Université Grenoble Alpes

The impact of climate vulnerability on exchange rates: an empirical assessment

Salem BOUBAKRI et Cyriac GUILLAUMIN

26/01 Les Cahiers de Recherche

Centre de Recherche en Economie de Grenoble

CREG – Centre de Recherche en Économie de Grenoble
Faculté d'Économie de Grenoble – UGA, CS 40700, 38058 Grenoble Cedex 9
Tél : +33 (0)4 76 74 29 92 ; E-mail : creg@univ-grenoble-alpes.fr
http://creg.univ-grenoble-alpes.fr/

The impact of climate vulnerability on exchange rates: an empirical assessment

Salem Boubakri[*†] Cyriac Guillaumin[‡]

Abstract: Given the rising global temperatures and increasing frequency (and severity) of natural disasters, it is essential to understand the relationship between climate change and macroeconomic indicators. This paper investigates the impact of climate change vulnerability on exchange rate movements across 140 countries between 1995 and 2021, distinguishing between low- and high-income economies. Unlike previous studies that rely on *ex post* measures of climate impacts, we use a forward-looking climate vulnerability index. Using a panel approach, our results show that the exchange rate is negatively impacted by climate vulnerability. The effect is more pronounced in low-income countries, suggesting greater exposure and lower resilience to climate-related risks. Moreover, our analysis reveals that flexible exchange rate regimes can help to mitigate the adverse impact of climate vulnerability, acting as a buffer against environmental shocks.

Keywords: climate risk, climate vulnerability, exchange rates, exchange rate regimes.

JEL classification: F31, F41, Q43, Q50.

[*] Sorbonne University Abu Dhabi, SAFIR, B.O.B 38044, Abu Dhabi, United Arab Emirates.
Email address: salem.boubakri@sorbonne.ae.
[†] Université Paris Cité, LIRAES, F-75006 Paris, France.
[‡] (Corresponding author) University Grenoble Alpes, 1241 rue des résidences, BP 47, 38040 Grenoble, France.
Email address: cyriac.guillaumin@univ-grenoble-alpes.fr.

L'impact de la vulnérabilité climatique sur les taux de change : Une évaluation empirique

Résumé : Face à la hausse des températures mondiales et à l'augmentation de la fréquence (et de la gravité) des catastrophes naturelles, il est essentiel de comprendre le lien entre changement climatique et indicateurs macroéconomiques. Cet article examine l'impact de la vulnérabilité climatique sur les fluctuations du taux de change dans 140 pays entre 1995 et 2021, en distinguant les économies à faible revenu de celles à revenu élevé. Contrairement aux études précédentes qui s'appuient sur des mesures *a posteriori* du changement climatique, nous utilisons un indice de vulnérabilité climatique prospectif. Grâce à une approche en données de panel, nos résultats montrent que le taux de change est affecté négativement par la vulnérabilité climatique. Cet effet est plus marqué dans les pays à faible revenu, ce qui suggère une plus grande exposition et une moindre résilience aux risques climatiques pour ces pays. De plus, notre analyse révèle que les régimes de change flexibles peuvent contribuer à atténuer l'impact négatif de la vulnérabilité climatique, en agissant comme un amortisseur face aux chocs environnementaux.

Mots-clés : risque climatique, vulnérabilité climatique, taux de change, régimes de change.

Classification JEL : F31, F41, Q43, Q50.

1. Introduction

Climate change is a serious contemporary issue that is affecting the world through global warming and environmental degradation, including cyclones, fires, floods and deforestation (Stott, 2016).

Several papers highlight that the fluctuations related to climate change can influence several macroeconomic variables,[1] such as trade balance (Loayza et al., 2012), productivity (Felbermayr and Groschl, 2014; Kalkuhl and Wenz, 2020), cost of capital (Kling et al., 2021), asset values and corporate financial performance (Bansal et al., 2016; Bernstein et al., 2019; Krueger et al., 2020; Bolton and Kacperczyk, 2021; Javadi and Masum, 2021), fiscal policy and sovereign risk (Lis and Nickel, 2009; Noy et Nualsri, 2011; Cevik et Jalles, 2022; Beirne et al., 2024), international trade (Dellink et al., 2017) and international capital flows (David, 2010; Shear et al., 2023; Fagbemi and Oke, 2024).

Many studies focuse on the macroeconomic impact of climate change on economic growth (Noy, 2009; Fomby et al., 2013; Kahn et al., 2021; Bayoumi et al., 2021; Zappalà, 2023; Bilal and Känzig, 2024). The primary findings highlight the negative impact of climate change on economic growth. Another strand of the literature focuses on the impact of climate change on inflation (Fratzscher et al., 2020; Mukherjee and Ouattara, 2021). All of these studies conclude that climate change increases inflationary pressure.

However, few studies examine the impact of climate change on exchange rates.[2] Theoretically, the impact of climate change on exchange rates is ambiguous. On the one hand, climate vulnerability can lead to a depreciation of the exchange rate. Indeed, as demonstrated by Dell et al. (2012), Burke et al. (2015), Rossello et al. (2020) and Heinen et al. (2019), the occurrence of natural disasters harms for supply chains, exports, tourism, productivity and economic growth, and the need for reconstruction increases imports. The result is a depreciation of the real exchange rate. On the other hand, as demonstrated by Jones and Olken (2010), Kablan and Strobl (2017) and Osberghaus (2019), natural disasters can lead to an appreciation of the real exchange rate through terms of trade effects. Moreover, appreciation of the real exchange rate can be accentuated by the higher flow of remittance and aid from international donors for reconstruction (Arezki et al., 2025). In this paper, we investigate the response of the real effective exchange rate to climatic vulnerability. Our motivation for studying the effect of

[1] See, for instance, Kolstad and Moore (2020), Bilal and Stock (2025) or Kim et al. (2025) for a recent and large review.

[2] The link between exchange rates and natural resource income is now well understood and studied, following the seminal work of Chen and Rogoff (2003). See also, for example, Kapfhammer et al. (2020).

climate shocks on the exchange rate is the view that the exchange rate is an asset price that reflects macroeconomic value (Stern, 2007; Engel, 2016). Moreover, understanding the relationship between climate vulnerability and exchange rates is helpful for i) investors assessing the risks associated with some currencies and ii) policymakers managing exchange rate volatility and reacting to climate shocks.

Our study contributes to the developing body of literature (Farhi and Gabaix, 2015; Hale, 2022; Lee et al., 2022; Nguyen and Nguyen, 2024) in the following ways. First, while most studies focus on the use of greenhouse gas emission metrics (Cheema-Fox et al., 2022), temperature elevation (Dell et al., 2009; Schlenker and Roberts, 2009; Burke et al., 2015) and natural risks (Hsiang, 2010), we focus on country climate vulnerability. Our investigation is specific in the sense that, instead of using the consequences of climate change, which can be only seen *ex post* by decision-makers, we use a climate vulnerability index, which can be evaluated *ex ante*. Second, our study contributes to the growing body of research on the relation between climate change and exchange rates.

The rest of the paper is organized as follows. Section 2 presents the econometric methodology and describes the data used. Section 3 comments the results. Section 4 concludes.

2. Econometric methodology and data

2.1. Econometric methodology

To assess the potential impact of climate vulnerability on the exchange rate, we rely on the following model:

$$\Delta reer_{it} = \alpha_i + \theta_1 VULN_{it} + \sum_{j=1}^{p} \delta_j \Delta reer_{it-j} + \varepsilon_{it} \quad (1)$$

for $t = 1, \ldots, T$ and $i = 1, \ldots, N$, with t denoting time and i country. Furthermore, α_i denotes the country fixed effects, $\Delta reer$ is the variation of the logarithm of the real effective exchange rate, $VULN$ is climate vulnerability and ε_{it} is an independent and identically distributed (i.i.d.) error term.[3] Equation (1) is our baseline specification, where $VULN$ is the unique regressor.

In a second step, we check whether the baseline specification results hold after controlling for the potential determinants of the exchange rate, as follows:

$$\Delta reer_{it} = \alpha_i + \theta_1 VULN_{it} + \theta_2 ERR_{it} + \gamma X_{it-j} + \sum_{j=1}^{p} \delta_j \Delta reer_{it-j} + \varepsilon_{it} \quad (2)$$

where ERR is the exchange rate regime and X_{it} is a set of control variables, including country characteristics (real GDP per capita growth, financial development and current account

[3] To control for potential autocorrelation, using AIC and BIC information criteria, we integrate $\Delta reer$ with 2 lags.

balance). The role of the exchange rate is well established in the previous studies. A large body of literature has studied the advantages and drawbacks of both flexible and fixed exchange rate regimes as for shock absorption.[4] A flexible exchange rate regime is generally advocated, thanks to its ability to insulate the domestic economy from external shocks.

2.2. Data

We construct a database for a large sample of 140 countries over the 1995–2021 period, which provides broad geographic and economic coverage, allowing for meaningful cross-country comparisons and robust empirical analysis. This extensive panel includes both advanced and developing economies, capturing a range of exchange rate regimes and levels of climate vulnerability (see Appendix). The real effective exchange rate (REER hereafter) is provided by the Darvas database (2012, 2021). The climate variable considered in this study is the Notre Dame Global Adaptation Initiative (ND-GAIN) overall vulnerability score (from 0 to 1). The vulnerability score measures “the propensity or predisposition of human societies to be negatively impacted by climate hazards” (Chen at al., 2015). A higher value corresponds to greater vulnerability to climate risks.

For the exchange rate regime, we use the Reinhart and Rogoff de facto exchange rate regime (coarse) classification updated by Ilzetzki et al. (2019). In this classification, from 1 to 6, a high index represents a more flexible exchange rate regime (Reinhart and Rogoff, 2004).

Data are collected from the Cepii database (CHELEM) for real GDP per capita. Different methods have been used to measure financial development.[5] Following Levine et al. (2000), we use the financial development index developed by the IMF. As an alternative indicator (Levine, 2005; Svirydzenka, 2016), and robustness checks, we also use domestic credit to the private sector (in % of GDP) and the ratio of M2 to GDP, both taken from the World Bank database (World Development Indicators).

3. Empirical results and discussions

We report the baseline results, namely estimation of equation (1) using the climate vulnerability index as the sole regressor, in column (1) of Table 1. The findings indicate that the impact of climate risk on the real exchange rate is negative and significant. On average, a 1% increase in climate vulnerability, such as that following a natural disaster, can depreciate the real exchange

[4] See Beckmann et al. (2024) for a review.
[5] For example, Ligonnière (2018) provides further discussion on this topic.

rate by up to 3.6%. This confirms our hypothesis and aligns with the previous studies, such as Hale (2022) and Nguyen and Nguyen (2024), which also emphasize the adverse macroeconomic consequences of climate risk on exchange rates.

In columns (2) and (3), we explore potential heterogeneity in this relationship by splitting the sample between low- and high-income countries.[6] Using a simple linear regression, we notice that low-income countries are more vulnerable to climate risk than high-income countries. This can be explained by multiple factors (infrastructure, environmental policies, etc.).[7] The results reveal that the effect is more pronounced in low-income countries, where the REER depreciates by an estimated 8.3%, although this coefficient is significant at the 10% level. For high-income countries, depreciation is more moderate, around 4%, and the statistical significance is weaker. These results suggest that lower-income economies may be more vulnerable to climate shocks, possibly due to weaker institutional frameworks, limited financial buffers or higher dependence on climate-sensitive sectors such as agriculture and natural resources.

Columns (4) to (6) and (4') to (6') provide estimates based on equation (2),[8] which introduces the exchange rate regime as an interacting variable. These specifications allow us to assess whether the flexibility of the exchange rate regime moderates the impact of climate vulnerability on REER movements. The coefficients in these columns support our hypothesis: across the full sample, and within low- and high-income groups, greater climate vulnerability is consistently associated with REER depreciation. However, the magnitude of this effect declines as exchange rate regimes become more flexible. For example, in column (4), which considers the full sample, the coefficient θ_2 is negative and significant at the 1% level, indicating that a more flexible exchange rate regime reduces the depreciation effect of climate vulnerability.

The results are robust to the inclusion of control variables in columns (4') to (6'). Specifically, even after accounting for potential confounding macroeconomic factors, the dampening effect of flexible regimes remains statistically significant in most cases. This suggests that exchange rate flexibility is as an important shock absorber, enabling countries to better cope with climate-related risks through nominal exchange rate adjustments rather than real economic disruptions.

Overall, the results confirm a significant negative relationship between climate vulnerability and real exchange rates, with stronger effects in low-income countries. They also show that

[6] To distinguish between low- and high-income countries, we use the classification established by the World Bank.
[7] See, for instance, Fajardo-Gonzalez et al. (2025) for a review.
[8] To save space, we only report the results of parameters θ_1 and θ_2 from equation (2). All detailed results are available upon request from the authors.

flexible exchange rate regimes can mitigate these impacts, acting as a shock absorber, as demonstrated by Elekdag and Tuuli (2023). These findings highlight the need to integrate climate risk into global macroeconomic analysis and exchange rate management and forecasting. They reinforce the urgency of coordinated international climate policies, as the economic costs of inaction include not only environmental damage but also heightened financial and exchange rate volatility.

Table 1. Empirical results

	(1)	(2)	(3)	(4)	(4')	(5)	(5')	(6)	(6')
θ_1	-0.036***			-0.041***	-0.048***				
	(0.003)			(0.002)	(0.003)				
θ_1^{low}		-0.083*				-0.082*	-0.078		
		(0.094)				(0.076)	(0.149)		
θ_1^{high}			-0.040					-0.055**	-0.070*
			(0.113)					(0.044)	(0.081)
θ_2				-0.005***	-0.005***				
				(0.000)	(0.001)				
θ_2^{low}						-0.003*	-0.003		
						(0.086)	(0.255)		
θ_2^{high}								-0.006***	-0.006**
								(0.004)	(0.011)
Constant	0.019***	0.045*	0.020**	0.031***	0.034***	0.051**	0.045	0.037***	0.041**
	(0.000)	(0.084)	(0.032)	(0.000)	(0.000)	(0.050)	(0.147)	(0.002)	(0.035)
Obs.	3309	1104	2205	3304	3045	1099	1092	2205	2043
Number of groups	138	46	92	138	134	46	45	92	89

Notes: *p-values* are in parentheses. Computing *p-value* using bootstrap.
Significant coefficient at 1% (***), 5% (**) or 10% (*).
Results in columns (1), (2) and (3) are estimated using equation (1), i.e. the baseline specification.
Results in columns (4), (5) and (6) are estimated using equation (2) without control variables. Results in columns (4'), (5') and (6') are estimated using equation (2) including control variables.

4. Conclusion

While the literature provides extensive reviews of the impact of climate change on economic growth and inflation, less attention has been paid to its effects on exchange rates. This paper investigated how climate vulnerability influences real effective exchange rate movements across 140 countries between 1995 and 2021. Using a panel approach, our results show that exchange rates are negatively affected by climate vulnerability, with low-income countries being disproportionately impacted. These countries appear more exposed and less resilient to climate-related shocks. Our results also reveal that flexible exchange rate regimes can help to mitigate the adverse impact of climate vulnerability, acting as a buffer against environmental shocks. Further research could focus on two main directions. First, a more detailed classification of currencies (e.g. commodity, safe haven) and countries (by region or level of vulnerability) could reveal differentiated exchange rate responses to climate risk. And second, future studies could deepen the analysis of climate vulnerability by exploring alternative indicators or breaking it down into key components such as type of natural disaster, exposure, sensitivity and adaptive capacity, to better understand its impact on exchange rate dynamics.

Appendix

Table A1. Descriptive statistics

Variable	Obs.	Mean	Q1	Median	Q2	St. Dev.	Min	Max
				Total sample				
$reer$	3777	104.52	93.62	100.60	111.61	25.13	10.79	622.81
y	3780	20242.21	5005.94	12678.79	30503.15	20329.88	469.19	121198.43
cay	3468	-2.09	-6.07	-2.38	1.72	8.79	-148.00	49.98
$FinDev$	3753	0.34	0.14	0.29	0.49	0.23	0.00	1.00
WB	3113	54.59	19.99	39.86	76.32	46.41	0.00	304.58
$M2$	3121	56.44	27.73	45.81	69.80	45.47	2.86	454.70
ToT	3390	100.20	91.93	99.72	106.49	20.68	18.70	273.08
RR	3775	1.93	1	2	3	1.11	1	6
$VULN$	3726	0.43	0.36	0.42	0.49	0.09	0.25	0.68
				Low Income sample				
$reer$	1242	106.36	94.16	100.85	113.20	27.39	32.98	622.81
y	1242	4163.84	1968.95	3339.06	5218.88	3140.54	469.19	19499.41
cay	1119	-4.73	-8.03	-4.18	-0.96	7.46	-40.69	49.98
$FinDev$	1242	0.16	0.09	0.13	0.21	0.10	0.00	0.58
WB	1114	27.51	11.54	19.54	36.08	22.91	0.49	124.28
$M2$	1200	42.04	19.12	30.55	52.21	36.32	2.86	260.62
ToT	1205	98.02	87.51	97.98	106.80	24.02	18.70	273.08
RR	1237	1.85	1	2	2	1.11	1	6
$VULN$	1242	0.51	0.48	0.51	0.56	0.07	0.32	0.68
				High Income sample				
$reer$	2535	103.62	93.27	100.49	110.99	23.90	10.79	363.83
y	2538	28110.35	12223.14	22170.29	40542.07	20550.57	1785.62	121198.43
cay	2349	-0.83	-4.95	-1.51	2.90	9.10	-148.00	45.46
$FinDev$	2511	0.43	0.24	0.39	0.60	0.23	0.06	1.00
WB	1999	69.68	31.56	55.50	100.15	49.25	0.00	304.58
$M2$	1921	65.44	37.83	53.54	76.85	48.22	5.74	454.70
ToT	2185	101.41	94.69	100.00	106.28	18.48	27.03	234.57
RR	2538	1.97	1	2	3	1.11	1	6
$VULN$	2484	0.38	0.34	0.38	0.43	0.06	0.25	0.62

Notes: Obs. is the number of countries in the panel. Q1 is the first quantile, Q3 is the third quantile. St. Dev is the Standard Deviation. Min is minimum. Max is maximum.

$reer$ is the real effective exchange rate, y is the GDP per capita, cay is the current account balance (in % of GDP), $FinDev$ is the financial development index developed by the IMF, WB is the level of financial development measured as the domestic credit to the private sector (in % of GDP), $M2$ is the ratio of M2 to GDP, ToT are the terms of trade, RR is the classification of the exchange rate regime and $VULN$ is the climate vulnerability.

Authors'calculations. See section 2 for details.

A.2. Composition of Samples

A.2.1. Total Sample

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belgium, Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Comoros, Congo Dem. Rep., Congo Rep., Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia, Eswatini, Ethiopia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea Rep., Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lesotho, Lithuania, Luxembourg, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Tunisia, Türkiye, Uganda, United Arab Emirates, United Kingdom, United States, Uruguay, Vietnam, Zambia.

A.2.2. Low Income Sample

Angola, Bangladesh, Benin, Bolivia, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Chad, Comoros, Congo Dem. Rep., Congo Rep., Côte d'Ivoire, Egypt, Eswatini, Ethiopia, Ghana, Honduras, India, Jordan, Kenya, Kyrgyz Republic, Lebanon, Lesotho, Malawi, Mali, Mauritania, Morocco, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Philippines, Rwanda, Samoa, Senegal, Solomon Islands, Sri Lanka, Togo, Tunisia, Uganda, Vietnam, Zambia.

A.2.3. High Income Sample

Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Barbados, Belgium, Belize, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Estonia, Fiji, Finland, France, Gabon, Georgia, Germany, Greece, Guatemala, Hong Kong, Hungary, Iceland, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Kazakhstan, Korea Rep., Kuwait, Latvia, Lithuania, Luxembourg, Malaysia, Maldives, Malta, Mauritius, Mexico, Moldova, Mongolia, Namibia, Netherlands, New Zealand, North Macedonia, Norway, Oman, Panama, Paraguay, Peru, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Serbia, Seychelles, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Suriname, Sweden, Switzerland, Thailand, Trinidad and Tobago, Türkiye, United Arab Emirates, United Kingdom, United States, Uruguay.

References

Arezki R., Camara Y., Imam P., Kpodar R. (2025). "Foreign aid and (big) shocks: evidence from natural disasters", *IMF working paper 25/6*, International Monetary Fund.

Bansal R., Ochoa M., Kiku D. (2016). "Climate change and growth risks", *NBER working paper 23009*, National Bureau of Economic Research.

Bayoumi T., Quayyum S., Das S. (2021). "Growth at Risk from Natural Disasters", *IMF working paper 21/234*, International Monetary Fund.

Beckmann J., Breitenlechner M., Scharler J. (2024). "Is the exchange rate a shock absorber? The shocks matter", *International Review of Economics and Finance*, vol. 89(B), pp. 114-130.

Beirne J., Park D., Saadaoui J., Uddin G. S. (2024), "Impact of climate risk on fiscal space: do political stability and financial development matter?", *ADB working paper 748*, Asian Development Bank.

Bernstein A., Gustafson M. T., Lewis R. (2019). "Disaster on the horizon: The price effect of sea level rise", *Journal of Financial Economics*, vol. 134(2), pp. 253-272.

Bilal A., Känzig D. R. (2024). "The macroeconomic impact of climate change: global vs. local temperature", *NBER working paper 32450*, National Bureau of Economic Research.

Bilal A., Stock J. H. (2025). "Macroeconomics and climate change", *NBER working paper 33567*, National Bureau of Economic Research.

Bolton P., Kacperczyk M. (2021). "Do investors care about carbon risk?" *Journal of Financial Economics*, vol. 142(2), pp. 517-549.

Burke M., Hsiang S., Miguel E. (2015). "Global non-linear effect of temperature on economic production", *Nature*, vol. 527, pp. 235-239.

Cevik S., Jalles J. T. (2022). "This changes everything: climate shocks and sovereign bonds", *Energy Economics*, vol. 107, 105856.

Cheema-Fox A., Serafeim G., Wang H. S. (2022). "Climate Change Vulnerability and Currency Returns", *Financial Analysts Journal*, vol. 78(4), pp. 37-58.

Chen Y., Rogoff K. (2003). "Commodity currencies", *Journal of International Economics*, vol. 60(1), pp. 133-160.

Chen C., Noble I., Hellmann J., Coffee J., Murillo M., Chawla N. (2015). "University of Notre Dame Global Adaptation Index", *working paper*, University of Notre Dame.

David C. A. (2010). "How do International Financial Flows to Developing Countries Respond to Natural Disasters?", *IMF working paper 10/166*, International Monetary Fund.

Darvas Z. (2012). “Real Effective Exchange Rates for 178 Countries: A New Database”, *Bruegel working paper 2012/06*, Bruegel.

Darvas Z. (2021). “Timely Measurement of Real Effective Exchange Rates”, *Bruegel working paper 2021/15*, Bruegel.

Dell M., Jones B. F., Olken, B. A. (2009). “Temperature and income: reconciling new cross sectional and panel estimates”, *American Economic Review*, vol. 99, pp. 198-204.

Dell M., Jones B. F., Olken B. A. (2012). “Temperature shocks and economic growth: Evidence from the last half century”, *American Economic Journal: Macroeconomics*, vol. 4, pp. 66-95.

Dellink R., Hwang H., Lanzi E., Chateau J. (2017). “International trade consequences of climate change”, *OECD working paper 17/01*, Organisation for Economic Co-operation and Development.

Elekdag S., Tuuli M. (2023). “Weather Shocks and Exchange Rate Flexibility”, *Review of International Economics*, vol. 31(5), pp. 1793-1832.

Engel C. (2016). “Exchange rates, interest rates, and the risk premium”, *American Economic Review*, vol. 106(2), pp. 436-474.

Fagbemi F., Oke D. F. (2024). “Climate change vulnerability-foreign direct investment linkage: Why climate change preparedness matters in Sub-Saharan Africa”, *Research in Economics*, vol. 78(1), pp. 52-60.

Fajardo-Gonzalez J., Lovell C. A. K., Lovell J., Edmonds H. (2025). “Measuring climate risks: A new multidimensional index for global vulnerability and resilience”, *Environmental Development*, vol. 56, 101227.

Farhi E., Gabaix X. (2015). “Rare Disasters and Exchange Rates”, *The Quarterly Journal of Economics*, vol. 131(1), pp. 1-52.

Felbermayr G., Gröschl J. (2014). “Naturally negative: The growth effects of natural disasters”, *Journal of Development Economics*, vol. 111(C), pp. 92-106.

Fomby T., Ikeda Y., Loayza N. V. (2013). “The Growth Aftermath of Natural Disasters”, *Journal of Applied Econometrics*, vol. 28(3), pp.412-434.

Fratzscher M., Grosse-Steffen C., Rieth M. (2020). “Inflation Targeting as a Shock Absorber”, *Journal of International Economics*, vol. 123, 103308.

Hale G. (2022). “Climate risks and Exchange Rates”, *working paper*.

Heinen A., Khadan J., Strobl E. (2019). “The Price Impact of Extreme Weather in Developing Countries”, *Economic Journal*, 2022, vol. 129(619), pp. 1327-1342.

Hsiang S. M. (2010). “Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America”, *Proceedings of the National Academy of Sciences of the United States of America*, vol. 107(35), pp. 15367-15372.
Ilzetzki E., Reinhart C., Rogoff K. (2019). “Exchange Arrangements Entering the Twenty-First Century: Which Anchor will Hold?”, *Quarterly Journal of Economics*, vol. 34(2), pp. 599-646.
Javadi S., Masum A.-A. (2021). “The impact of climate change on the cost of bank loans”, *Journal of Corporate Finance*, vol. 69, 102019.
Jones B. F., Olken B. A. (2010). “Climate Shocks and Exports”, *American Economic Review*, vol. 100(2), pp. 454-459.
Kablan S., Strobl E. (2017). “How do natural disasters impact the exchange rate: an investigation through small island developing states (SIDS)?”, *Economics Bulletin*, vol. 37(3), pp. 2274-2281.
Kahn M. E., Mohaddes K., Ng R. N. C., Pesaran M. H., Raissi M., Yang J. C. (2021). “Long-term macroeconomic effects of climate change: A cross-country analysis”, *Energy Economics*, vol. 104, 105624.
Kalkuhl M., Wenz L. (2020). “The impact of climate conditions on economic production. Evidence from a global panel of regions”, *Journal of Environmental Economics and Management*, vol. 103(C), 102360.
Kapfhammer F., Larsen V. H., Thorsrud L. A. (2020). “Climate risk and commodity currencies”, *CESifo working paper 8788*.
Kim H. S., Matthes C., Phan T. (2025). “Severe Weather and the macroeconomy”, *American Economic Journal: Macroeconomics*, vol. 17(2), pp. 315-341.
Kling G., Volz U., Murinde V., Ayas S. (2021). “The Impact of Climate Vulnerability on Firms’ Cost of Capital and Access to Finance”, *World Development*, vol. 137, 105131.
Kolstad C. D., Moore F. C. (2020). “Estimating the Economic Impacts of Climate Change Using Weather Observations”, *Review of Environmental Economics and Policy*, vol. 14(1), pp. 1-24.
Krueger P., Sautner Z., Starks L. T. (2020). “The Importance of Climate Risks for Institutional Investors”, *The Review of Financial Studies*, vol. 33(3), pp. 1067-1111.
Lee S., Mark N. C., Nauerz J., Rawls J., Wei Z. (2022). “Global temperature shocks and real exchange rates”, *Journal of Climate Finance*, 100004.
Levine R. (2005). “Finance and growth: Theory, evidence, and mechanisms”, in P. Aghion, S. Durlauf (eds.), *Handbook of economic growth*, pp. 865-934).

Levine R., Loayza N., Beck T. (2000). “Financial intermediation and growth: causality and causes”, *Journal of Monetary Economics,* vol. 6(1), pp. 31-77.
Ligonnière S. (2018). “Trilemma, dilemma and global players”, *Journal of International Money and Finance*, vol. 85, pp. 20-39.
Lis E. M., Nickel C. (2009). “The impact of Extreme Weather Events on Budget Balances and implications for Fiscal Policy”, *ECB working paper 1055*, European Central Bank.
Loayza N. V., Olaberría E., Rigolini J., Christiaensen L. (2012). “Natural Disasters and Growth: Going Beyond the Averages”, *World Development*, vol. 40(7), pp. 1317-1336.
Mukherjee K., Ouattara B. (2021). “Climate and monetary policy: do temperature shocks lead to inflationary pressures?”, *Climatic Change*, vol. 167(32).
Nguyen A. T. N., Nguyen H. M. (2024). “Currencies in Turbulence: Exploring the Impact of Natural Disasters on Exchange Rates”, *IMF working paper 24/186*, International Monetary Fund.
Noy I. (2009). “The macroeconomic consequences of disasters”, *Journal of Development Economics*, vol. 88(2), pp.221-231.
Noy I., Nualsri A. (2011). “Fiscal storms: public spending and revenues in the aftermath of natural disasters”, *Environment and Development Economics*, vol. 16(1), pp.113-128.
Osberghaus D. (2019). “The Effects of Natural Disasters and Weather Variations on International Trade and Financial Flows: a Review of the Empirical Literature”, *Economics of Disasters and Climate Change*, vol. 3(3), pp. 305-325.
Reinhart C., Rogoff K. (2004). “The Modern History of Exchange Rate Arrangements: A Reinterpretation”, *Quarterly Journal of Economics*, vol. 119(1), pp.1-48.
Rosselló J, Becken S, Santana-Gallego M. (2020). “The effects of natural disasters on international tourism: A global analysis”, *Tourism Management*, vol. 79, 104080.
Schlenker W., Roberts M. J. (2009). “Non-linear temperature effects indicate severe damages to U.S. crop yields under climate change”, *Proceedings of the National Academy of Sciences of the United States of America*, vol. 106, pp. 15594-15598.
Shear F., Ashraf B. N., Butt S. (2023). “Sensing the heat: Climate change vulnerability and foreign direct investment inflows”, *Research in International Business and Finance*, vol. 66, 102005.
Stern N. (2007). *The economics of climate change: The stern review*, Cambridge University Press.
Stott P. (2016). “How climate change affects extreme weather events”, *Science*, vol. 352(6293), pp. 1517-1518.

Svirydzenka K. (2016). “Introducing a new broad-based index of financial development”, *IMF working paper 16/5*, International Monetary Fund.
Zappalà G. (2023). “Sectoral Impact and Propagation of Weather Shocks”, *IMF working paper 23/53*, International Monetary Fund.