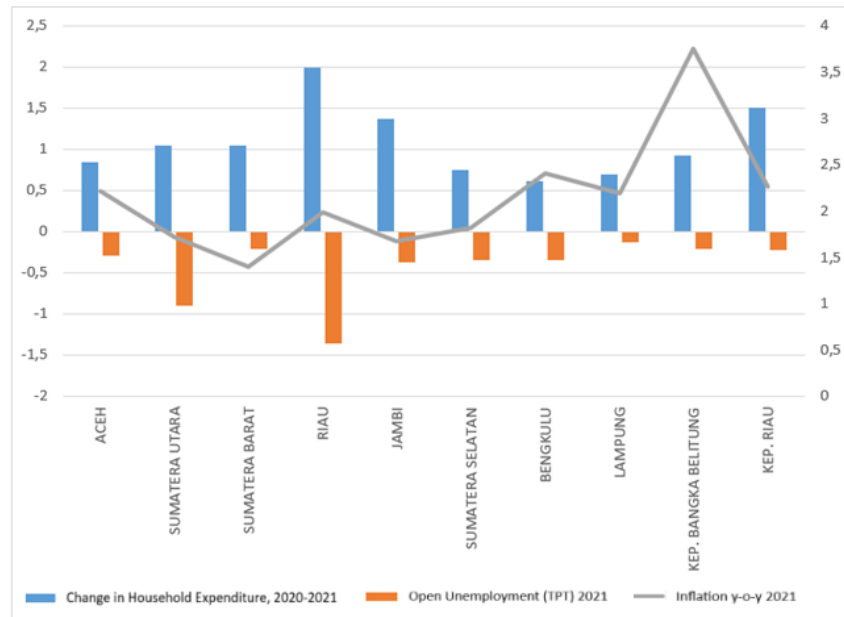
**Figure 6.** Comparison of Changes in Household Consumption Expenditures 2020-2021 with 2021 YoY Inflation

4.2. Inferential Analysis

The analysis was continued with modeling, statistical tests, and interpretation. Previously, data preprocessing was done first by deleting the series which had missing value, which was 2010, so the data used was the data of 2011-2021. Each period had a cross-section of 10 provinces, so the data form was panel with total of 110 individuals. The first stage was Cluster Analysis, that grouped the 110 individuals into two clusters. Previously, the variables V_1, V_2, V_3, and V_4, which had different units, were standardized against the average value so that the values could be compared with one another. The average value in question was the average of the 110 individuals or in other words the average of the 10 provinces in Sumatera during the 2011-2021 period. The number of groups was determined into two clusters because it was based on the research objectives and also confirmed by the hierarchical method using a dendogram to see the comparison of the number of members between clusters if more than 2 clusters were formed. Therefore, the cluster method used was K-Means because the number of clusters to be formed was determined in advance. The K-Means algorithm made it possible to iterate many times to get the optimum cluster midpoint, which was a point with the farthest distance between clusters and the shortest distance to individuals in the cluster. The final midpoint graphic that was resulted from these iterations for each cluster is shown in Figure 7.
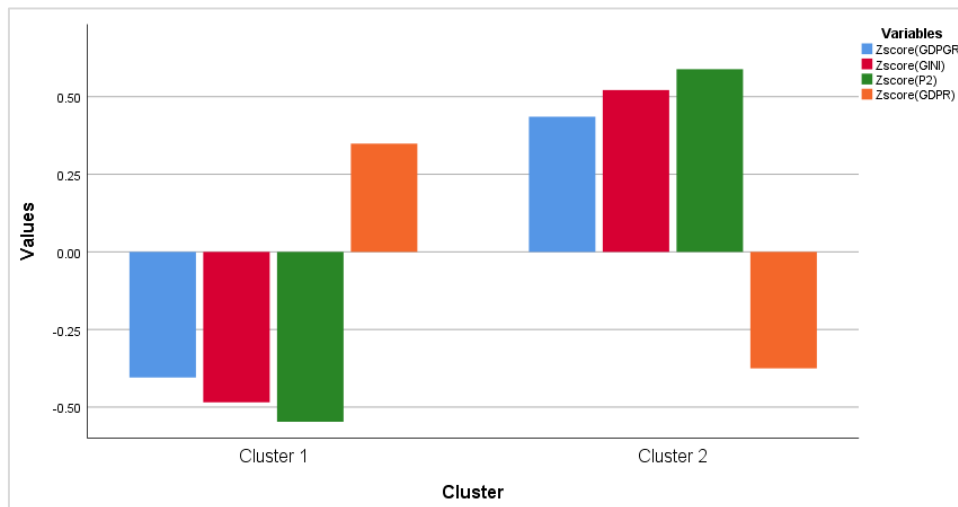
Figure 7. Center Point of Cluster as Iteration Result

Based on the graph in Figure 4, it can be seen that the midpoint of the cluster was a representation of the general characteristics of each cluster. Cluster was grouping result of provinces in Sumatera Island whether it is vulnerable or not. Cluster 1 generally had characteristics, namely GDPGR (V_2), Gini Ratio (V_3), and P2 (V_4) below the average with the distance of each variable to the average, namely $V_2 < V_3 < V_4$. Meanwhile, GRDP (V_1) was higher than the average. Then cluster 2 generally has the opposite characteristics to cluster 1, namely GDPGR (V_2), Gini Ratio (V_3), and P2 (V_4) above the average with the distance of each variable to the average, namely $V_2 < V_3 < V_4$. Meanwhile, GRDP (V_1) was lower than the average. Based on the characteristics and theories related to this matter, it could be determined that cluster 2 was a vulnerable group, while cluster 1 was a non-vulnerable group. Evaluation was carried out to see whether the clustering was good enough in grouping data. The number of members of cluster 1 and cluster 2 respectively were 57 and 53 individuals, so it could be considered as balance. Then, through ANOVA testing it was known that the variables V_1, V_2, V_3, and V_4 were significant in dividing the cluster at an alpha of five percent. This was in accordance with the study of Zerlita et al (2021). So, based on the test results it could be said that the clustering results were good enough to be used in grouping. A summary of the grouping results is shown in Figure 8 below.
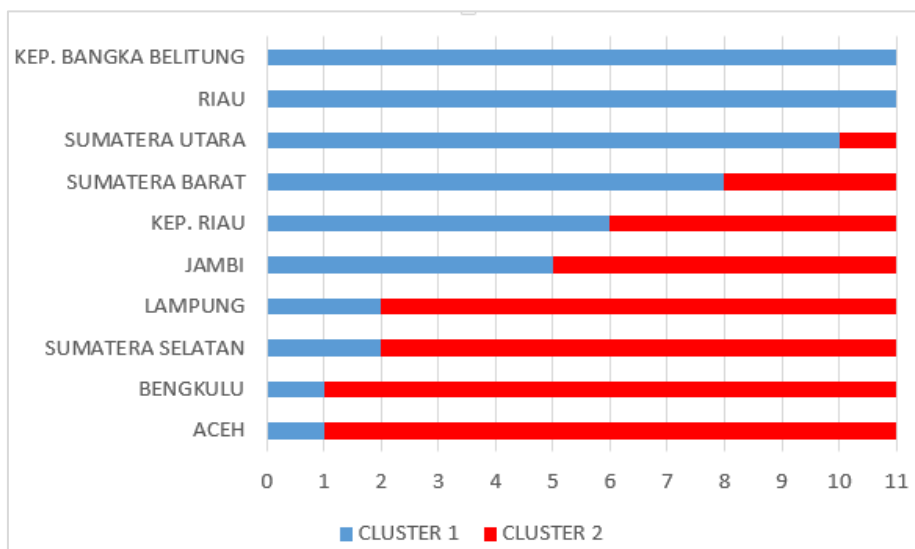
Figure 8. Summary of Results of Grouping Provinces on Sumatera Island Based on Economic Vulnerability Status

From the Figure 8 above, index number from 0 to 11 meant the number of years counted from 2010 to 2021 as classified to whether cluster 1 or 2. With a threshold of 5,5 the general grouping showed that there were 5 provinces that tended to be in Cluster 1 (non-vulnerable), such as the Provinces of Kepulauan Bangka Belitung, Riau, Sumatera Utara, Sumatera Barat, and Kepulauan Riau. Meanwhile, the other 5 provinces tended to be in Cluster 2 (vulnerable), namely the provinces of Jambi, Lampung, Sumatera Selatan, Bengkulu and Aceh. The next analysis was to perform panel data regression of the independent variables X_1, X_2, X_3, and X_4 against Y_1. Before forming the panel model, a natural logarithm transformation was performed first to avoid the influence of extreme values on the model. Then formed the CEM, FEM, and REM panel models and then the Hausman, Lagrange Multiplier, and Chow tests were carried out to determine the best model. The test results are presented in Table 2.

Table 2. Result Summary of Hausman Test, Lagrange Multiplier, and Chow Test

Test Summary	Statistics	Probability
Hausman test (Cross-section random)	38.5249	0.0000
Lagrange Multiplier (Breusch-Pagan)	215.1647	0.0000
Chow test (Cross-section F)	443.5928	0.0000

The Chow test yold a statistic of 443.5928 with probability less than five percent alpha, so it could be said that the FEM model was better than the CEM. Then the Lagrange Multiplier test produces statistics of 215.1647 which meant the REM model was better than CEM. Furthermore, the Hausman test produces statistics of 38.5249 which shows that the FEM model was better than the REM model. Based on these test results it can be concluded that the best model was the FEM panel model. The parameter estimation results are in Table 3 below.

Based on Table 3, it could be seen that the variables X_1, X_2, and X_4 had a probability less than five percent alpha, so it could be said that X_1, X_2, and X_4 significantly affected Y_1. Whereas X_3 had a probability greater than five percent so that it could be said that X_3 did not significantly affect Y_1. These results were consistent with the research of Daru et al (2020), Sauwaluck (2012), and Budi et al (2021).

Table 3. Parametric Estimation Result by FEM Model

Dependent Variable: LOG(KONS) (Y_1)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	17.94829	0.113406	158.2662	0.0000
LOG(INF) (X_2)	-0.052911	0.014454	-3.660600	0.0004
EV (X_1)	-0.090619	0.026639	-3.401687	0.0010
LOG(TPT) (X_3)	-0.088718	0.050461	-1.758136	0.0819
LOG(INVS) (X_4)	0.060210	0.007380	8.158837	0.0000
Effects Specification				

Cross-section fixed (dummy variables)

R-squared	0.987979	Mean dependent var	18.15972
Adjusted R-squared	0.986351	S.D. dependent var	0.741534
S.E. of regression	0.086634	Akaike info criterion	-1.935846
Sum squared resid	0.720516	Schwarz criterion	-1.592148
Log likelihood	120.4715	Hannan-Quinn criter.	-1.796440
F-statistic	606.9041	Durbin-Watson stat	1.084426
Prob(F-statistic)	0.000000		

Based on the estimated parameters, it was estimated that every 1 percent increase in X_2 would reduce Y_1 by 0.053 percent, an increase in X_3 by 1 percent would reduce Y_1 by 0.088 percent, an increase in X_4 by 1 percent would increase Y_1 by 0.06 percent, and if a province had the status vulnerable ($X_1 = 1$) it would tend to reduce Y_1 by 0.09 percent. Based on the R-squared value, the model could explain the Y_1 variation of 98 percent, while the other 2 percent was explained by variables not included in the model. Then, evaluated the model using cross-section correlation and normality tests. Table 4 below shows the test results.

Table 4. Result Summary of Cross-section Autocorrelation Test

Test Summary	Statistics	Probability
Cross-section correlation (Breusch-Pagan LM)	128.7689	0.0000
Normality Test (Jarque-Bera)	5.3563	0.0687

Based on this test, the residuals were normally distributed because the Jarque-Bera statistical probability was more than five percent, but there were indications of a cross-sectional correlation, such as the existence of links between regions, or in other words, it indicated the existence of spatial effect. If this spatial effect was not accommodated in the model, then it was possible for the estimation to be inconsistent. This could interfere with the estimation results to be inconsistent because there was still a pattern in the residuals. Therefore, the analysis was continued by using the GWPR model to capture these symptoms. GWPR modeling was done by first determining the optimum bandwidth using three kernel approaches, namely Gaussian, Exponential, and Bisquare. The results of the comparison of the three kernel approaches are presented in Table 5.

Table 5. Summary of Modeling Results with Three Kernel Approaches

Kernel	AIC	R-squared
Gaussian	108.7153	0.7429
Exponential	80.96451	0.8037
Bisquare	14.67118*	0.9027*

From the comparison of the three kernels, the Bisquare kernel was better than Gaussian and Exponential with the smallest AIC value, the largest R2, and the minimum Cross Validation score (*). Therefore, in this study the bisquare kernel function was used to determine the bandwidth of each province in the GWPR modeling. Then parameter estimation for each province was carried out so that there were 10 models. Then the goodness of fit test was carried out using ANOVA and the global model SSE (Sum Squared Error) was 28.9458; GWPR model SSE of 5.8291; F-statistic of 4.9658; and the p-value was less than five percent so that it could be said that the model had a geographical effect, that were, there were differences between regions so that the GWPR model was suitable for use in the data. The next test was a spatial variable partial test with the following results: variables X_1, X_2, and X_3 had a p-value of less than five percent, while X_4 had a p-value of more than five percent. Therefore, it could be concluded that only the variables X_1, X_2, and X_3 had a significant difference in influence on Y_1 between one province and another. This was in accordance with research by Antelo, et al (2017). Then, the test was continued with a cross-section correlation test using the Breusch-Pagan test and obtained a t-statistic of 3.7813 and a p-value of 0.4364, so that it couldbbe said that the residual had no regional linkage effect. In addition, the multicollinearity test for all independent variables produces a VIF value of less than 5 so that it could be said that there were no symptoms of multicollinearity (Table 6). Based on the results of the evaluation of the model, the GWPR model was considered as good for producing parameter estimates. Parameter estimates are presented in Table 6 and the significance of each variable is presented in the form of a thematic map in Figure 7.

Based on Table 6 and Figure 9, it could be concluded that the provinces of Lampung and the Kepulauan Bangka Belitung were more significantly (probability <0.05) affected by the impact of inflation on household consumption expenditure than other nuvinces. Furthermore, the two provinces together with the Province of Sumatera Selatan experienced more impact of the economic vulnerability

factor on household consumption expenditure than the other provinces. In addition, only the Provinces of Aceh, Sumatera Utara, Kepulauan Riau and Kepulauan Bangka Belitung that were not significantly affected by changes in the open unemployment rate, and only Aceh and Kepulauan Riau Provinces that did not feel a significant impact from changes in incoming foreign investment on household consumption expenditure ladder.

Table 6. VIF Value of Independent Variable Multicollinearity Test

LNINF (X_2)	EV (X_1)	LNTPT (X_3)	LNINVS (X_4)
1,047925	1,132725	1,074490	1,166988

Table 7. Parameter Estimation with the GWPR Model

PROVINCE	LNINF (X_2)	EV (X_1)	LNTPT (X_3)	LNINVS (X_4)
Aceh	0,011160008	-0,043190774	-0,397447361	0,011278174
Bengkulu	0,077001878	-0,127652849	1,5025061*	0,395025115*
Jambi	-0,062561268	-0,100848916	0,943236347*	0,309554553*
Kep. Bangka Belitung	-0,355993048*	1,17822033*	0,138020658	0,298286443*
Kep. Riau	0,081786919	-0,092161115	0,294184657	0,172533447
Lampung	-0,328104594*	0,803780102*	0,722845177*	0,319268862*
Riau	-0,086680581	-0,107005052	0,553005824*	0,27874411*
Sumatera Barat	-0,060192253	-0,172661108	0,663695704*	0,267147209*
Sumatera Selatan	-0,097225131	0,281548127*	1,4790564*	0,379039502*
Sumatera Utara	-0,117062382	-0,04996341	-0,117630033	0,305877631*

(a)   (b)

(c)   (d)
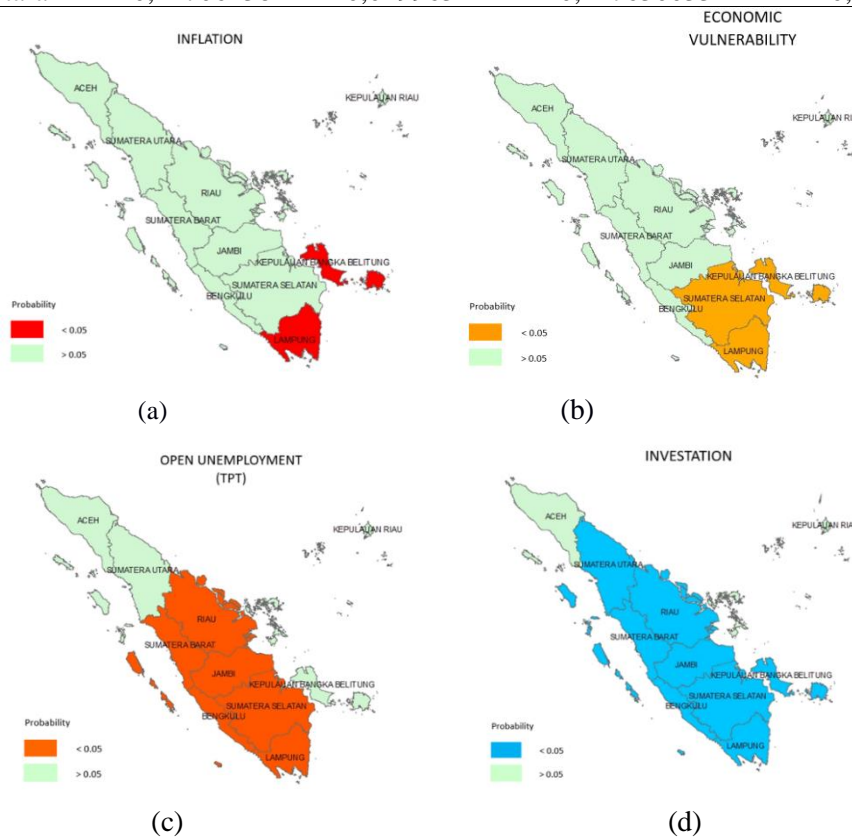
Figure 9. Thematic Map of Significance of Inflation Variables (a), Economic Vulnerability (b),Open Unemployment Rate (TPT) (c), and Investment (d)

5. Conclusion and Recommendation

In general, the provinces on the island of Sumatera could be grouped into two clusters based on their relative vulnerability status, that were the vulnerable group which was dominated by the provinces of the southern part of the island and the tip of the island, and the non-vulnerable group which was dominated by the provinces in the north of the island and the middle of the island. Based on the analysis' result, and it was also aligned with the previous studies, the economic vulnerability (EV) factor in general had negative impact on household consumption in all provinces on the island of Sumatera, especially the provinces of Lampung, Sumatera Selatan, and the Kepulauan Bangka Belitung. This needed special attention by policy makers because the economic vulnerability of a region would have an impact on the surrounding area.

Lampung Province was one of the provinces most significantly affected by the variables of economic vulnerability (EV), inflation, Open Unemployment Rate (TPT), and Realization of Foreign Investment, on household consumption expenditure compared to other provinces. In addition, Lampung Province, which was included in cluster 2 (vulnerable cluster), would also not experience high economic recovery in 2021. Accordingly, further studies needed to be carried out considering the location of Lampung Province which was close to Java Island so that it should become the main land route to connect Sumatera and Java Island. The high flow of distribution of goods and services from Java Island should be able to improve the economy of the area it traverses.

Based on this research, it is recommended that the government as a policy maker apply different policies according to the characteristics and needs of each province in order to maintain price stability and support economic growth. In addition, policies can be focused on creating jobs through investment, especially for the provinces of Riau, Sumatera Barat, Jambi, Bengkulu, Sumatera Selatan, and Lampung because there was laid the potential for a significant double effect, such as a direct positive effect due to incoming investment, plus with an indirect positive effect of reducing open unemployment due to increased employment due to additional capital. Increased production factors would increase output in the form of goods and services so as to encourage economic growth. Apart from that, the multiplier effect would also be distributed to the surrounding areas due to regional influences, so that there was a potential for the absorption of workers in the surrounding areas and the stability of prices for goods and services between provinces.

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