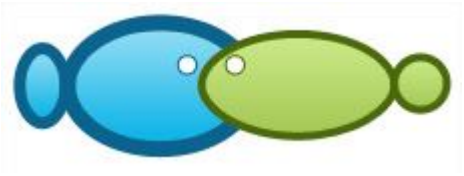

Macroeconomic variables development against poverty toward Natuna's local fishers

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Abstract. Sustainable management and planning are challenging for the fisheries and aquaculture sectors working in harmony along with the blue economy perspective. Therefore, identifying the potential and parameters that can accelerate the optimization of natural resources is needed to achieve profitable growth. By using a quantitative approach through the Generalized Method of Moments System (GMM-SYS) estimator, this study processed six secondary data such as poverty (POV), investment (IV), government expenditure (GOVEX), fisheries total production (TP), Gross Regional Domestic Product (GRDP), employment (LABOR), and net export (EXPORT) in Natuna Regency from 2010 to 2020. This study aims to comprehend the variables that can help raise the standard of living of the people in Natuna Regency through econometric analysis of macroeconomic variables. Furthermore, the discussion related to these variables is reinforced with a blue economy standpoint to provide an overview of how the economic variable strengthens the people's economic stability in the Natuna Regency while preserving nature. The present study found that investment has the most significant influence on poverty alleviation in the long term, where a 1% percent increase in investment will reduce poverty by 0.675%. On the other hand, a 1% increase in total production, GRDP, and labor can reduce poverty by 0.026%, 0.065%, and 0.053%, respectively. The key to rigorous development is the coordination of all parameters that can back up, boost, and serve each other in economic development aspects. Therefore, it is highly recommended for Natuna Regency local government to focus on macroeconomic variables, specifically the investments, in fighting poverty in Natuna Regency while also taking into consideration a sustainable manner when optimizing the impending investment.
Key Words: economic development, fisheries and aquaculture, macroeconomic, Natuna Regency.

Introduction. The blue economy principle is portrayed as a modern social and economic phenomenon embraced by various sectors, especially in the marine technology sector, marine economy, and aquaculture. This principle aims to fulfill regional and national economic resilience by prioritizing lands and seas integration as its instrument (Silver et al 2015; Winder & Le Heron 2017; Chen et al 2018; Brent et al 2020; Carver 2020; Voyer et al 2020). In addition, several studies (Morrissey et al 2014; OECD 2016; Becker et al 2017; Brent et al 2020; Kedia & Gautam 2020) defined blue economy principles as interrelated activities traversing a series of economic, cultural, and political sectors in strengthening the optimization and management of marine resources in a sustainable manner.

The blue economic sector is characterized by high-tech and high-value-added economic activities (Morrissey et al 2011). The blue economy system also encourages development in unique economic governance, ease of logistics, regional policy formulation, market provision, and access to investment (Martínez-Vázquez et al 2021). In his study on economic complexity and the blue economy using the blue economic diversity development (BEDD) parameters on 235 countries from 2008 to 2017, Qi (2022) drew a map of the current development of blue economic diversity in the world. They found that, in the Asia-Pacific region, Indonesia is one of the countries that may have competitive prices for related blue products together with Australia, Indonesia, North Korea, Japan, Thailand, Malaysia, and the Philippines.

Rapid economic growth by a country in a coastal area effectively reduces poverty, considering that coastal communities have long been associated with the most backward group of people (Dolan & Walker 2006; Pomeroy et al 2006; Thanh et al 2021). The Indonesian Central Statistics Agency (2020) even defined poverty as the inability of the community to meet basic needs. Such conditions cause the poor to be unable to secure the same rights that the upper class also enjoy, such as access to public facilities and modernization.

Several studies (Kireyeva 2016; Nurlanova et al 2019) found that economic growth is generally concentrated geographically based on the unique and valuable resources offered by a region. The prices of these selling resources then form economic centers that allow people to influence each other in productivity. This situation causes investors from various industrial companies to come and gradually assemble the poles of a productive economy equipped with high production and intense performance.

Generally speaking, the investment method is related to the management of funds and the ability to purchase or obtain the benefits of an asset. In the fisheries scenario, investment by fishery business actors is closely related to the company's overall expenditure, including purchasing raw materials, production equipment, and other equipment that can support fishery activities both on land and at sea. Theoretically, macroeconomic variables such as investment, total production, gross regional domestic product (GRDP), and labor expansion in the global economic growth scheme encourage aggregate and efficient economic growth. Furthermore, several studies have found that the investment model of economic growth can accelerate the collaborative economy due to the diffusion of technology from developed countries to candidate-invested countries (Borensztein et al 1998). Therefore, investment is not only limited to money; it is a combination of capital stock, knowledge, and technology that can increase the expertise of the candidate-invested countries (Balasubramanyam et al 1996; De Mello 1999). Besides, investment also often affects the targeted sector through various means, such as workforce training, management, and organizational arrangements.

Labianca & Valverde (2019) found that job creation due to growth in the construction and manufacturing sectors has effectively reduced poverty in the Philippines. Furthermore, considering that the industrial sector has made a fair and sustainable contribution to the Philippines' gross domestic product (GDP) of around 28% in 2021, just below the service sector (60%) (Bajpai 2022), it is clear that the shift of the farming sector to the industrial and service sectors is playing an essential role in poverty reduction.

Several studies have examined the impact of investment on economic growth, particularly in terms of technology, production, and socio-economic factors (Blomström et al 1996; Bende-Nabende & Ford 1998; Nair-Reichert & Weinhold 2001; Bende-Nabende et al 2002, 2003; Choe 2003; Sarea 2012). Fan et al (2004) analyzed and identified trends in the impact of investment in globalization as they found that investment can influence research and product development in various villages in China. These activities have also contributed to poverty alleviation and the development of rural areas.

The Millennium Development Goals (MDGs) initiated in 2001 are the beginning to reach the 2030 Sustainable Development Goals (SDGs), aiming to eradicate poverty and hunger. However, this will be achievable if international coordination is further strengthened by avoiding discriminating against other countries. Generally, people in areas that embrace globalization will find it easier to get through macroeconomic crises than in self-isolating areas. For example, a study by Roy & Pal (2002) found that poverty reduction occurred more significantly when India opened up to foreign investment. These findings prove that globalization allows low-income countries to integrate financially with more stable countries in macro and microeconomics.

Stern et al (1996) argued that rapid economic development is influenced by human resources and the ability to master technology. Human resources as productive workers are inputs in the production process. When capable skills strengthen large amounts of human resources, a company's performance will be more efficient and effective in generating income. Such conditions will affect regional and national opinion, represented by high GDP. In organizational structural studies, although the effects of

structure on productivity are not entirely direct, Carillo & Kopelman (1991) found that subunit sizes and numbers of hierarchical levels were negatively related to productivity. Therefore, an excellent organizational structural arrangement affects the perceptions and attitudes of each workforce, affecting the efficiency of organizational productivity.

Economic development aims to create an equal distribution of decent living, equal income opportunity, poverty alleviation, and most importantly, the equity of employment opportunities because work is the only way to provide a better economy. Employment issues are sensitive issues that have always been a significant concern in various countries. When many people demand welfare through the demand for employment, unfortunately, productive work is now starting to be replaced by an automation system (Nazareno & Schiff 2021). The ineffective employment system and the lack of job opportunities make the unemployment problem more urgent to be tackled besides preparing skilled workers. Closely related to poverty, unemployment also has implications for crime and other destructive social phenomena. Therefore, providing sufficient employment opportunities and preparing skilled workers at the same time can be a solution to accelerate economic development.

The level of science and technology related to the coast and the sea in various countries, such as infrastructure and transportation, affects how abundant natural resources are utilized. Therefore, for national policymakers, efficiency in fisheries product management contributes to sustainable economic goals by maximizing fishers' access to supply chain facilities, processing, fuel, and capital, so that more people can increase their income through their work.

According to several studies (World Bank & UNDESA 2017; Brent et al 2020; Qi et al 2020; Voyer et al 2020), better and sustainable management and planning is a significant challenge for the fisheries and aquaculture sectors from a blue economy perspective. To achieve good growth in the blue economy, one region and its government must have the ability to identify production processes from an economic perspective by looking at how long-term strategies are designed to support economic growth and sustainable development (Qi et al 2021; Voyer et al 2020).

Given that the achievement of blue economic growth depends on profitable and sustainable economic activities (Morrissey & O'Donoghue 2012; Morrissey et al 2014; Kronfeld-Goharani 2018; Qi et al 2020), the process of economic integration in the region and the related sectors must have a consistent foundation, and it should be executed with absolutely no compromise (Badinger & Nitsch 2019; Baldwin et al 2020). In addition, everyone should be engaged; the community, the local government, and the private sector must consistently understand that the blue economy concept focuses on promoting sustainable economic growth that includes social inclusion, balanced livelihood enhancement, and without compromising the preservation of the marine environment and marine life (World Bank & UNDESA 2017).

Therefore, this study desires to know the variables that can help raise the standard of living of the people in Natuna Regency through econometric analysis of macroeconomic variables such as poverty levels, investment, total fishery production, GRDP, employment, and total exports from 2010-2020. Furthermore, the discussion related to these variables is reinforced with a blue economy view to provide an overview of how the economic variable strengthens the people's economic stability in the Natuna Regency.

Method. Research related to economic growth will always positively impact eradicating poverty and unemployment, significantly increasing the level of the human development index as a whole. However, economic growth data are generally dynamic, and biased results are inevitable when each variable is correlated with one another. Therefore, an exemplary method is needed to produce a more accurate estimate. For example, the study by Blundell & Bond (1998) stated that the First-Difference Generalized Method of Moments (FD-GMM) on a small sample could cause bias and inaccurate calculations. Therefore, a satisfactory and efficient estimator for time series data within a short period is needed to significantly determine the simultaneity of variables.

The presence of the Generalized Method of Moments System (GMM-SYS), which is also known as the Blundell and Bond GMM-System Estimator proposed by Blundell & Bond (1998), can give better results than the FD-GMM estimator because the moment conditions and the matrix between the first difference (order 1) and level (order 0) are combined and complement each other. By using a quantitative approach through the GMM-SYS estimator, this study processes six secondary data such as poverty level (POV), investment (IV), government expenditure (GOVEX), fisheries total production (TP), Gross Regional Domestic Product (GRDP), employment (LABOR), and net export (EXPORT) in Natuna Regency.

The GMM-SYS estimator procedure in this study begins by composing a simultaneous model through variables identification that affect regional economic growth in Natuna Regency and examining how each of these variables interact with one another. The model specification related to the macroeconomic variable in this study adopted the simultaneous equation regression model by Ford et al (2010), which constructs the following equations:

$$\ln POV_{it} = \alpha_0 + \alpha_1 \ln IV_{it} + \alpha_2 \ln GOVEX_{it} + \alpha_3 \ln TP_{it} + \alpha_4 \ln GRDP_{it} + \alpha_5 \ln LABOR_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln POV_{i,t-1} + u_{it}$$

$$\ln IV_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln GOVEX_{it} + \alpha_3 \ln TP_{it} + \alpha_4 \ln GRDP_{it} + \alpha_5 \ln LABOR_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln IV_{i,t-1} + u_{it}$$

$$\ln GOVEX_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln IV_{it} + \alpha_3 \ln TP_{it} + \alpha_4 \ln GRDP_{it} + \alpha_5 \ln LABOR_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln GOVEX_{i,t-1} + u_{it}$$

$$\ln TP_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln IV_{it} + \alpha_3 \ln GOVEX_{it} + \alpha_4 \ln GRDP_{it} + \alpha_5 \ln LABOR_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln TP_{i,t-1} + u_{it}$$

$$\ln GRDP_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln IV_{it} + \alpha_3 \ln GOVEX_{it} + \alpha_4 \ln TP_{it} + \alpha_5 \ln LABOR_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln GRDP_{i,t-1} + u_{it}$$

$$\ln LABOR_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln IV_{it} + \alpha_3 \ln GOVEX_{it} + \alpha_4 \ln TP_{it} + \alpha_5 \ln GRDP_{it} + \alpha_6 \ln EXPORT_{it} + \alpha_7 \ln LABOR_{i,t-1} + u_{it}$$

$$\ln EXPORT_{it} = \alpha_0 + \alpha_1 \ln POV_{it} + \alpha_2 \ln IV_{it} + \alpha_3 \ln GOVEX_{it} + \alpha_4 \ln TP_{it} + \alpha_5 \ln GRDP_{it} + \alpha_6 \ln LABOR_{it} + \alpha_7 \ln EXPORT_{i,t-1} + u_{it}$$

where: Ln POV = poverty; Ln IV = investment; Ln GOVEX = government expenditure; Ln TP = fisheries total production; Ln GRDP = gross regional domestic product; Ln LABOR = labor/employment; Ln EXPORT = net export; i = observed component; t = observed time; it = observed component in the observed time; α_0 = constant; $\alpha_1 - \alpha_1$ = individual component effect; u_{it} = error.

When results of the structural equation in the GMM-SYS simultaneous model are revealed as overidentified, the equation is translated as correctly determined. Therefore, the simultaneity test can be carried out. In addition, the simultaneity test finds empirical evidence that the variables in the structural equation have a relationship. Each variable, when determined as an endogenous variable in the simultaneity test, will produce information on whether the variable is simultaneous or not.

The autocorrelation test was performed using Arellano-Bond statistics (Arellano-Bond M1 and Arellano-Bond M2) to see the consistency of the estimation results. The consistency of the estimation results is represented if the p-value in Arellano-Bond M1 is proven to be significant at the 5% level while Arellano-Bond M2 is insignificant. In addition, if the results of the Sargan Test are not significant at the 5% level, then the instrument used is valid. Each variable that is proven to be simultaneous will look for the estimated coefficients, short-run multiplier, and long-run multiplier in GMM-SYS in order to know how one variable simultaneously affects other variables.

The results of the simultaneity using the GMM-SYS are then linked to blue economy perspectives related to the aquaculture sector in Natuna Regency, such as data access, monitoring, and product development in order to develop the fisheries sector in Natuna Regency. The output of this research is expected to become a recommendation on how the government should prepare strategies to help the future of the aquaculture system in the Natuna Regency.

Results and Discussion. The specification of the formula with the simultaneous equation regression model, where every variable is separately placed as endogenous and regressed with all other variables, resulted in the identification of order condition status, as presented in Table 1.

Table 1

Generalized Method of Moments System structural model for finding order conditions and simultaneous status

Variable	*t-statistics*	*P-value*	*Oder condition*	*Simultaneous annotation*
Poverty (LNPOV)	-4.4125216	0.0031*	Identified	Simultaneous
Investment (LNIV)	-1.6157129	0.0627	Identified	Nonsimultaneous
Government Expenditure (LNGOVEX)	-5.6128932	0.0931	Identified	Nonsimultaneous
Fisheries Total Production (LNTP)	-4.9210512	0.0792	Identified	Nonsimultaneous
Gross Regional Domestic Product (LNGRDP)	-4.9403231	0.0647	Identified	Nonsimultaneous
Labor (LNLABOR)	-5.6415915	0.0922	Identified	Nonsimultaneous
Net Export (LNEXPORT)	-5.6431410	0.0731	Identified	Nonsimultaneous

* significant at 5% level.

Table 1 above shows that the seven variables in the structural equation were categorized as identified order conditions, indicating that all of the variables above were valid and can be further processed into simultaneous equations. Simultaneous equation estimation through the simultaneity test serves to see whether a group of variables identified through structural equations have the potential to be empirically related to each other. Although all variables were identified and eligible to be processed in the simultaneity test (Table 1), this study empirically found that when all variables were placed as the dependent variable separately, only the LNPOV variable had simultaneity with other variables. Meanwhile, the other six variables were found to be nonsimultaneous.

In economics, testing a model requires the concept of goodness of fit, equipped with a definition of the coefficient of determination, standard deviation, and hypothesis testing. The estimation results using the GMM-SYS estimator indicate that the instrument used in this study is valid because the structural equation shows that the variables are well identified. In addition, the model criteria in this study were also found to be statistically consistent, valid, and unbiased, indicated by the statistical values of Arellano-Bond M1 and Arellano-Bond M2 that matched the criteria, where Arellano-Bond M1 had to be significant. In contrast, Arellano-Bond M2 had to be insignificant, as presented in Table 2.

Table 2

Arellano-Bond test results

Arellano-Bond	*Z*	*P-value*	*Annotation*
Arellano-Bond M1	-4.1288	0.044*	Significant
Arellano-Bond M2	0.07311	0.342	Insignificant

* significant at 5% level.

As presented in Table 2, estimation consistency is shown by the Arellano-Bond M1 results of -4.1288 with a probability value of 0.044 (significant at the 5% level). On the other hand, Arellano-Bond M2 was 0.07311, with an insignificant probability value at the 5%

level (0.342). Given that the economic parameters built in the GMM-SYS model are dynamic data, the validity of avoiding correlations between residuals and identified variables can be explained by the results of Pooled Least Square and fixed effect values, as presented in Table 3.

Table 3

Validity tests results

Test	*Lag estimated test*	*Standard error*	*P-value**
Pooled Least Square	0.973122	0.0243	0.000*
Fixed effect	0.996531	0.0157	0.000*

* significant at 5% level.

As presented in Table 3, the value of Lag Estimated Coefficients on Pooled Least Square and fixed effect is significant at a 5% level. Therefore, the model used in this study had no problems regarding the instrument's validity.

Because this study empirically found that the LNPOV variable has simultaneity with other variables, the GMM-SYS model continued to look for the estimated coefficient of Short-run Multiplier and Long-run Multiplier, which can explain how LNPOV simultaneity is related to other variables in ceteris paribus, as presented in Table 4.

Table 4

Generalized Method of Moments System where LNPOV is set as the dependent variable

Variable	*Coefficient*	*Std. Error*	*Prob.**	*Short-run Multiplier*	*Long-run Multiplier*
Investment (LNIV)	-0.67532	0.013111	0.010886*	-38.4886	-14.8776
Government Expenditure (LNGOVEX)	0.045751	0.075962	0.076093	0.5029	0.55008
Fisheries Total Production (LNTP)	-0.026131	0.014729	0.049299*	-22.7371	-36.8852
Gross Regional Domestic Product (LNGRDP)	-0.064693	0.016364	0.012287*	-31.6925	-19.1076
Labor (LNLABOR)	-0.053206	0.010851	0.026128*	-67.3136	-20.6922
Net Export (LNEXPORT)	0.061921	0.115247	0.067560	0.11008	0.90306

* significant at 5% level.

Based on Table 4, it can be seen that the simultaneity of investment, GRDP, and labor have a long-run multiplier toward poverty alleviation. In contrast, total production has a short-run multiplier, seen from the probability that the variables are significant at the 5% level. Therefore, when the poverty variable is placed as the dependent variable, investment, fisheries total production, GRDP, and labor as independent variables can affect poverty as much as the given coefficient.

Of the four independent variables, only investment has the most significant influence on poverty alleviation, where a 1% increase in investment will reduce poverty by 0.675%. On the other hand, a 1% increase in total production, GRDP, and labor can reduce poverty by 0.026%, 0.065%, and 0.053%, respectively.

Investment affecting community development. Various economists broadly define economic growth (Pindyck & Rubinfeld 1991; Perry 1999; Chen & Zhu 2008; Kang 2014; Ananda 2015). According to Perry (1999), economic growth is represented by an increase in GDP, both regionally and nationally. Such growth overrides the size of the individual population's economic growth and the improvement of the collective economic structure.

Although policy and politics have significant consequences in the fisheries sectors, studies focusing on investment strategies' impact on fisheries access are relatively limited (Nøstbakken et al 2011). In general, the object of investment in the commercial fishery sector consists of access rights, licenses, and means of production. These two things are divided into capital assets and physical capital.

Given that an increase in output per capita in the long term can illustrate the achievement of a high prosperity level, the role of the state in maturing the capacity of the state in the long term cannot be separated from the availability of tangible economic goods, infrastructure, and easy access to sources of capital. In addition, several studies

argued that factors affecting community development generally consist of GDP, life expectancy, education level, health conditions, and the number of unemployed (Pindyck & Rubinfeld 1991; Chen & Zhu 2008; Kang 2014; Ananda 2015). More specifically, the economic backwardness suffered by the population in macroeconomics is influenced by investment and access to capital (Dauda 2017; Alviano et al 2020). Therefore, Todaro (1995) emphasized that the progress of development by the state can be studied from the current conditions of poverty.

Investment as a macroeconomic variable in this study is significantly correlated simultaneously with the poverty level, where a 1% increase in investment, in the long run, can reduce poverty by 0.675%. Investments in dealing with the poverty variable can specifically improve the phenomenon of income inequality, absolute social mobility, and the availability of employment opportunities; ultimately accumulating to an increase in GDP based on the type of employment and production results. Investment in many developing countries plays a vital role in improving people's lives collectively (Greene & Villanueva 1991; Loungani & Razin 2001; Agosin & Machado 2005). The local government of Natuna Regency needs to change its long-term strategy in viewing the investment as a driver that pushes economic growth at the local and national levels.

The capture fisheries and aquaculture business in Natuna Regency are very promising as a sector that can absorb skilled workers considering that the Natuna waters have 628,3005 km^2 as conservation areas and are migration locations for several important marine biotas such as turtles, tuna, and some marine mammals. However, the wealth of the Natuna sea area is still not optimally explored, as shown by 127 of the 154 islands spread in the Natuna Regency being uninhabited. In addition, 99% of the Natuna area consists of the sea, which causes Natuna's community mobility to be limited to certain areas only (Riau Island Province Land Registration Certificate Office 2022). Apart from the existing potential wealth, economic activity in Natuna is the lowest (0.02%) compared to three other districts in Riau Province, where Batam (3.43), Karimun (2.37), and Bintan (0.23) are among the top three.

Unfortunately, when COVID-19 occurred, the poverty suffered by fishers got worse as they needed investment assistance from the central government. Based on Presidential Regulation No. 41/2022 concerning the Zoning Plan for the Natuna-North Natuna Sea Interregional Area, the Indonesian Ministry of Maritime Affairs and Fisheries urges business actors who wish to legally and sustainably use marine space to apply for approval for the suitability of marine spatial utilization activities as one of the requirements for conducting legal business in Indonesia. Through this regulation, the local government of Natuna Regency wants to help various business actors affected by the pandemic by embracing investments that want to penetrate Natuna Regency. This investment acceleration is also expected to connect people from various circles, especially small fishing communities that are most affected by COVID-19.

The cycle of poverty in developing countries can be cured by forming healthy capital. The way of looking at investment for optimizing fishery activities and reducing poverty requires valiant efforts so that the results can have a drastic impact. Capital is one of the main factors in economic development that can create market expansion and reduce poverty. Capital formation is achieved if more people's income is turned back into market activity rather than used for personal consumption. Therefore, the government needs to focus on growing the fishery and aquaculture business in Natuna Regency so that they have a mindset of diligently expanding their business. Investment-based growth models that involve communities in the long term from the present findings are supported by Nøstbakken et al (2011), saying that investment behavior is closely related to organizational structure behavior. Fisheries businesses appearing as small units may not respond to investment as directly as fishers owning big fisheries companies. Big businesses as massive fishing companies are certain to have large fishing vessels that require large crews, and they undoubtedly must require a significant source of capital as well.

Theoretically, macroeconomic variables such as investment in the global economic growth scheme can encourage massive and efficient economic growth. Several studies have found that economic growth models prioritizing investment can accelerate the

technological economy from developed countries that provide diffuse investment to investment destination countries (Borensztein et al 1998).

Indonesia's dream as a Global Maritime Fulcrum that puts forward the creation of modern and technically efficient port-based fisheries management is expected not to separate large-scale industrial fisheries and small-scale fisheries as has happened in Kerala, South India (Sathiadhas et al 2006). It is worrying that the unequal treatment between traditional fishers and large-scale fishermen in Natuna Regency could lead to a conflict of interest, in which the government will focus more exclusively on maximizing investment schemes for large-scale fishers in the short term because they can produce much more total production compared to traditional fishermen (Meynen 1989). Therefore, although large-scale fishing businesses are more likely to respond to investment proactively, a considerable gap between the two classes within the same sector regarding investment absorption and government treatment should be avoided.

Total production based on sustainable use. At the subsistence level, fishery resources are the primary source of nutrition. As a mainstay element for many households and industries, fishery products as primary ingredients are essential. Unfortunately, the dependence on these resources in terms of consumption levels with a sustainable perspective is minimal. Natuna Regency, throughout 2021 has continued to meet the demand for cultured fish products in various countries, especially Hong Kong. As of April 2021, Natuna Regency has been able to export 50.8 tons of aquaculture products to Hong Kong despite the pandemic hitting Indonesia (Nursyamsi 2021). In fisheries production research, the poverty experienced by fishers is due to the current poor status of fishery production with unpromising prospects resulting from not much variation at the management level (Worm et al 2009; Worm & Branch 2012).

The present study found that an increase of 1% in total production can reduce poverty by 0.026%. The poverty suffered by fishers is related to the paradigm that fishers become poor because they work as fishermen; no matter how hard they try, they will always be poor. Even a study by Bailey et al (1986) found that fishers are the poorest of the poorest communities. Several studies (Gutiérrez et al 2011; Cinner et al 2012) found that areas with productive fishery resources are still widely found worldwide, but their prospects are still poor.

Therefore, although the fisheries ecosystem in Natuna Regency is relatively productive, it is terrifying that the increased level of exploitation will cause fishery biomass to become low from time to time. Furthermore, high average fish biomass stored when exposed to low controls at the management level will lead to significant future fishing capacity reductions. Therefore, the government of Natuna Regency is expected to increase production capacity and perform better management to increase the value of aquaculture production, which will raise people's living standards through poverty alleviation.

For fishers, production seasons and productivity levels depend on how available fishery resources are. Decreased availability will encourage them to migrate to alternative types of livelihoods. Shifting livelihoods requires specific skills, even though fishing communities are identical to groups that do not have diversified skills other than fishers. The availability of fishery resources may not be a big issue for big fishers because they can expand their catch area, modify nature for aquaculture, and even have other business branches beside the fisheries sector. However, such complexity and fluctuations become a poverty trap for most fishers, especially small fishers.

Availability of fishery and fish seeds is the main asset for those who depend on total fishery production to survive. Technically, aquaculture fisheries depend heavily on fishery seeds generally obtained from capture fisheries. Then, to maintain and develop their business, they must have adequate knowledge and equipment for these production materials to become high-value outputs when harvest season comes. Unfortunately, when fisheries' resources such as fish larvae are limited or have decreased in quality, aquaculture business players will find it challenging to carry out their activities. They will be forced to spend more money to buy high-quality seeds, yet the availability of the fish larvae in the market is limited. In addition, they will encounter difficult, complex, and

expensive maintenance if the quality of fishery materials available in the market is low. Such fundamental limitations make it difficult for fishers to perform productively as full-time fishermen.

Optimization of fishing production plays a critical role in gaining optimized production. Such schemes can be arranged through assessment of technical efficiency (Kirkley et al 1995; Flores-Lagunes et al 2007), measurement of optimal capacity (Felthoven 2002; Felthoven et al 2009; Horrace & Schnier 2010), assessment of the evidence of technical change (Squires & Vestergaard 2013), skipper skills (Kirkley et al 1998; Squires & Kirkley 1999; Alvarez & Schmidt 2006), prediction on the effects of input controls (Squires 1987; Dupont 1991), and examination on the potential for consolidation (Weninger & Waters 2003; Weninger 2008; Drakopulos 2022). However, assessments and examinations for gaining optimized total production require technology as it functions to maintain the sustainability of fishery resources in fishing areas that are being explored and seek/find new/not optimally utilized fishery resources. In terms of the management of fishery products, improvement in storage and processing technology has helped many fishers to maintain the value of their fishery production. However, such technology is still out of reach for some fishermen. The inability of fishers to maintain the quality of their catch makes them far from access to commercial markets, considering that the goods on the market have high competition in terms of production yields and production value.

Good production results if not accompanied by optimal market access are useless. Therefore, the role of the local government of Natuna Regency in encouraging fishers to optimize their production needs to be boosted. Good production quality will provide optimal sales results because the production value of fishery products will be high. The sales proceeds from the high production value can then be turned back into the capital. Given that capital is the main thing encouraging fishers to be optimally productive, increased purchasing power will enable them to expand massively in the sector they are engaged in. Although Béné et al (2010) found that many fishers in various industrialized countries left the fishing profession because they have accumulated capital, the fishing profession is still very promising if maintaining fish production can be done while ending illegal fishing and overfishing. For Natuna Regency to reduce poverty through increasing total production, basic measures such as preservation, product quality, and logistics must be resolved.

The study by Béné et al (2003) in Chad found that fishing, which accounts for the most significant proportion of income, can only be enjoyed by wealthy households. In many worse scenarios, poor fishers who do not have full fishing gear can only sell their catch but are unable to enjoy the fish taste without contemplation. The poverty suffered by fishers is not only an external conflict where fishers feel that the government treats investors more like kings. Several studies (Kireyeva 2016; Nurlanova et al 2019) found that economic growth is generally concentrated geographically based on the unique and valuable resources offered by a region. Besides, the prices of these selling resources form economic centers that allow people to influence each other in productivity. Unfortunately, ownership of and access to privileged resources tends to be monopolized internally by fellow fishermen, and these elements are often a significant factor in wealth differentiation. Such phenomenon is supported by Neiland et al (1997) research in Nguru-Gashua, Nigeria, who found that wealthy fishers with ownership rights and access to fishery resources tend to use their authority to isolate poor fishers from productive fishing zones. Therefore, instead of historically being fishery resources for poor fishers, research shows that access to fishery resources can be manipulated by powerful hands even before the government can act (Neiland et al 1997; Béné et al 2003).

Failure of production, known as a Malthusian crisis, perceives no linear relationship between population, production, resource availability, and poverty (Locher 2020). Oppositely, low production conditions are usually accompanied by meager survival rates (Sharif 1986). Given that small-scale fisheries are usually located in rural, remote areas, this argument is invalidated because there are generally few alternative employment opportunities in isolated areas; this illustration explains a lot about how systematized poverty occurs in the fisheries sector (Smith & Kluegel 1979; Royce 2018).

In line with the previous studies, Béné (2004), through the concept of low opportunity income, found that the inability of fishers to meet their basic needs through alternative income outside the fisheries sector pushed the purchasing power of fishers to a low level due to the crisis of skills between sectors they passed by.

Gross Regional Domestic Product in eradicating poverty. One of the most dominant parameters in the development economy is income, as reflected by GRDP. The GRDP and poverty naturally affect each other directly and indirectly. Income will affect the most basic level of consumption; food. Therefore, the inability of people to fulfill basic needs as the priority of each individual is the most concise translation of the poverty phenomenon.

GRDP as a macroeconomic variable in this study is correlated simultaneously with the poverty level, where a 1% increase in GRDP in Natuna Regency in the long term can reduce poverty by 0.065%. The result of the present study agrees with the results of previous investigations (Dauda & Makinde 2014; Sehrawat & Giri 2018; Michálek & Výbošťok 2019; Feriyanto et al 2020) as they found that GRDP can be used as means in reducing poverty. Furthermore, the GRDP growth can indirectly reduce poverty because the increase in GRDP is identical to the improvement in the community's ability to meet needs.

The economic basis theory by Richardson (1978) stated that external demand as the primary determinant of regional economic performance could act as the main determinant of a region's economic growth. Therefore, the demand for goods and services from the local and outside areas is essential in making the economy come alive. When a region can find its economic pole and create its market, it has reached a self-sufficiency level in managing its potential.

The study by Nurlanova et al (2018) related to the spatial distribution of economic growth and inequality found that the beginning of social and economic development in a community group plays a significant role in the sustainability and future of that group in the future. They also found that the structure and specialization of a community group need to receive specific attention by expanding attention to the group's expertise based on the area in which the group resides. Therefore, the expertise coupled with the optimization of regional natural resources greatly influences the actualization of the community in the regional and national economic order, especially in reducing poverty.

According to the Indonesian Central Statistics Agency (2020), GRDP growth which is used to understand economic acceleration, is defined as the amount of added value generated by all business units in a region. Therefore, the increase in GRDP growth can directly represent an increase in the demand for goods and services available in the region. Thus, when a region's economy increases, the poverty rate will decrease because purchasing power increases. However, studies by Dahliah & Nur (2021) using the Gini Index found that GRDP had an insignificant effect on poverty levels in East Luwu Regency during the 2010-2020 period because development and the economy in their study area were found to be uneven. Therefore, it is critical to quash uneven economic development within the society in the first place.

The fish farming industry is a sub-sector with great potential in various countries (Ottinger et al 2018). In Natuna Regency, mining and fisheries are the dominant sectors contributing to GRDP. As one of the vital economic aspects, fishery resources have an essential meaning for the progress of regional and national economic progress. Wardono et al (2020) stated that GRDP significantly influences employment because GRDP is an accumulation of income carried out by productive activities. The fisheries and mining sectors, two jobs as labor-intensive sectors, are the highest contributors to regional income due to the creation of economic growth that does not satisfy some economic actors. As an output of economic activity, high GRDP will continue to require a large number of productive workers to maintain and even increase output.

For poverty to be effectively suppressed, all levels of society are expected to be able to enjoy the advantage of the GRDP, which can be translated into high levels of community productivity in the fisheries sector. GRDP is one of the practical factors in alleviating poverty in the Natuna Regency. Therefore, an increase in GRDP needs to be done immediately so that poverty in Natuna Regency can be reduced significantly

through increasing worker productivity and creating an investment climate that is friendly to investors' objectives. Because GRDP represents the output from all economic activities locally, it is necessary to provide employment opportunities that can massively boost the number of productive workers. In addition, the equitable distribution of development acting as a medium for how activities in the exact occupation run must also gain proper attention.

High GDP will increase welfare. However, financial disparities such as inequality in income distribution and access to good public infrastructure are challenging to control because they must target specific problems at each community layer. Social inequality will be more visible if the welfare of the low-income group is slow, stagnant, or even declines while the high-income group continues to develop. If this problem persists, high GRDP will always be followed by social inequality. Tragically, GRDP is exclusively a number for certain groups because it excludes aspects of life satisfaction measured from the Human Development Index.

Labor expansion for leveraging productive workers. The 2001 MDGs as the conception to achieve the goals of the 2030 SDGs in eradicating poverty and hunger are goals for all countries that can be achieved by increasing the productive workforce. Economic development to produce optimal GRDP can be done through structural changes to increase productivity at work. In their study, Stern et al (1996) found that one of the crucial elements that must be improved to reduce poverty is the quality of human resources through education. Barahona (2018) supports the previous findings by stating that the unemployment rate can reduce income and worsen poverty levels.

Although education plays a vital role in reducing poverty in the long term (Arsyad 2010; Nandori 2014; Bader et al 2016; Chen et al 2019), training programs, knowledge, and skills that may not be found in formal education can improve productivity and community skills that will ultimately educate the poor who cannot pay for formal schooling (Tilak 2002; Palmer 2007; Dunn 2012). Labor as a variable in this study is simultaneously correlated with the poverty rate, where a 1% increase in labor in Natuna Regency in the long term can reduce poverty by 0.053%. Panama (2022) found that the total number of current fishers in Natuna are 194 thousand, of which 34 thousand fishermen are currently still utilized under 5 gross tonnage (GT). According to the Ministry of Fisheries and Maritime Affairs, fishers that use vessels with a size of 30 GT are categorized as small fishermen, emphasizing that many fishers are classified under the category of small fishers (using vessels lower than 30 GT). Therefore, reducing the poor population can be done by increasing the number of professional fishers who can operate above the category of small fishers.

Riau Islands Province, where Natuna Regency is located, generally experienced a decline in economic growth up to -6.66 during the second quarter of 2020. More specifically, the unemployment rate in Natuna Regency in 2021 increased from 4.10% to 5.15% within a year. The study by Gabriel et al (2005) found that if fishers can master the latest technology, it can increase fishing effort because fishers can technically navigate the ocean with a more comprehensive range. Fishers with a broad reach to fishery access will generally have higher incomes because a high total production will be followed by a high production value, especially if the fishers can maintain the quality of their production.

Jabbar et al (2010) studying participatory welfare using data on food insecurity, land ownership, and employment in 14 districts of Bangladesh, found that the perspective of fishers as poor people are distinguished between rich, medium, and poor. Poor fishers generally do not have access to productive fishing areas, have minimal fishing gear, and do not have good fishery product management skills due to limited knowledge. On the other hand, wealthy fishers are those who have the privilege of modernization, making them able to manage their business well and even be able to expand their business to be more significant in a certain period.

The phenomenon mentioned earlier is supported by the findings of Daniels (2002), who stated that a greater allocation of resources, especially in hard skills, for underprivileged fishers will effectively reduce the number of poor fishers. Therefore, for

the Natuna Regency's poverty to be reduced, the government must encourage business players to improve community skills in the fisheries sectors and help open more job opportunities, resulting in increased incomes and improved local economic growth.

The high global demand for fish increases competition for high-quality fishery products (Swartz et al 2010). In response to this competitive demand, the Indonesian government has begun to intensify a program known as the regulated and integrated fishing scheme through the Ministry of Fisheries and Maritime Affairs. This fishing method was presented at the 2022 United Nations Oceans Conference (UNOC) international conference in Lisbon, Portugal, and has attracted a large number of investors, given that the total targeted production is worth up to 5.6 million tones in four fishing zones with a production value of IDR 180 trillion. Integrated fishing implemented in the waters of the Natuna Regency will have a positive multiplier effect (Hakim 2022; Parluhutan 2022). Its effect is also expected to give significant growth to various new businesses that can yield more employment. In addition, several skilled workers are needed for the program to run optimally.

The presence of skilled and productive workers will eventually be absorbed so that economic growth in Natuna Regency increases due to increased income by the community. Although scalable fishing will favor local communities because the government requires investors to employ local fishers, environmental concerns have also become important since the government pushes the scheme of quota-based scalable fishing regulations to combat overfishing. This system is believed to be able to control the preservation of fish populations so that fish resources in the ocean are controlled by maintaining the ecosystem.

The blue economy reshapes Natuna's future. Fishery resources for the Indonesian people have long become a source of livelihood (Kholis et al 2020). Fisheries is an important sector for the people of Natuna Regency, with the sea area dominating 99% of its territory. However, the Coronavirus Disease-19 (COVID-19) pandemic has dramatically affected the fisheries sector, especially the income of local fishermen. A study by Barhanuddin & Abdi (2020) found that a significant decline in economic activity occurred in various Asia Pacific countries, including Indonesia, China, Australia, Hong Kong, Singapore, Japan, South Korea, and Thailand. Even China, one of the countries with the most active economic activity in the world, experienced a decline in the economic growth of up to 5.7%. Worse than that, countries that rely on the tourism sector as the primary contributor to GDP have experienced a decline in income of up to 10%.

The Indonesian Central Statistics Agency (2020) reported that the decline in total fish production occurred in February 2020 when COVID-19 officially hit Indonesia. The decline in total fish production greatly affected the production value in the fishery sector by 0.35% in one month. The decline also affects fish prices and causes low demand cannot compensate for the energy and production costs that have been spent. A study by Panama (2022) found that the demand for Indonesian fish from abroad fell by 40%. The decline in demand has had a domino effect on the current and perfect food production processes. As a result, various fish warehouses are overloaded due to accumulation, and on the one hand, old fish stocks are damaged due to non-stop accumulation.

The fisheries sector is essential to economic activity in many developed and developing countries (Villasante 2010). Moreover, this sector allows hundreds of millions of people access to survive. However, amid the complexity of fisheries problems such as illegal fishing, the decline in the number of catches, environmental damage, and the difficulties suffered by the community have been exacerbated by the COVID-19 pandemic.

Destructive Fishing Watch (DFW) in 2020 reported that fishers in Indonesia have suffered from restrictions on human activities since the COVID-19 hit, mainly due to low demand for fish (Mahrofi 2020). When many tourism and culinary sectors close their businesses due to restrictions on activities, fish consumption directly declines due to a drastic fall in demand. Falling fish prices then exacerbated the lost demand in the market. Small fishers most feel the lack of demand and the decline in commodity prices

because of their inability to market their products independently. Kholis et al (2020) confirmed this barrier, which stated that limiting community activities will make it difficult for local fishers and the capture fisheries industry to market their catch. In addition, the regulations of working from home for an extended period impact the daily income of local fishers. Nevertheless, the fisher's obstacle in marketing their products is a logistical problem that has long been a hindrance even when the COVID-19 pandemic was not a thing.

A study by Imron (2003) found that fishing communities are trapped mainly by infrastructure poverty. The poverty of this infrastructure is reflected in the minimal and even unavailability of physical infrastructures such as access to clean water, the distance of the market being too far, and the absence of infrastructure that makes it easier for fishers to buy fuel to fit their budget. The inability of each fishing family to access infrastructure directly related to their work causes each family to spend more money to continue their profession. If continuing the work requires high costs, the income will not be commensurate with the production costs incurred. In most scenarios, fishing communities become unproductive only because access to basic needs is very limited. This situation causes many fishing families to be still trapped in poverty. A study by UNDP-OPHI (2020) found that fishing communities along the coastlines of tropical countries experience the highest poverty rates. The constraints they face are mainly concentrated on issues of economic stability and social cohesion, even though they play a crucial role in food security for many people (Kimani et al 2009; Cinner & Bodin 2010; UNEP & WIOMSA 2015; Taylor et al 2019).

The fisheries sector and food security influence each other, and both highly depend on ecosystem variability. Besides, these two components represent a fishery market activity that can maintain essential ecosystem functions (UNEP, UNDESA, FAO). Therefore, the practice of illegal fishing and the use of explosives in the exploitation of fishery resources in various countries has been proven to damage the quality and safety of fishery products on the world market (UNEP, UNDESA, FAO; UNEP & WIOMSA 2015; UNEP 2020), especially in Indonesia (Glaser et al 2019). Furthermore, many local fishers still do not have direct access to the market. Even if the market exists, the remote area where they reside forces them to spend more money selling their catch. As a result, the accumulated costs of catching fish and the costs incurred are often disproportionate to the incoming income. Worse still, many fishers have to sell their catch to intermediaries at low and below market prices. Therefore, infrastructure poverty can make families living on the poverty line even poorer, and such a continuous situation will lead to an endless cycle of poverty.

Because the quality and logistics of fishery products are essential elements in the capture fisheries and aquaculture domains, it is highly recommended for the government and related authorities to seek solutions to logistical problems that fishers have long suffered. Furthermore, it is essential to issue a comprehensive policy and legal system in addressing the issue of fishers' income because income and financial management are fundamental issues weighing down every group in poverty.

The local government needs to establish supervision and management of fishery resources that adopt advanced logistics technology by creating an integrated fishery management system equipped with an integrated communication and monitoring system. Furthermore, end-users and fishers should be connected in real-time to break the boundaries that have ensnared them. The study by Cooke et al (2021) found that technological innovations in the fishing sector have positive implications for fisheries management and policy. Furthermore, Fan et al (2004) analyzed and identified trends in the impact of investment in globalization as they found that investment can influence product research and development, data access, and monitoring in various villages in China.

Technology assembled in a curated manner to boost fishery activities can be used to track types of aquatic products to ensure the quality and safety of fishery resources. Furthermore, if communication between communities concerning the quality and safety of fishery products is easier to acquire, more consumers will likely be interested in

directly interacting with fishers. Such a dream is very beneficial for both parties, especially fishers, as they can instantly escape from unhealthy ties with middlemen.

Conclusions. Over the four independent variables, only investment has the greatest influence on poverty alleviation in the long term, where a 1% increase in investment will reduce poverty by 0.67%. On the other hand, a 1% increase in total production, Gross Regional Domestic Product, and labor can reduce poverty by 0.026%, 0.065%, and 0.053%, respectively. The key to achieving good development is the coordination of all parameters of the country's development, which can back up and serve each other in each aspect of economic development, such as investment, production systems, and employment opportunities. Eventually, a healthy local economy will stockpile in the Regional Gross Economic Product. Given that the formation of an economic pole is essential, it is highly recommended for the local government of Natuna Regency to focus on macroeconomics variables, specifically investments, in fighting poverty in Natuna Regency.

Fisheries communities in Natuna Regency need development and assistance to find a progressive economic pole in their area. Such a pole will ultimately improve the community's standard of living, which is better translated into a high human development index. Besides, regional policies should primarily focus on optimizing performance and avoiding economic deficiencies. Furthermore, the blue economy perspective should also be fully embraced for the Natuna Regency can prosper side by side with a sustainable environment. Therefore, the role of the investment variable with the highest and long-term power in eradicating poverty can be considered by the Natuna Regency government to ignite energetic economic activities for fishing communities.

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