Economical and Political Interrelations in the Asia-Pacific Region
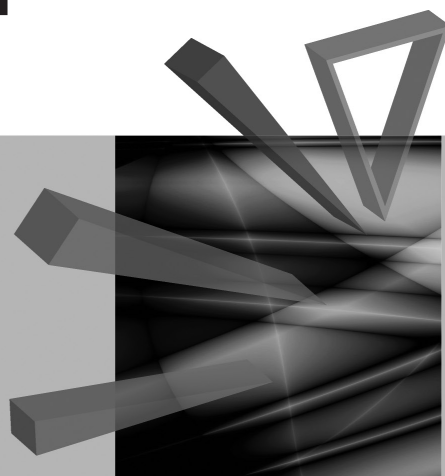
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Streszczenia

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NATURAL DISASTERS AND TRADE LINKAGES
IN ASIA – THE CASE OF INDONESIA

Abstract: In the era of globalization, strong trade linkages between countries have become the channels of the immediate transmission of any kind of shock. One of the causes of such a shock may be a natural disaster. Since Indonesia is the country where a lot of natural disasters have taken place in recent years, the purpose of this paper is to investigate the impact of these phenomena on Indonesian trade flows. With the use of the OLS method we estimate the model taking into consideration the Indonesian export and import flows with its main trading partners. Among explanatory variables we have included the number of natural disasters per year, the distance between the capitals of trading partners, their GDP and population. The results show a correlation between trade flows and natural phenomena, visibly stronger as far as the industrialized trading partners of Indonesia are concerned.

Keywords: catastrophic risk, natural disasters, trade flows, Indonesia.

1. Introduction

Natural disasters touch many countries every year and produce great devastation, both in terms of human life and material losses. According to the Emergency Events Database (EM-DAT) collected by the Centre for Research on the Epidemiology of Disasters (CRED),[1] 35% of all disasters since 1900 have been floods, 26% storms, 7.5% earthquakes, 4% droughts and 4% extreme temperatures. The number of occurrences of natural disasters has increased substantially since 1900 (see Figure 1), causing at the same time much higher material losses. In 2011, 332 natural disasters killed over 33,000 people, and more than 244 million people were injured as a result of disasters while the losses amounted to over USD 366 billion (the highest number in history, in 2010 losses were about USD 123.9 billion).

Indonesia is an example of a country often beset by natural disasters. The purpose of the paper is to investigate the impact of natural disasters on Indonesian trade (export and import) flows with its major trading partners, concentrated mainly within

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[1] The EM-DAT database contains data on the occurrence and effects of over 18,000 mass disasters in the world from 1900, www.emdat.be.

the region. There is a growing literature (reviewed below) in the field of the economic consequences of natural disasters. The majority of macro analyses are concentrated on changes in the rate of economic growth, treating trade as one of a set of explanatory variables, next to FDI inflows and foreign exchange rate. Our study focuses particularly on trade as the most important channel of international shocks' transmission. Trade ties may increase the scope of the economic impact of the disaster, making its effects noticeable abroad.

The rest of the paper consists of four parts. In the second section there is a short review of the literature on the economic consequences of natural disasters. The third section is devoted to the analysis of changes in the structure and dynamics of Indonesian trade flows after 1980. In this section we present the methodology of our research and data sources. In the fourth section we show the estimation results of a model which describes the effect of the total number of natural disasters in Indonesia on exports and imports with particular countries. In the fifth section we present our conclusions.

2. Economic impact of natural disasters

A natural disaster may cause two kinds of damage – direct and indirect. The first includes those which cause damage to fixed assets, capital, raw materials, natural resources, mortality and morbidity and are the direct consequences of the particular type of disaster. The size of a country, i.e. its population and land area, as well as its GDP level can have an influence on the magnitude of direct damages. In countries with a lower GDP *per capita*, M. Skidmore and H. Toya[2] observed more deaths than in the countries with higher GDP *per capita*. Indirect damage, on the other hand, is related to economic activity, i.e. the production of goods and services,[3] as well as the economic behaviour of households, i.e. precautionary savings, insurance, better protection against future events, the consolidation of buildings, and migration. Moreover, a natural disaster is an example of the negative supply shock which may reduce production, the volume of exports and at the end of the day can lead to a slowdown of an economy. Furthermore, because of the dissemination of urbanization, the fact that more and more people occupy disaster prone areas with an increased catastrophic risk, the losses associated with the occurrence of natural disasters are getting bigger and more serious. The tsunami on the east coast of Japan in March 2011, when the nuclear reactor was destroyed, endangering not only the residents of this region, shows the scale of the risk and damage associated with the occurrence of a natural disaster. It should also be noted that during the period of intense globalization, when trade between countries is more intense and significant,

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[2] M. Skidmore, H. Toya, Do natural disasters promote long – run growth?, *Economic Inquiry* 2002, vol. 40, no. 4, pp. 664–687.

[3] E. Cavallo, I. Noy, *The Economics of Natural Disasters*, Inter-American Development Bank Working Paper Series No. IDB-WP-124, 2010, pp. 1–50.

the effects of a natural disaster may not only be felt in the country where the disaster took place, but also in the country's trading partners, where the demand for the imported goods can be affected in terms of the cessation or reduction of production in the exporting country.
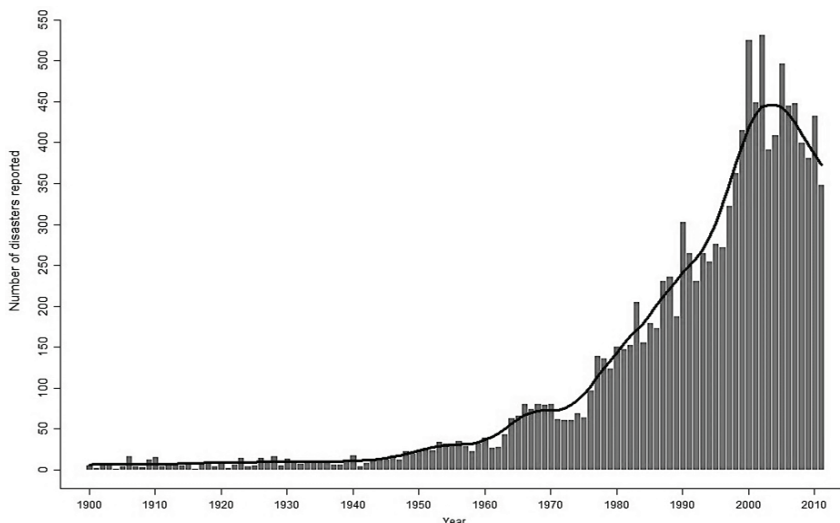
Figure 1. The number of natural disasters reported 1900–2010

Source: EM DAT, http://www.emdat.be/natural-disasters-trends (retrieved 20.04.2013).

Due to the increasing number of reported natural disasters and greater level of damages, both to society and the economy, more and more attention is paid to this phenomenon. Ch. Benson and E. Clay[4] provide a theoretical framework of the economic and financial impact of natural disasters. Economic activity may be lower due to the possible decrease in exports and imports (confirmed by Ch. Oh and R. Reuveny[5] in their empirical work, i.e. bilateral trade declines as disaster risk increases) but also may be higher in the presence of post-disaster investment. A large part of empirical studies uses panel data estimation in order to check whether a natural disaster affects growth and trade on the macro level, or demand, insurance and savings on the micro level. I. Noy,[6] using such a technique, looks at the macroeconomic consequences of disasters, i.e. on economic growth. As explanatory variables he takes direct damages, the number of people affected and killed, strength

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[4] Ch. Benson, E. Clay, *Understanding the Economic and Financial Impacts of Natural Disasters*, Disaster Risk Management Series No. 4, World Bank, Washington, DC, 2004, pp. 1–119.

[5] Ch.H. Oh, R. Reuveny, Climatic natural disasters, political risk, and international trade, *Global Environmental Change* 2010, vol. 20, pp. 243–254.

[6] I. Noy, The macroeconomic consequences of disasters, *Journal of Development Economics* 2009, vol. 88, pp. 221–231.

of the particular phenomenon, condition of the institutional setting, and foreign exchange rate and FDI. His main finding is that, indeed, a natural disaster has a significant impact at the macro level, and it is larger in developing countries. J.M. Abala-Bertrand[7] also takes into consideration the macroeconomic side of natural disasters. Examining 26 countries between the years 1960 and 1979 with the use of before-after statistical analysis, he finds that GDP dynamics and inflation measured by CPI remains unaffected by natural disasters.

One study which examines the long-term impact of natural disasters on economic growth is that of M. Skidmore and H. Toya.[8] In line with theoretical considerations, they examine long-term relationships among investment decisions, total factor productivity, economic growth and risk associated with disaster. The main insight of their study is that economic growth is affected by a disaster via total factor productivity. The authors put emphasis on the fact that in countries prone to natural catastrophes, on the one hand, foreign investment in physical capital can be lower, but on the other, in such countries new technologies that better predict disasters can attract many investors. Another problem undertaken in literature is the question about the correlation between the inflow of foreign direct investment and the number of natural disasters. M. Escaleras and Ch. Register[9] in their work check this correlation using quantitative methods. As the dependent variable the authors take investment inflows into the country in a given year. The most important conclusion of the estimated model is the statistical significance of the negative coefficients next to the number of natural disasters. It means that a natural disaster curtails the inflow of foreign direct investments.

Noteworthy is the fact that next to the devastating influence of natural disasters, there were cases in which the upgrading of productive capital was observed.[10] Among the positive consequences of natural disasters S. Hallegatte and P. Dumas pointed to the replacement of technology embodied in new and more productive machinery in the case of firms and, in the case of households, either the building of houses with better protection and consolidation or at least with the use of better materials. N. Loayza et al.[11] indicate, however, that the net economic effect of a natural disaster depends strongly on its type and strength as well as the country's level of development.

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[7] J.M. Albala-Bertrand, *Political Economy of Large Natural Disasters*, Clarendon Press, Oxford 1993.

[8] M. Skidmore, H. Toya, *op. cit*.

[9] M. Escaleras, Ch. Register, Natural disasters and foreign direct investment, *Land Economics* 2011, vol. 87, no. 2, pp. 356–363.

[10] S. Hallegatte, P. Dumas, Can natural disasters have positive consequences? Investigating the role of embodied technical change, *Ecological Economics* 2009, vol. 68, pp. 777–786.

[11] N. Loayza, E. Olaberria, J. Gigolini, L. Christiaenses, Natural disasters and growth: Going beyond the averages, *World Development* 2012, vol. 40, no. 7, pp. 1317–1336.

3. Research data and methodology

Our study focuses on Indonesia, a developing country with a GDP *per capita* in current USD of 3,492,[12] which belongs to the group of countries where, in recent years, the most natural disasters took place. Since 1980, 334 natural disasters have been reported, with the majority of them floods and earthquakes (see: Table 1), affecting more than 21.5 million people, and causing the death of over 192,000 people. Material losses due to all these disasters are estimated to be about USD 24,000 million.

Table 1. Types of natural disasters in Indonesia in 1980–2011

The type of a disaster	Frequency	Percent
Drought	6	1.80
Earthquake (seismic activity)	78	23.35
Epidemic	29	8.68
Flood	126	37.72
Mass movement dry	1	0.30
Mass movement wet	42	12.57
Storm	5	1.50
Volcano	38	11.38
Wildfire	9	2.69
	334	**100.00**

Source: own calculations based on EM-DAT, www.emdat.be (retrieved 20.04.2013).

During the three decades after 1980, Indonesian trade flows grew on average 8 and 11% per year (on the export and import side respectively), making its economy the twentieth trader in the world[13] (Table 2).

Table 2. The value of Indonesian trade flows between 1980 and 2010 (USD million)

	1980	1990	2000	2010
Exports	21,922	25,690	62,139	157,791
Imports	10,837	22,005	33,518	135,691

Source: own calculations based on DOT database, IMF DOT CD-ROM (retrieved 5.05.2013).

However, as can be seen in Table 3, trade dynamics fluctuated sharply on the yearly basis. After 2000, in seven periods, the growth rates of Indonesian trade flows were lower than for the world as a whole (shaded cells). There were numerous natural

[12] World Development Indicator 2012, http://databank.worldbank.org.
[13] According to the WTO estimates, excluding intra-EU trade flows (see International Trade Statistics at www.wto.org).

disasters in each of those years, but five of them in particular have to be mentioned, as they belong to the top 10 of Indonesian natural disasters in terms of the value of damage they caused. All of them appeared in the periods in which the trade flows' dynamics dropped below the world average. Such an observation provoked us to test formally the correlation between these two phenomena.

Table 3. Indonesian trade dynamics and natural disasters in 2000–2010

Year	Exports		Imports		Disaster date damage, 000 USD
	Indonesia	World	Indonesia	World	
2000	28	12	40	13	
2001	–9	–4	–8	–4	
2002	1	4	1	4	Flood 27.01.2002 350,000
2003	7	16	4	16	
2004	13	21	30	21	Earthquake 26.12.2004 4,451,600
2005	22	13	27	13	
2006	19	15	6	14	Earthquake 27.05.2006 3,100,000
2007	14	15	15	15	Flood 31.01.2007 971,000
2008	31	15	36	15	
2009	–14	–23	–28	–23	Earthquake 30.09.2009 2,200,000
2010	32	22	46	21	

Source: *WTO International Trade Statistics*, Issues 2001–2011 and EM-DAT, *The OFDA/CRED International Disaster Database*, www.emdat.be (retrieved 5.05.2013).

We have chosen 12 main trading partners of Indonesia (with a share in total trade value greater than 1%), accounting together for about 80% of the Indonesian trade flows in 2010. The rankings of leading importers and exporters from and to Indonesia are presented in Figures 2 and 3, respectively.

Among the main trading partners there are only two economies outside Asia – the USA and the Euro Area (EA 17). Among Asian traders Japan, China and newly industrialized economies (Hong Kong, Republic of Korea and Singapore) visibly dominate in the Indonesian trade structure. From here on they will be named as Indonesia's industrialized partners. The remaining partners will be called as developing.

Figure 2. Indonesian main export partners (1980, 1995 and 2010, %)

Source: own calculations based on DOT database, IMF DOT CD-ROM (retrieved 5.05.2013).

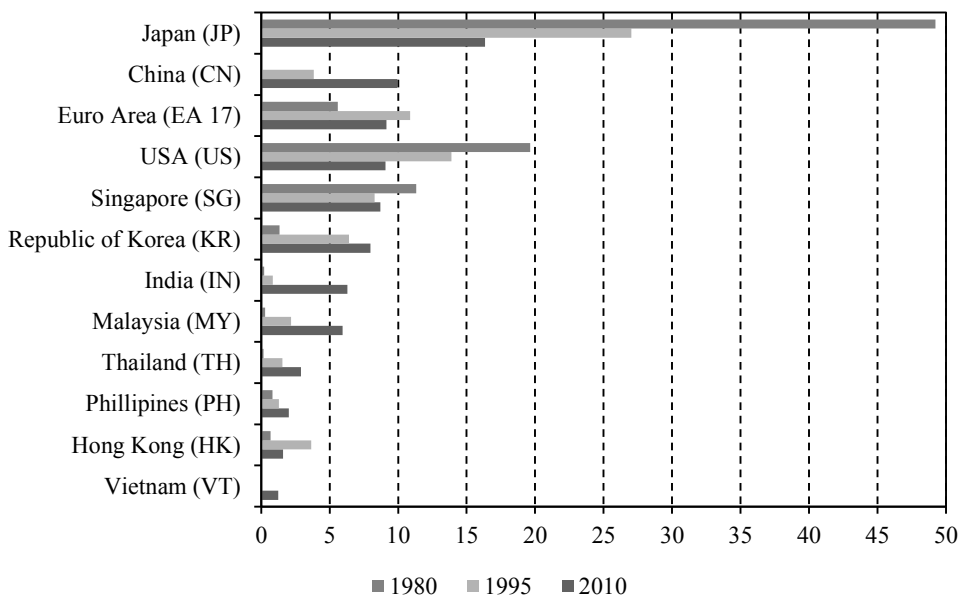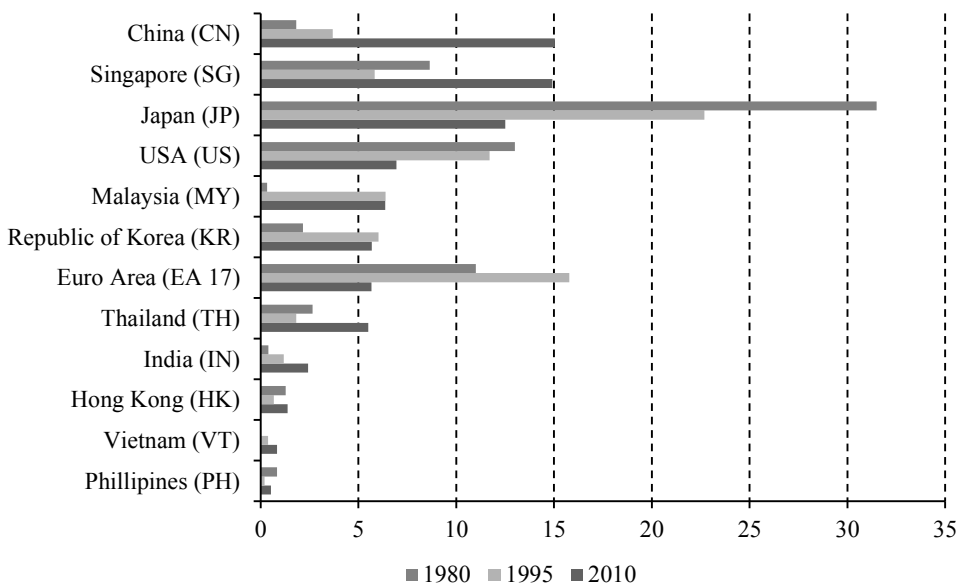**Figure 3.** Indonesian main import partners (1980, 1995 and 2010, %)

Source: own calculations based on DOT database, IMF DOT CD-ROM (retrieved 5.05.2013).

Data concerning natural disasters, with the total number of events per year as the independent variable, are publicly available at the Emergency Events Database (EM-DAT) collected by the Centre for Research on the Epidemiology of Disasters. An event is included in the database if it fulfils one of four conditions: (1) ten or more people reported killed, or (2) one hundred or more people reported affected, (3) or the declaration of a state of emergency or (4) a call for international assistance. The other explanatory variables (all in natural logarithms), i.e., the level of GDP (in USD millions), or the population level are taken from the World Bank database (World Development Indicators). In addition, the distance between Jakarta and the respective other country's capital is included in the model. The dependent variable is the value (in USD millions) of an export or an import with the particular trade partner of Indonesia (data available via Direction of Trade Statistics, IMF), with the descriptive statistics presented in Table 4. Indonesia, as a country with a high catastrophic risk, on average has experienced more than 10 natural disasters per year since 1980 (the highest number of disasters is 19 and they took place in 2007).

Table 4. Descriptive statistics

Variable	Mean	Max	Min	Source
Natural disaster	10.45	19	4	EM-DAT
Ln(GDP)	12.01	13.5	11.2	WDI
Ln(pop)	19.1	19.3	18.8	WDI
Ln(ex)	7.08	10.23	−2.23	DOT
Ln(im)	6.64	9.98	−0.92	DOT

Source: own estimation based on EM-DAT, WDI and DOT, www.emdat.be; www.databank.worldbank. org; IMF DOT CD-ROM (retrieved 5.05.2013).

To estimate the model, the OLS method with robust standard errors is implemented. The estimated equation is as follows (for each country separately):

$$y_t = \text{Dist} + \beta_1 ND_t + \beta_2 \ln\text{GDP}_t + \beta_3 \ln\text{Pop}_t + \varepsilon_t,$$

where: y_t – ln of export or import at t, ND_t ND_t – the total number of reported natural disasters in Indonesia, $\ln\text{GDP}_t$ – logarithm of the level of Indonesia GDP in USD millions, $\ln\text{Pop}_t$ – logarithm of population in Indonesia, ε_t – error term, β_i – estimated coefficients.

4. Empirical results

The results of the estimation are presented in Tables 5 and 6 for industrialized and developing countries, respectively. In all cases but one R-squared is above 0.7, meaning that the model fits well with the data. The most important conclusion is the negative relationships between the number of natural disasters in Indonesia and its

Table 5. Estimation results – industrialized countries

Dependent variable (ln)	Explanatory variable				
	Natural disaster	GDP (ln)	Popul. (ln)	Distance (ln)	R^2
Ex to US	0.01	0.4*	1.8***	−1.9	0.85
Ex to EA 17	−0.02**	0.2	5.9***	−11.7***	0.95
Ex to JP	0.01***	0.6***	−0.8**	2.0***	0.89
Ex to HK	−0.04***	−0.2	7.4***	16.3***	0.93
Ex to KR	−0.01	0.4***	6.5***	−14.1***	0.97
Ex to SG	0.01	0.6***	1.3	−3.7	0.83
Im from US	−0.03**	0.7***	0.3	−0.6	0.81
Im from EA 17	−0.04**	0.5***	1.6*	−3.1*	0.74
Im from JP	−0.02*	0.9***	−1.0	2.0	0.75
Im from HK	−0.04**	1.1***	1.8	−5.1**	0.81
Im from KR	−0.05**	0.9***	4.3***	−10.0***	0.87
Im from SG	0.04**	1.2***	−0.1	−0.8	0.85

*, **, ***– significance levels 90%, 95%, 99%, respectively.

Source: own estimation.

Table 6. Estimation results – developing countries

Dependent variable (ln)	Explanatory variable				
	Natural disaster	GDP (ln)	Popul. (ln)	Distance (ln)	R^2
Ex to CN	−0.07*	−0.8	22.1***	−47.6***	0.86
Ex to PH	0.02	1.1***	1.6	−4.7	0.81
Ex to IN	0.01	0.7**	11.5***	−26***	0.93
Ex to TH	−0.02**	0.3**	10.3***	−24.9***	0.99
Ex to MY	−0.01	0.5***	10.1***	−27.6***	0.99
Ex to VT	−0.07*	−0.2	19.1***	−44.4***	0.89
Im from CN	0.01	1.2***	4.3***	−10.5***	0.99
Im from PH	0.05*	1.6***	−3.7*	7.0	0.65
Im from IN	0.01	1.5***	3.2*	−8.6**	0.89
Im from TH	0.03	1.2***	4.0*	−11.0**	0.88
Im from MY	−0.02	1.0***	7.4***	−21.1***	0.95
Im from VT	0.00	−0.4	17.7***	−41.1***	0.94

*, **, *** – significance level 90%, 95%, 99%, respectively.

Source: own estimation.

trade values (both on the export and import sides). The estimated coefficients indicate that trade with industrialized countries is more sensitive to the occurrence of natural disasters. In eight out of twelve estimated equations, the coefficient next to the variable describing the natural disasters is negative and statistically significant. This means that each subsequent natural disaster which takes place in Indonesia reduces exports to the European Union (–2%) and Hong Kong (–4%), as well as imports from all countries but Singapore, where the coefficient is positive and statistically significant (0.04). However, imports from this country have increased substantially in the last decade. Natural disasters being a supply shock may negatively influence an economic activity, therefore exports decrease as well, which can be seen in our results.

When a developing country is considered as a trade partner, the results are not so strong. As far as exports are concerned, statistically significant and negative coefficients were estimated for China, Thailand and Vietnam. China, as can be seen in Figure 2, in recent years has arisen as a main trade partner, both in terms of exports and imports. However, in the equations where the value of imports is the dependent variable, natural disasters seem not to be relevant. Only for the Philippines the coefficient is statistically significant and positive, meaning that there are higher imports from the Philippines after a natural disaster.

5. Conclusions

As we have proved in our research, the natural disasters which take place in Indonesia affect the trade flows of this country. In most of the considered cases both exports and imports decline as the result of natural disasters. The higher the share in total Indonesian trade, the stronger is the impact. It is noteworthy that the countries for which we observed a positive impact of the disasters in Indonesia on the bilateral trade flows (e.g. Singapore) belong to trading partners that substantially increased their shares in Indonesian trade structure over the considered period. This may possibly distort the results. In addition, many Indonesian trading partners (especially from the "developing" group) also experience natural disasters every year. Therefore, the extension of the model is planned in future research.

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KATASTROFY NATURALNE A RELACJE HANDLOWE W AZJI – PRZYPADEK INDONEZJI

Streszczenie: W dobie globalizacji silne powiązania handlowe pomiędzy gospodarkami stają się kanałami transmisji różnego typu szoków. Jedną z przyczyn powstawania takich szoków mogą być katastrofy naturalne. Za cel artykułu przyjęto zbadanie wpływu zjawisk katastroficznych na indonezyjski handel. Przy wykorzystaniu klasycznej metody najmniejszych kwadratów oszacowano model, w którym zmienną objaśnianą były strumienie eksportu i importu pomiędzy Indonezją a jej głównymi partnerami handlowymi. Wśród zmiennych objaśniających znajdują się: liczba katastrof w ujęciu rocznym, odległość pomiędzy partnerami, PKB oraz wielkość populacji. Wyniki estymacji potwierdzają negatywną korelację pomiędzy strumieniami handlu a występowaniem katastrof naturalnych. Jest ona jednak widocznie silniejsza w odniesieniu do wymiany z partnerami wysoko uprzemysłowionymi.

Słowa kluczowe: ryzyko katastroficzne, katastrofy naturalne, handel zagraniczny, Indonezja.