PhD DISSERTATION

Doctorado en Economía Industrial

Essays on International Trade and Climate Change

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A mi marido

Ojalá pudiera verme como él me ve

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INFORMAN:

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AUTORIZAN:

El depósito de la citada tesis doctoral.

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Resumen

El objetivo de la presente tesis doctoral es el análisis del impacto que el cambio climático puede ejercer sobre los flujos de comercio internacional, así como los canales a través de los cuales se produce dicho efecto. Hasta el momento, la investigación se había centrado en las consecuencias que la fuerte intensificación de los intercambios comerciales internacionales en las últimas décadas podía tener sobre la generación de dióxido de carbono y, de aquí, en el calentamiento global del planeta. Paralelamente, también se ha estudiado si las clausulas medioambientales incorporadas en los nuevos acuerdos comerciales contribuían a la adopción de medidas en el ámbito productivo que pudieran aliviar dicho efecto pernicioso. Sin embargo, no se ha prestado apenas atención sobre el otro sentido de la relación: el cambio climático también puede afectar a las transacciones comerciales internacionales.

El cambio climático, aceptado ya por la inmensa mayoría de la comunidad científica, se concreta en un incremento generalizado de la temperatura media del planeta, así como en una acentuación tanto en la generación como en la intensidad de eventos climatológicos extremos (por ejemplo, huracanes) derivados de dicho calentamiento global. Existen, esencialmente, tres causas por la cuales el cambio climático puede afectar al comercio internacional: daños a infraestructuras

críticas, reducción o menor ritmo de crecimiento en la productividad laboral y la apertura de nuevas rutas marítimas. Los dos primeros factores actuarían como un mayor coste de comerciar, el tercero, lo reduciría.

Las infraestructuras se pueden ver afectadas por la ocurrencia de sucesos climáticos extremos (tornados, ciclones tropicales, incendios, inundaciones, etc) así como por la subida del nivel del mar. El daño causado por estos eventos a diversas instalaciones directamente relacionadas con el comercio internacional como puertos, aeropuertos, etc, puede dificultar el transporte de mercancías entre países. Un efecto indirecto podría también derivarse del hecho de que estas construcciones precisen de un mayor número de labores de mantenimiento o bien afecten al funcionamiento de aparatos electrónicos (como podría ser el caso de las tormentas eléctricas). Un análisis exhaustivo de las consecuencias materiales del cambio climático se puede encontrar en Dellink et al. (2017).

Por otro lado, el cambio climático puede reducir el crecimiento de la productividad de los factores de producción y, muy especialmente, el del factor trabajo (también afectado por las consecuencias biológicas del calentamiento global como la propagación de plagas de insectos o de virus). El comercio internacional, como una actividad económica más, se puede ver también afectado por este hecho. La relación entre la elevación de las temperaturas y la productividad del factor trabajo se ha analizado en la literatura científica. El denominado “estrés térmico” afecta al desempeño laboral de las personas (Hancock et al., 2007) y, por tanto, perjudica a la productividad en los centros de trabajo tanto si son al aire libre como si no lo son (Federspiel et al., 2002). Desde este punto de vista, Gosling et al. (2018) obtienen una pérdida de productividad de entre un 10-15% para los países del sur de Europa y de entre 2-4% para los del norte en el escenario más adverso de ausencia de mitigación del impacto y/o de la adaptación al mismo, siendo las consecuencias más graves cuando nos referimos al trabajo al aire libre. Para el caso de Estados Unidos, Deryugina and Hsiang (2014) estiman una pérdida de productividad en el entorno del 1,7% para cada incremento adicional de un grado centígrado en la temperatura media diaria por encima de los 15 grados centígrados y un coste en el entorno de los 20 dólares por persona si la temperatura excede los 30 grados.

No obstante, como se verá a lo largo de la investigación, el incremento en las temperaturas tiene también un efecto positivo sobre la eficiencia energética, muy especialmente en los países más fríos. Varias investigaciones sugieren una relación entre temperaturas y consumo energético con forma de “U”, es decir, el consumo energético se reduce a medida que se incrementa la temperatura para los países relativamente fríos mientras que ocurre lo contrario para los países relativamente cálidos.

Por último, el incremento generalizado de las temperaturas puede facilitar la apertura de nuevas rutas marítimas a causa del deshielo, especialmente las del Ártico. Las estimaciones apuntan a que las distancias de transporte pueden situarse entre un 20% y un 40% por debajo de las actuales a través del Canal de Panamá y el Canal de Suez, si bien la caída en los costes no necesariamente es de la misma magnitud. En todo caso, esta alternativa es todavía marginal en estos momentos.

La investigación se articula en un capítulo introductorio, tres capítulos de desarrollo más un último capítulo de conclusiones. Tras la introducción, en el capítulo dos, se realiza un análisis descriptivo de los efectos del cambio climático para la muestra de países y el período elegido para el posterior análisis econométrico. En el tercer capítulo se estima el impacto que el cambio climático, medido por la evolución de las temperaturas y los sucesos climatológicos y biológicos consecuencia de dicha evolución tiene en los flujos de comercio internacional. Para ello, se estima un modelo de gravedad estructural teniendo en cuenta todos los sesgos conocidos en la literatura. Asimismo, se hace un análisis del bienestar, en línea con los últimos desarrollos en la ecuación de gravedad. En el cuarto capítulo se analizan los canales a través de los cuales el cambio climático incide sobre el comercio centrando el análisis en las dos variables que se consideran más relevantes: el consumo energético y la productividad laboral. Finalmente, un último capítulo resume las conclusiones más relevantes del estudio.

Una de las aportaciones de esta tesis doctoral se centra en la utilización de variables que miden el output del cambio climático (temperaturas y eventos extremos) en lugar del input (nivel de emisiones de CO_2). Si bien esta causación está aceptada por la comunidad científica, en la parte inicial del primer capítulo de esta tesis se hace un análisis de regresión confirmando este extremo, habiéndose encontrado una elasticidad de 0,1 para el impacto de la evolución de las emisiones de dióxido de carbono sobre la evolución de las temperaturas y de 0,9 para el caso de los eventos extremos.

Como se ha comentado, el segundo capítulo se centra en analizar los datos de temperaturas y número de eventos para los 67 países de la muestra durante el periodo 1986 – 2016. Se toman las temperaturas medias para cada año y país, así como el número total de eventos extremos y la correspondiente descomposición en ocho tipos de sucesos que la literatura considera como relacionados con el cambio climático. Dos de estos tipos de eventos son biológicos (epidemias y plagas) y los otros seis climáticos (incendios, inundaciones, temperaturas extremas, tormentas, sequías y deslizamientos de tierras). Los datos de temperaturas se han extraído del "Climate Change Knowledge Portal" (Banco Mundial) mientras que los sucesos se han tomado de la "International Disasters Database" (Centre for Research on the Epidemiology of Disasters).

La metodología utilizada en este capítulo es el cálculo para cada serie de datos de la tendencia lineal temporal centrando el análisis en el correspondiente parámetro estimado de la pendiente, así como en el coeficiente de determinación (R^2). De esta forma, tan solo si obtenemos un coeficiente estimado significativo podemos afirmar que dicha tendencia existe. Por otra parte, un valor del coeficiente de determinación elevado nos indicará que dicha tendencia es sostenida en el tiempo mientras que un valor reducido será indicativo de una evolución en "oleadas".

En lo referente a las temperaturas, el incremento es generalizado para el conjunto de los 67 países (tan sólo hay unas pocas excepciones) con un aumento de la temperatura media de 1.5 grados en los 31 años de la muestra.[1] No obstante, se observa concentración geográfica. En este sentido, Europa es el continente más afectado por el calentamiento global mientras que América se sitúa en el extremo opuesto. Por su parte, Asia y África se encuentran en una posición intermedia.[2] Además, tanto en Europa como en América, el incremento de temperaturas se

[1] Éste es precisamente el límite de riesgo con respecto a la era preindustrial establecido con consecuencias probablemente irreversibles.
[2] Oceanía está representada por Australia, con crecimiento de las temperaturas a lo largo del periodo, pero con un coeficiente estimado no significativo. Al ser un único país, se trata como un caso particular.

produce en oleadas al contrario de lo que ocurre en Asia y África, donde es más progresivo.

Si nos centramos en el número total de eventos extremos y, contrariamente a lo que sucede con las temperaturas, no se puede afirmar que el incremento medio observado sea generalizado. Sólo diecisiete países muestran una tendencia lineal de los datos positiva y significativa. Por continentes, dos países son africanos, tres americanos, ocho asiáticos y cuatro europeos. Por tipos de eventos extremos, las tormentas y las inundaciones aparecen como los sucesos más frecuentes y que presentan además una clara tendencia ascendente, al igual que ocurre con los incendios y los casos de temperaturas extremas. El resto de fenómenos no muestran una clara tendencia ascendente y tienen lugar en oleadas. Una característica interesante es que buena parte de los eventos extremos tienden a concentrarse espacialmente en Asia a medida que transcurre el periodo, muy especialmente en China.

En el tercer capítulo de esta tesis doctoral se estudia el impacto del cambio climático en los flujos comerciales bilaterales. Con este propósito, estimo un modelo de gravedad del comercio internacional con una especificación en línea con los últimos desarrollos teóricos utilizando la mencionada muestra de 67 países durante el periodo 1986-2016. La especificación utilizada controla por todos los sesgos conocidos en este tipo de estudios. En este sentido, se tiene en cuenta la resistencia multilateral al comercio por parte de los distintos socios (Anderson y van Wincoop, 2003), la existencia de heterogeneidad inobservable o los posibles problemas de endogeneidad. Asimismo, en aras de evitar cualquier tipo de sesgo, la muestra incorpora también los flujos de comercio doméstico (Yotov, 2012; Bergstrand et al., 2015; Yotov et al., 2016; or Baier et al., 2019). La medida del output del cambio climático, es decir, las temperaturas anuales medias y el número anual de los eventos extremos relacionados con el cambio climático son las variables de interés.

En términos generales, los resultados apuntan a que el comercio internacional se incrementa en relación al comercio doméstico con el incremento de las temperaturas mientras que sucede lo contrario con los eventos extremos. No obstante, se detecta una clara heterogeneidad entre países y tipos de eventos. En relación al incremento de las temperaturas, entre los países afectados que impulsan el resultado general (en los que los costes del comercio internacional caen respecto a lo domésticos) se encuentran Alemania, Reino Unido o Países Bajos. En lo referente a los eventos, las estimaciones sugieren que los sucesos biológicos (epidemias y plagas), los fenómenos puntuales de temperaturas extremas, las tormentas y los deslizamientos de tierra tienen un impacto negativo sobre los flujos internacionales (relativo a los nacionales). En todo caso, se observa cómo la influencia de China (el mayor exportador mundial) y Japón (el quinto exportador mundial) en el resultado global es decisiva, particularmente en lo relativo a las tormentas en el primer caso y las temperaturas extremas en el segundo. Por último, las estimaciones de equilibrio general sugieren un impacto perjudicial sobre el bienestar de plagas, tormentas, sucesos de temperaturas extremas y deslizamientos de tierras. En términos generales, los resultados obtenidos en relación a los sucesos climáticos extremos son coherentes con el análisis efectuado en el segundo capítulo, donde se observa cómo el incremento de eventos se concentra en Asia y, muy particularmente, en China. Además, también se señala el gran impacto sufrido por Japón, gran exportador, en la parte final del periodo en cuanto a temperaturas extremas se refiere.

En el cuarto capítulo se indaga acerca de las causas que están detrás del resultado encontrado en el capítulo tercero. Como se ha apuntado anteriormente, la literatura sugiere que los daños a las infraestructuras y la afectación a la evolución de la productividad laboral serían las variables a tener en consideración. En todo caso, un reciente estudio (Canova y Pappa, 2022) apunta que el impacto sobre el consumo energético podría explicar los efectos económicos reales de los desastres asociados al cambio climático en el caso de Estados Unidos. Por tanto, en el capítulo cuarto, analizo hasta qué punto el incremento global de las temperaturas y la ocurrencia de sucesos extremos inciden sobre el consumo energético de los países y su productividad laboral y, de aquí, sobre comercio internacional.

El sistema energético es vulnerable a una amplia variedad de impactos del cambio climático en términos de producción y oferta. Por un lado, el aumento de las temperaturas puede inducir una reducción en la capacidad de generación termoeléctrica, así como disminuir la eficiencia de la red de transmisión. No obstante, la demanda residencial parece más afectada por las temperaturas que la demanda manufacturera o de servicios. Por ejemplo, Chukwuemeka y Nnaemeka (2022), observan cómo la demanda de electricidad residencial en los países del G7 responde a los días fríos en lugar de a los días calurosos. Por su parte, Yao (2022), obtiene una relación en forma de U entre el consumo de electricidad y la temperatura con un punto de inflexión global de consumo mínimo de electricidad alrededor 14,6°C (es más alto en las zonas urbanas y más industriales). Un planeta en calentamiento podría reducir la necesidad de calefacción en las estaciones frías y aumentar la demanda de refrigeración en las estaciones cálidas, lo que afectaría de manera heterogénea a países en diferentes ubicaciones geográficas (van Ruijven, De Cian y Wing, 2019). Por lo tanto, al caracterizar la relación entre temperatura y consumo de electricidad (derivado de la generación de energía primaria), la literatura suele asumir una curva en forma de U, siendo el punto mínimo la temperatura de equilibrio entre las necesidades de calefacción y refrigeración (ver también Gupta, 2012, o Li, Yang y Long, 2018).

Por otro lado, los fenómenos meteorológicos extremos tienen una amplia variedad de impactos energéticos. En primer lugar, la escasez de agua (sequías) puede causar interrupciones en el suministro de energía al reducir la producción de energía hidroeléctrica y amenazar la extracción y refinación de petróleo y gas, así como las plantas termoeléctricas que dependen del agua superficial para enfriarse. Los incendios forestales y los vientos extremos pueden dañar las líneas eléctricas terrestres y las torres de transmisión, provocando interrupciones en la transmisión de electricidad. Las inundaciones y los deslizamientos de tierra pueden afectar a las líneas eléctricas subterráneas y dañar carreteras, ferrocarriles, oleoductos e instalaciones de almacenamiento y, cerca de la costa, las tormentas pueden destruir los tanques de almacenamiento de petróleo, así como carreteras y ferrocarriles. Además, los fenómenos de frío extremo, incluidos el hielo y la nieve, pueden dañar las líneas eléctricas y afectar el suministro de combustible.

Un primer paso en el análisis efectuado en el capítulo cuarto consiste en estimar el impacto del incremento en las temperaturas y los eventos extremos, por una parte, en el consumo de energía primaria y, por otra, en la productividad laboral. Se observa cómo el alza de las temperaturas incrementa la eficiencia energética mientras ésta se ve reducida por los eventos extremos. Por su parte, la productividad laboral no parece verse afectada en términos medios por el incremento de las temperaturas, aunque se ve incrementada por los sucesos extremos, un resultado que contradice la intuición económica y que viene muy influenciado por el impacto de China, al igual que ocurría en el capítulo anterior.

Al estimar el modelo de gravedad del comercio internacional, nuestros resultados muestran que la eficiencia energética es el canal a través del cual el aumento de las temperaturas afecta el comercio internacional. En este sentido, países como Alemania, Países Bajos, Reino Unido y Estados Unidos influyen notablemente en el resultado medio. Además, el impacto de los eventos extremos en el comercio internacional no parece canalizarse ni a través de la eficiencia energética (sólo marginalmente) ni de la productividad laboral. Un análisis más profundo sugiere claramente el papel clave desempeñado por China en este sentido. La enorme inversión en infraestructura realizada por el gobierno chino desde 1998 para gestionar este tipo de desastres parece ser la explicación razonable. En este sentido, si dividimos nuestra estimación de la ecuación de gravedad entre los períodos anteriores y posteriores a este año, los coeficientes estimados para tormentas y deslizamientos de tierra (con las mismas causas que las inundaciones) para el caso de China influyen fuertemente en el resultado general.

Como conclusión, en esta tesis doctoral se demuestra que el cambio climático efectivamente tiene impacto en los flujos de comercio internacional. En primer lugar, porque el incremento de las temperaturas mejora (en media) la eficiencia energética en países con una elevada influencia en los flujos de comercio bilateral, como es el caso de Alemania. En segundo lugar, los fenómenos climatológicos (y biológicos), parte de los cuales se han incrementado con claridad como consecuencia del cambio climático, inciden en general reduciendo en términos relativos el comercio internacional y, en consecuencia, el bienestar. China, el mayor exportador del mundo, aparece como el país que más influye en este resultado, pero parece que por un motivo inesperado ya que no se debe ni a la ineficiencia energética ni a la laboral sino a la necesidad de reaccionar por parte del gobierno chino a los desastres que tenían lugar en su territorio.

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CHAPTER 1.

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1. Motivation

Climate change involves alterations in the average climate conditions in a region over a long period. Scientists have observed that the Earth's surface is warming, with many of the warmest years on record occurring in the past 20 years. This is why climate change is one of the biggest concerns in the world and is subject to intense discussion in international forums.

The Earth's climate has changed throughout its history. In the last 800,000 years, there have been eight cycles of ice ages and warmer periods; the end of the last ice age, around 11,700 years ago, ushered in the modern climate era and human civilization. Most of these climate changes are attributed to variations in the Earth's orbit that change the amount of solar radiation the planet receives.

However, the current warming is occurring at a rate not seen in the last 10,000 years. Ancient evidence from tree rings, ocean sediments, coral reefs, and sedimentary rock layers reveals that current warming is occurring faster than in the past. Scientists have recently observed unusual changes.

“Climate change” and “global warming” are often used indistinguishably, but they have different meanings. Global warming refers to the long-term warming of the Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily the burning of fossil fuels and increasing levels of greenhouse gases that trap heat in the Earth's atmosphere. This trend has been intensifying since the 1950s and is advancing at an unprecedented rate over the millennia. Figure 1.1. (from NASA) is based on comparisons between atmospheric samples contained in ice cores and more recent direct measurements (Lüthi et al., 2008, Etheridge, D.M., et al. 2010); it shows that atmospheric carbon dioxide (CO_2) has strongly increased since the Industrial Revolution. This additional energy has warmed the atmosphere, ocean, and land, and rapid and widespread changes have occurred in the atmosphere, ocean, cryosphere, and biosphere.

Climate change, in contrast, is a long-term change in average temperatures and climate patterns. These changes have a wide range of observed effects:

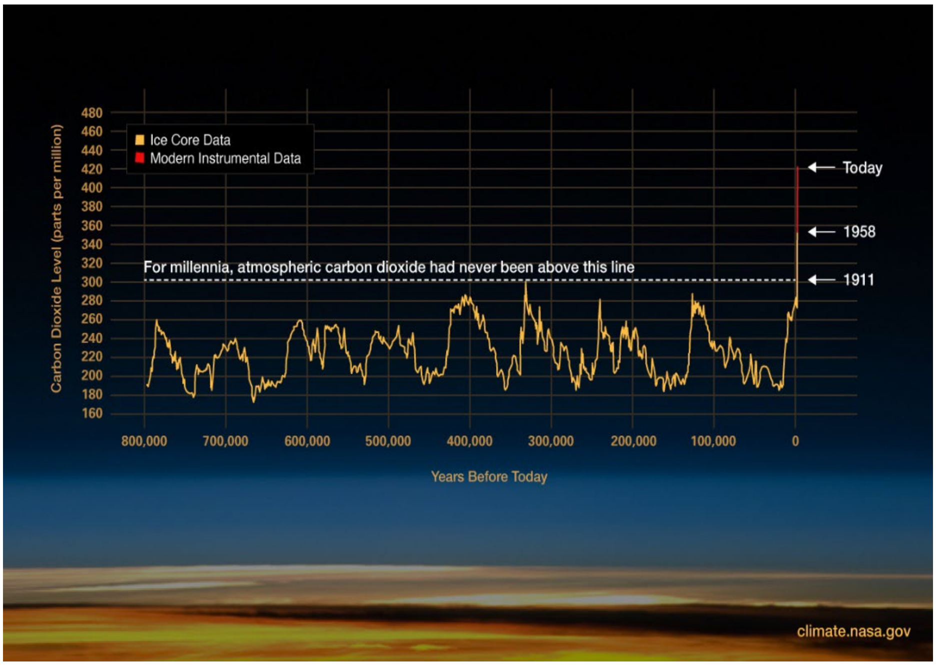
- Global temperature is rising: Most of the warming has occurred in the last decades, with the most recent years being the warmest.
- The oceans are warming: The oceans have absorbed much of this increased heat. The Earth stores 90% of the additional energy in the oceans.
- Ice sheets are shrinking The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate

Experiment shows that Greenland lost an average of 279 billion tons of ice yearly between 1993 and 2019, while Antarctica lost about 148 billion tons.

- Glaciers are disappearing: Glaciers are retreating in almost all parts of the world, including the Alps, the Himalayas, the Andes, the Rocky Mountains, Alaska, and Africa.
- Declining snow cover: Satellite observations reveal that the amount of spring snow in the Northern Hemisphere has decreased over the past five decades and that the snow is melting earlier.
- Sea levels are rising: The global sea level has risen by about 20 centimeters in the last century. However, the rate in the past two decades is almost double that of the past century and is accelerating slightly each year.
- Arctic sea ice is declining: The amount and thickness of Arctic Sea ice have been declining rapidly in recent decades.
- Extreme climate events are increasing in frequency: The number of record high-temperature events in the United States has increased, while the number of record low-temperature events has decreased since 1950. However, the latter is discussed in the literature not in terms of number but magnitude.

- Ocean acidification is increasing: Since the start of the Industrial Revolution, the acidity of ocean surface waters has increased by approximately 30%. This increase is due to humans emitting more CO_2 into the atmosphere, and therefore more is being absorbed into the ocean. Over the last few decades, oceans have absorbed between 20 and 30% of all anthropogenic CO_2 emissions.

Figure 1.1. CO_2 record.



Among the causes attributed to economic activity, the impressive increase in international trade in lasts decades is one of them. The World Bank (e.g., World Bank, 2010; Onder, 2012; Brenton and Chemutai, 2021), the World Trade Organization, the United Nations Environmental Program (the WTO and UNEP reports, 2009) or the OECD (e.g., Dellink et al., 2017; van Hassel, 2017; Martinez Zarzoso, 2018; Yamaguchi, 2021) have raised concerns about this issue. However, not attention has been paid to looking at it the other way around: the impact of climate change on international trade. Throughout this research, I analyze how the increase in temperatures and climate events (or their biological consequences) affect international trade and what the causes may be.

This aspect is especially interesting because the impact on international trade is an additional way through which climate change can affect the welfare of societies. Precisely, the improvement of citizens' welfare of those countries involved in international trade is practically the only area of our discipline in which there is a unanimous consensus. Therefore, the effect of climate change on international trade in one sense or another will influence welfare; so it is of great importance what this impact is and the channels through which it takes place. Knowing these mechanisms is the aim of this research.

1.2. Methodology

The econometric analysis is based on a methodology widely used in the international trade analysis and with solid theoretical foundations: the gravity model. This technique begins with the pioneering article of Timbergen (1962), initially without robust theory behind, and it has been improved along the years with contributions by different authors. This is the case of Anderson (1979), Berstrand (1985), Deardoff (1998), Baier and Berstrand (2001), Anderson and van Wincoop, E. (2003), Baier and Bergstrand, 2007, Santos Silva and Tenreyro (2006), Yotov et al., 2016 or Baier et al. (2019), or Beverelly et al. (2023), among others.

Taking into account these contributions (some of them, very recent) not only is there a solid theoretical basis that justifies the use of this methodology but it is also possible to account for a variety of econometric problems such as endogeneity, unobservable heterogeneity, heterokedastic residuals, etc (see Chapter 3). Therefore, we can be fairly confident that my estimates adequately capture the impact of my variables of interest measuring climate change on international trade flows. In my estimates, I have incorporated the most recent advances in this technique, including the welfare impact of my variables of interest.

1.3. Contributions

This research has various contributions. Firstly, and unlike what is usual in other studies on this topic, the variables of interest in my research are the real consequences on climate of human action (temperatures and events) rather that emissions their selves. Here, we can establish a parallelism with research in the field of Economics of Innovation. At first, the studies in this ambit focused on the input (R&D expenses), later (and of greater interest) on the output (innovations). Secondly, to the best of my knowledge no research has been conducted analyzing whether climate change can influence trade and its welfare implications. Additionally, this impact has been estimated trough a robust methodology taking into account all the possible biases established in the literatures. Some of these developments are very recent. Finally, a deep analysis has been carried out looking for the causes of the results found.

This thesis dissertation is structured as follows. In the next chapter, I perform a descriptive analysis on the variables of interest that measure climate change in my data sample (temperatures and extreme climate events). In Chapter 3, I estimate a theory-based gravity model to study the impact of climate change on international trade. Additionally, I perform a welfare analysis. In chapter 4, I look for the causes of the results obtained in the estimations. In particular, I study the role of energy efficiency and labor productivity on this relationship. Finally, Chapter 5 concludes.

1.4 References

Anderson, J.E. (1979). A theoretical foundation to the gravity equation. American Economic Review, 69, pp. 106–116.

Anderson, J.E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle, *American Economic Review*, 93 (1), pp. 170-192.

Baier, S.C. and Bergstrand, J.H. (2001). The growth and world trade: tariff, transport cost, and income similarity. Journal of International Economics 53 1–27.

Baier, S. L. & Berstrand, J. H. (2007). Do free trade agreements actually increase members´ international trade? Journal of International Economics, 71, 72-95.

Baier, S. L., Yotov, Y. V. & Zylkin, T. (2019). On the widely differing effects of free trade agreements: Lessons from twenty years of trade integration. *Journal of International Economics*, 116, 206-226.

Brenton, P. and Chemutai, V. (2021). "The Trade and Climate Change Nexus: The Urgency and Opportunities for Developing Countries", World Bank, Washington.

Bergstrand, J.H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. Review of Economics and Statistics, 67, pp. 474–481.

Beverelli, C., Keck, A., Larch, M. and Yotov, Y. V. (2023). Institutions, trade, and development: identifying the impact of country-specific characteristics on international trade, Oxford Economic Papers, gpad014, https://doi.org/10.1093/oep/gpad014

Dellink, R., Hwang, H., Lanzi, E. and Chateau, J. (2017). International trade consequences of climate change. OECD Trade and Environment Working Papers 2017/01.

Deardoff, A.V. (1998). Determinants of bilateral trade: does gravity work in a neoclassic world? In The Regionalization of the World Economy, edited by J. Frankel. Chicago: University of Chicago Press.

Etheridge, D., Luhar, A., Loh, Z., Leuning, R., Spencer, D., Steele, P., Zegelin, S., Allison, C., Krummel, P., Leist, M., and van der Schoot, M. (2011). "Atmospheric monitoring of the CO2CRC Otway Project and lessons for large scale CO2 storage projects". *Energy Procedia*, 4, pp. 3666-3675.

Lüthi, D., Le Floch, M.; Bereiter, B, Blunier, T, Barnola, J.-M., Siegenthaler, U., Raynaud, D., Jouzel, J., Fischer, H., Kawamura, K., Stocker, T. F. (2008). CO2 record from the EPICA Dome C 1999 (EDC99) ice core (Antarctica) covering 650 to 800 kyr BP measured at the University of Bern, Switzerland. PANGAEA. https://doi.org/10.1594/PANGAEA.710901, In supplement to: Lüthi, D et al. (2008): High-resolution carbon dioxide concentration record 650,000 - 800,000 years before present. *Nature*, 453, pp. 379-382, https://doi.org/10.1038/nature06949.

Martínez-Zarzoso, I. (2018). Assessing the effectiveness of environmental provisions in regional trade agreements: An empirical analysis, OECD Trade and Environment Working Papers 2018/02.

Onder, H. (2012). Trade and Climate Change: An Analytical Review of Key Issues. *Economic Premise*, 86, the World Bank, Washington, DC.

Santos Silva, J. M. C., & Tenreyro, S. (2006). The log of gravity, *The Review of Economics and Statistics*, 88 (4), 641-658.

Van Hassel, H. (2017). Climate change and trade policy interaction: Implications of regionalism. OECD trade and environment working papers 2017/03.

World Bank (2010). World development report: Development and climate change. Washington, DC.

Tinbergen J (1962). Shaping the World Economy. Twentieth Century Fund, New York.

World Bank. 2010. World Development Report: Development and Climate Change. Washington, DC.

WTO and UNEP report (2009). Trade and climate change. WTO Publications, Switzerland.

Yamaguchi, S. (2021). International trade and circular economy. Policy alignment. OECD Trade and Environment Working Papers 2021/02.

Yotov, Y. V., Piermartini, R., Monteiro, J. A., & Larch, M. (2016). An advanced guide to trade policy analysis: The structural gravity model. United Nations and World Trade Organization. http://vi.unctad.org/tpa/index.html.

CHAPTER 2.

CLIMATE CHANGE: THE DATA

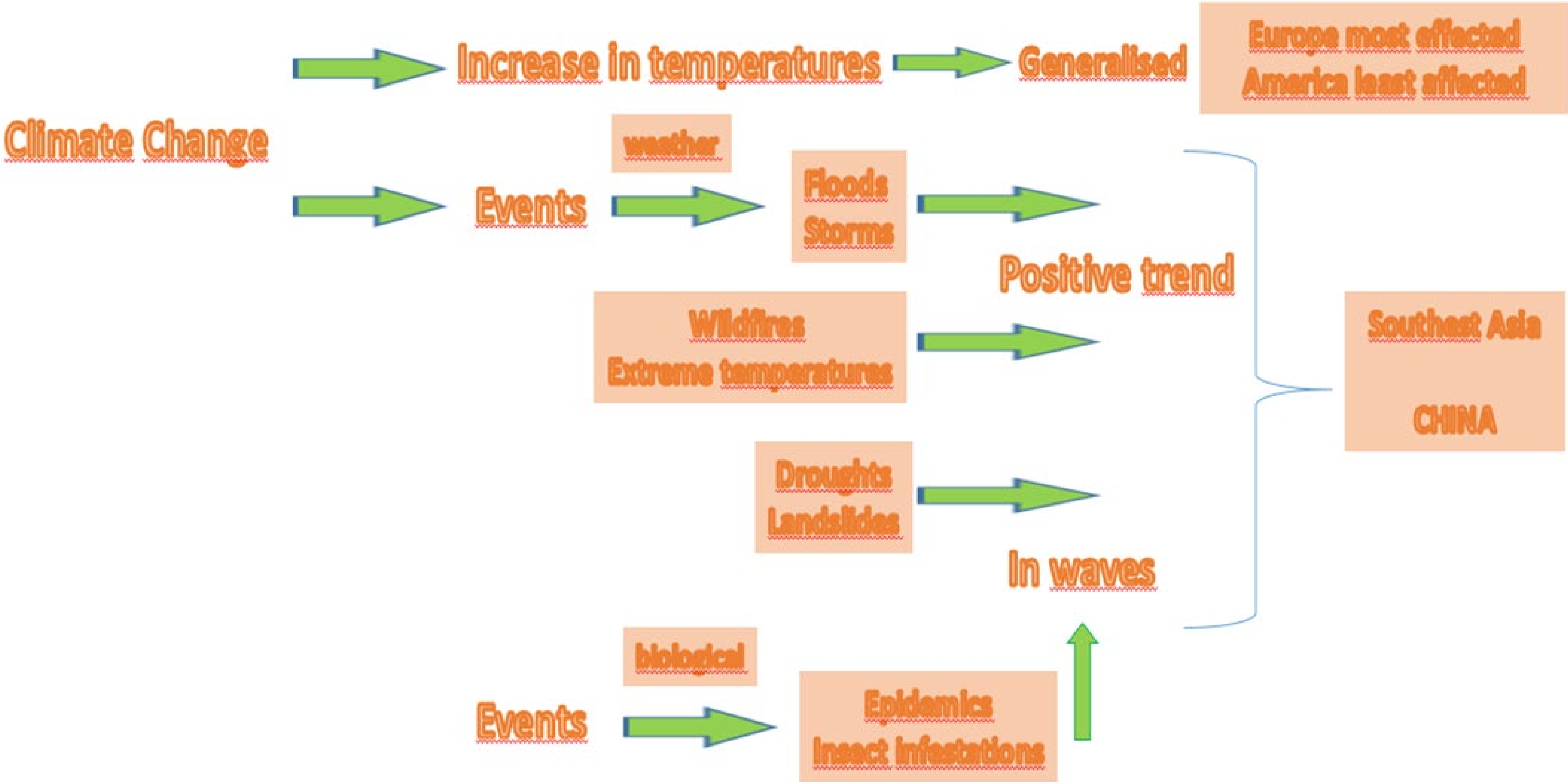
CHAPTER 2.

CLIMATE CHANGE: THE DATA

Abstract

In this chapter, I look at what the climate change data tells us about its evolution over the last decades. The sample for the econometric estimations is comprised of 67 countries over the period 1986–2016. I use yearly average temperatures and climate and biological extreme events as the variables of interest. The descriptive analysis shows how temperature increase (with an average rise of 1.5 degrees Celsius) is generalized over the world but with geographical concentrations. Europe is the most affected continent, and North America is the least affected; Africa and Asia are in an intermediate position. Concerning extreme climate events, floods and storms are the most frequent; both present a clear upward trend along with wildfires and periods of extreme temperatures. The rest of these events do not display an evident positive trend; instead, they occur in waves. An interesting feature of this dataset is that these events have been concentrated in Asia, particularly China.

Graphical abstract



CHAPTER 2.
CLIMATE CHANGE: THE DATA

2.1. Introduction

In this chapter, I am going to make a descriptive analysis of the information about the increase in temperatures and the occurrence of extreme climate events provides the sample on which I will sustain the subsequent econometric analysis. For my research, I have selected 67 countries during the period 1986-2016.

Throughout the next lines, I am going to study in depth for each country in particular and for them altogether what the real scope is of the so-called climate change in the two dimensions mentioned (temperatures and events). This will provide me with a more detailed vision of the phenomenon and will help me to better interpret the results of the subsequent econometric study.

One of the contributions of the present dissertation consists of using the output of climate change (temperatures and events) instead of the input (CO_2 emissions) as the variables to be taken into account for the analysis of its impact on the economic variables in question. To support this decision (moreover, widely corroborated by the scientific community), the connection between both variables will be studied firstly.

2.2. From the input to the output of climate change

One of the contributions to the trade and climate change literature that this work aims to make is to focus directly on an outcome measure of climate change rather than an input-based measure. Usually, this kind of research uses emissions as a variable of interest because, as before stated, this variable is attributed to climate change. However, from my point of view, it is more interesting to examine the effects of climate change, which are the phenomena that directly affect economic variables.

In this section, I perform a regression analysis to determine the extent of the relationship between the evolution of CO_2 and the increase in temperatures and meteorological disasters. This analysis checks whether the chosen variables of interest reflect the conception of climate change to be studied throughout this work.[1]

Based on the database Our World in Data, Figure 1 shows the evolution of CO_2 emissions in the world in the period 1750–2021, which shows that global warming has intensified since 1950. Likewise, the graph shows how starting this year, the increase has had a much more pronounced effect. The sample period for the research contained in this thesis includes the years from 1986 to 2016. In this

[1]In any case, the connection between CO_2 emissions and climate change is clear in the literature. See IPCC (2013) or Lacis et al. (2010).

period, there is a clear upward trend; CO_2 emissions increased by no less than 82% (see Figure 2). From here, a regression analysis was done to see the impact of CO_2 emissions on temperature increase and meteorological disasters.

The variables of interest in this research are average temperatures and extreme climate (and biological) events. In the first case, the Climate Change Knowledge Portal database of the World Bank is used, while in the second case, the data comes from the International Disasters Database (EM-DAT). I focus on a sample of 67 countries (Table 1).

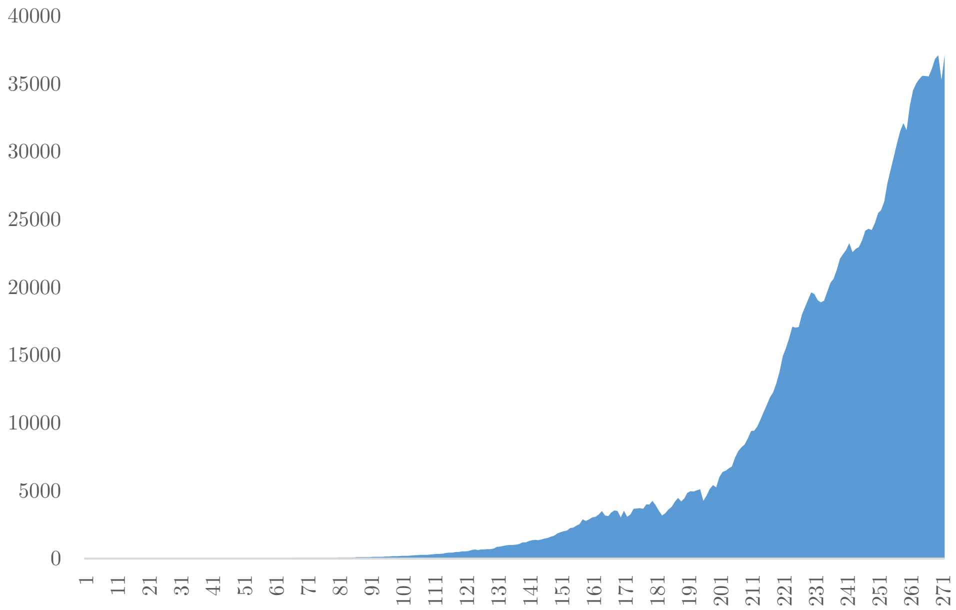
With these premises in mind, I made an ordinary least square (OLS) regression relating climate change (the logarithm of average temperatures and events for the sample of countries) and (the logarithm of) CO_2 emissions for my sample period.

The relationship between CO_2 emissions and temperatures in the sample can be seen in Table 2. A positive and highly significant estimated coefficient is obtained with an elasticity of 0.1. That is, CO_2 emissions clearly impact temperatures. Additionally, the coefficient of determination (R^2) is around 0.73, a reasonably high value. Making lags of the variable shows the same significant trend, although it loses magnitude over time.

Performing the same exercise but this time relating it to events reveals again a positive and significant estimated coefficient (Table 3), reflecting an elasticity of 0.9. Moreover, for the lagged variables, the same thing happens with temperatures; the coefficient is still significantly positive but with less impact going further back in time. In this case, however, R^2 is smaller, showing that these phenomena do not follow a trend as strongly as temperatures.

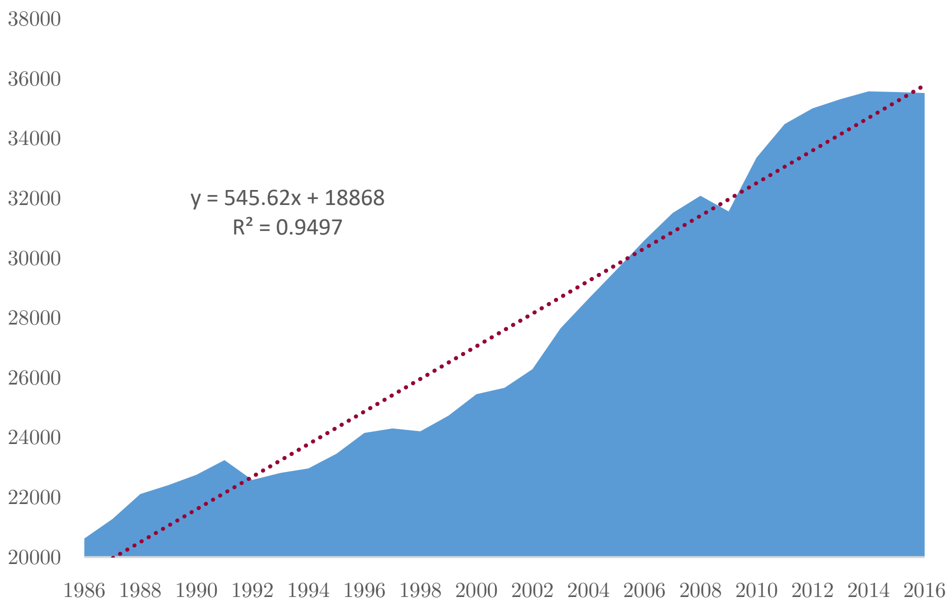
Therefore, this analysis shows that the variables of interest chosen in this study to reflect climate change effectively are the output of human economic activities.

Figure 2.1. Evolution of CO_2 emissions (millions of tons) in the world. Period 1750–2021.



Source: Data on CO2 and Greenhouse Gas Emissions by Our World in Data.

Figure 2.2. Evolution of CO_2 emissions (millions of tons) in the world. Period 1986–2016.



Source: Data on CO2 and Greenhouse Gas Emissions by Our World in Data.

2.3. The increase in temperatures is widespread around the world

There is increasing consensus among the scientific community that climate change is a fact. For the econometric estimations, and due to the availability of data on key variables at the time this research began (see Chapter 3), as stated, this study focuses on the period 1986–2016 and a sample of 67 countries. Twelve of these countries are from Africa, twelve from the Americas, nineteen from Asia, twenty-three from Europe, and one from Oceania. Our sample already comprise close to 85% of world merchandise exports (WTO, 2017) and around 91% of world GDP (OECD, 2017) of the year 2016. Therefore, the period and the number of selected countries significantly represent the phenomenon under study.

Table 2.1. List of Countries.

Australia	Malawi
Austria	Malaysia
Belgium	Malta
Bolivia	Mauritius
Brazil	México
Bulgaria	Morocco
Cameroon	Myanmar
Canada	Nepal
Chile	Netherlands
China	Niger
Colombia	Nigeria
Costa Rica	Norway
Cyprus	Panama
Denmark	Philippines
Ecuador	Poland
Egypt	Portugal
Finland	Qatar
France	Romania
Germany	Senegal
Greece	Singapore
Hungary	South África
Iceland	Spain
India	Sri Lanka
Indonesia	Sweden
Iran	Switzerland
Ireland	Tanzania
Israel	Thailand
Italy	Trinidad and Tobago
Japan	Tunisia
Jordan	Turkey
Kenya	United Kingdom
Korea	United States
Kuwait	Uruguay
Macao	

Table 2.2. Impact of carbon dioxide emissions on temperatures. Period 1986–2016.

	(1)	(2)	(3)	(4)
Dependent variable	**Log of temperatures**	**Log of temperatures**	**Log of temperatures**	**Log of temperatures**
$lnCO_{2t}$	0.102***			
	(0.012)			
$lnCO_{2(t-1)}$		0.095***		
		(0.002)		
$lnCO_{2(t-2)}$			0.092***	
			(0.011)	
$lnCO_{2(t-3)}$				0.091***
				(0.011)
Constant	1.804***	1.881***	1.909***	1.918***
	(0.125)	(0.109)	(0.109)	(0.117)
Observations	31	30	29	28
R2	0.733	0.731	0.713	0.689

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Table 2.3. Impact of CO_2 emissions on climate events. Period 1986–2016.

	(1)	(2)	(3)	(4)
Dependent variable	**Log of events**	**Log of events**	**Log of events**	**Log of events**
$lnCO_{2t}$	0.900***			
	(0.185)			
$lnCO_{2(t-1)}$		0.784***		
		(0.188)		
$lnCO_{2(t-2)}$			0.721***	
			(0.209)	
$lnCO_{2(t-3)}$				0.659***
				(0.234)
Constant	-4.024***	-2.821	-2.155	-1.497
	(0.910)	(1.937)	(2.154)	(2.403)
Observations	31	30	29	28
R2	0.386	0.321	0.277	0.229

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

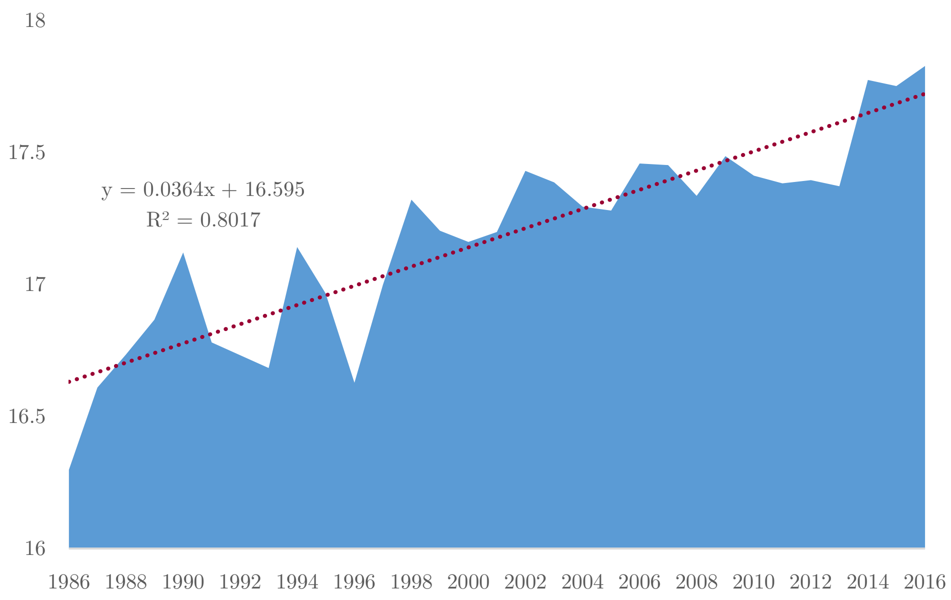
This study analyzes the increase in temperatures and climate events in these countries. I present the evolution of average yearly temperature in my sample in Figure 3. In this section, I calculate the linear time trend of the data by focusing on the corresponding estimated parameter of the slope and the value of the coefficient of determination (R^2). This information appears on the respective chart when the estimated coefficient of the slope is statistically significant. As observed, temperatures increase constantly over time with a clear positive (and significant) trend with a slope value of 0.0364, which implies that, in the period analyzed, the average temperature increases by one degree every 28 years approximately.[2] The value of 0.8 for the coefficient of determination is enough to clarify the persistence of the temperature increase over time. The average temperature difference between 1986 and 2016 is 1.53 degrees Celsius in the sample. Scientists consider that beyond the value of 1.5 degrees of increase in global temperatures, we are at a critical point.

Maps 1 and 2a/2b present differences in temperatures by country for the thirty-one years, both in absolute value and as a percentage. Among the 67 countries, 65 show an increase (more or less intense) in the average temperature; only Uruguay and Bolivia have seen a slight decrease. Among the top ten countries are four Asian countries (i.e., Korea, Iran, Japan and Kuwait) and six

[2] This occurs if the trend does not change over time.

European countries (i.e., Finland, Denmark, Sweden, Poland, the Netherlands, and Norway). More interesting is the increase in percentage terms (see Map 2a). Among the top ten are nine European countries (i.e., Norway, Finland, Sweden, Iceland, Denmark, Switzerland, Austria, Poland, and Great Britain) and one country in the Americas (i.e., Canada). If we remove the outliers (Finland, Iceland, Norway and Sweden) Deutschland, the Netherlands, Korea and Belgium also enter the top 10 list (Map 2b). Therefore, concerning global warming, a remarkable spatial concentration exists in Northern European countries.

Figure 2.3. Evolution of the average annual temperature in the sample (67 countries)



Note: This elaboration is based on data from the Climate Change Knowledge Portal (World Bank).

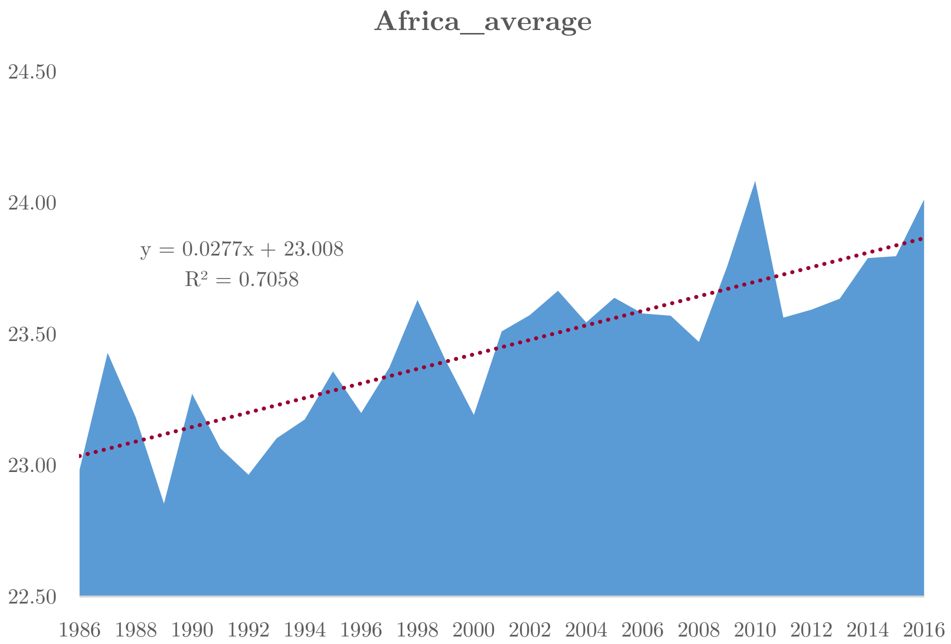
The figures for all the countries of the sample are in the Appendix. The graphs for those countries in which the slope is not significant (at least at ten percent) do not show the respective linear equation because I cannot confirm that there is a trend for these cases. Additionally, if the R^2 of the linear fit is high, this would imply that the evolution is sustained (or gradual) over time, while if the R^2 is small, this means that the estimated trend is given by "jumps."

The analysis reveals the following. Among the 67 countries, there is a significant positive trend in 59 countries or 88 percent of the cases. Therefore, it is possible to confirm that temperature increase is widespread. However, I found differences according to the continent to which the countries belong. In other words, temperature increase is spatially concentrated, a fact suggested by the data (Map 1 and 2a/2b).

Three of the eight countries that do not show an increase in average temperature over time are found in the Americas, three in Asia, one in Europe, one in Oceania (the examined only country on this continent) and none in Africa. While examining the countries, I see common behavior across continents. Generally speaking, the strongest impacts are in Europe, and the lowest are in the Americas. Africa and Asia are in an intermediate situation. Additionally, in Europe and the Americas, the impact felt by the countries is usually due to "jumps" in time. In Africa and Asia, temperatures have increased progressively over time.

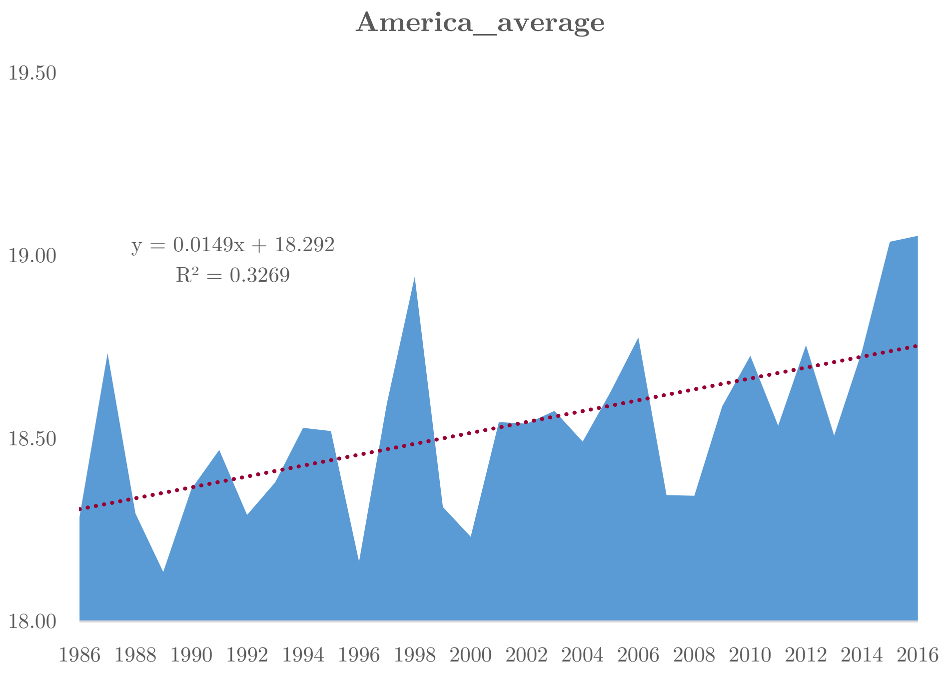
To get an average impact within continents, I grouped the data accordingly and calculated the corresponding trend. Figures 4 to 7 present the results. In Europe, on average, an increase of one degree Celsius occurred over 26 years, while in the Americas, it took 67 years (one and a half times more). Africa and Asia have a similar estimated coefficient, which implies that it takes around 36 years for a temperature increase of one degree Celsius for those continents. Additionally, in Africa and Asia, the fit of the linear adjustment is relatively high (especially in Africa); it is clearly lower in Europe and the Americas. Therefore, the data indicates that the increase in worldwide temperatures is especially intense in Europe (but occurs in waves), less intense in Africa and Asia (but persistent over time), and hardly intense at all (and by "jumps") in the Americas. A one-degree increase in average temperature does not have the same implications in cold countries (such as Northern Europe) as it does in hot countries (such as those in Africa), where people are already suffering from heat stress. Therefore, econometric analysis is needed to know the real impact on the economic variables of the above-mentioned pattern of increasing temperatures worldwide.

Figure 2.4. Evolution of average annual temperatures: Africa.



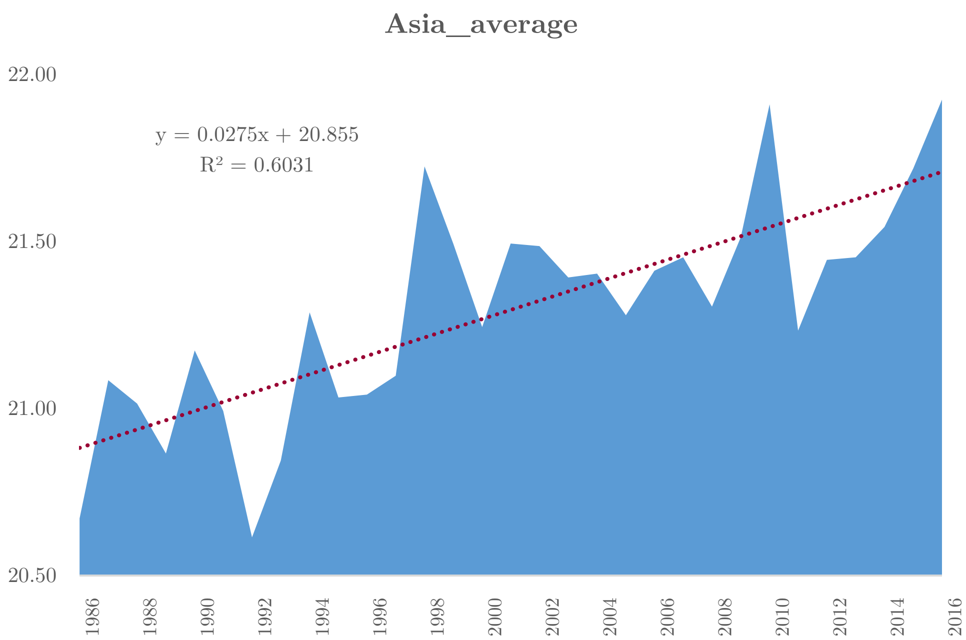
Note: The elaboration is based on data from the Climate Change Knowledge Portal (World Bank).

Figure 2.5. Evolution of average annual temperatures: the Americas.



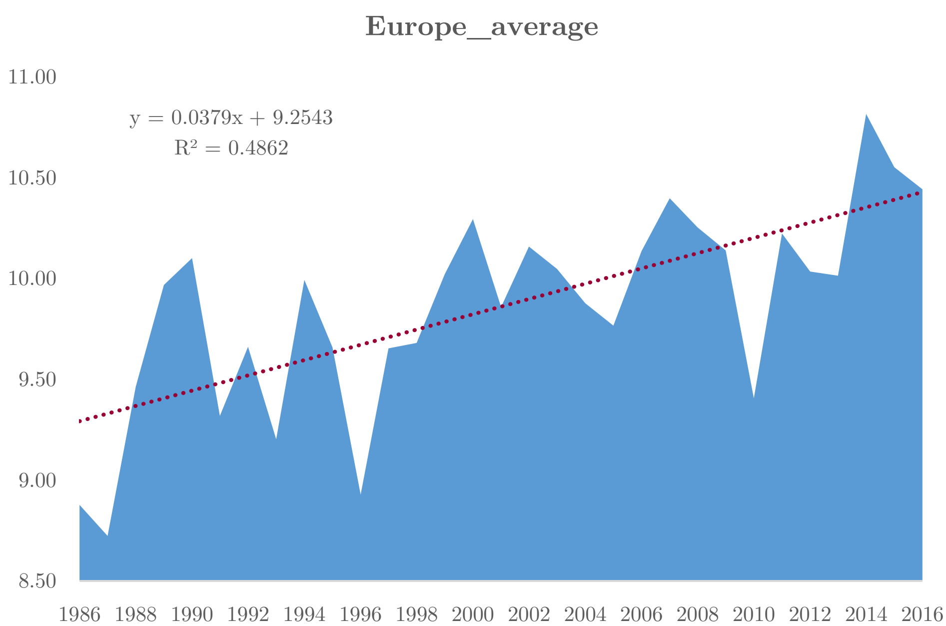
Note: The elaboration is based on data from the Climate Change Knowledge Portal (World Bank).

Figure 2.6. Evolution of average annual temperatures: Asia.



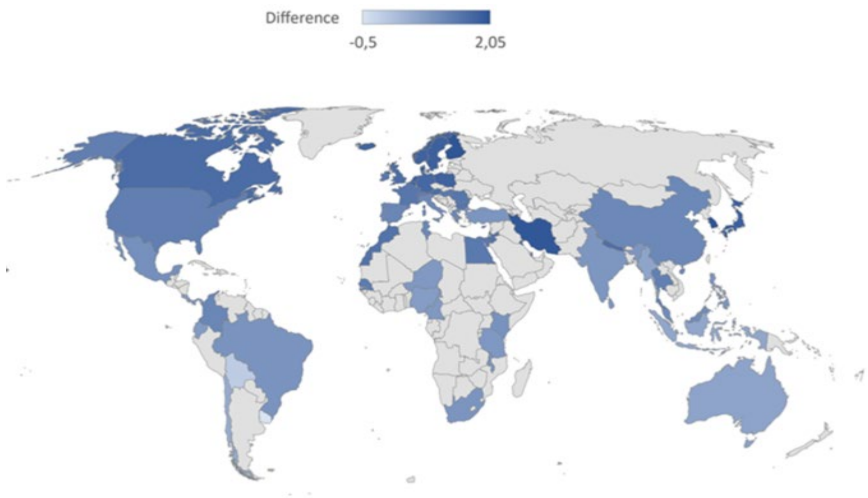
Note: The elaboration is based on data from the Climate Change Knowledge Portal (World Bank).

Figure 2.7. Evolution of average annual temperatures: Europe.

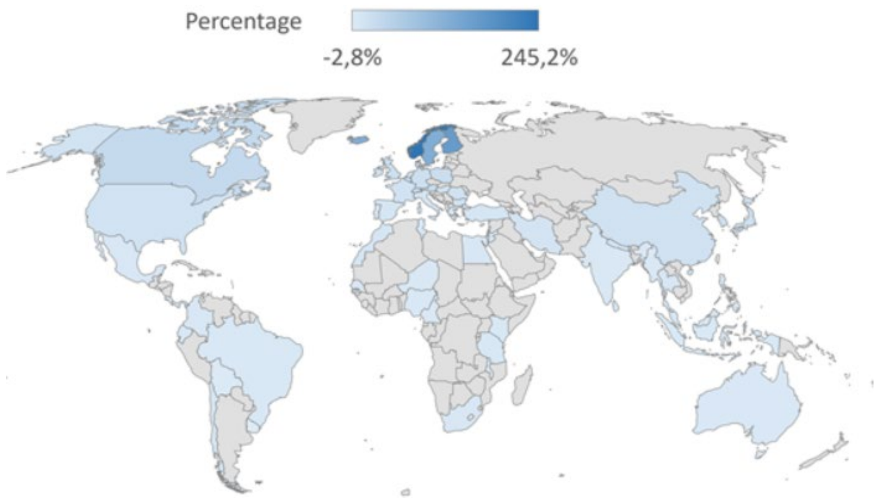


Note: The elaboration is based on data from the Climate Change Knowledge Portal (World Bank).

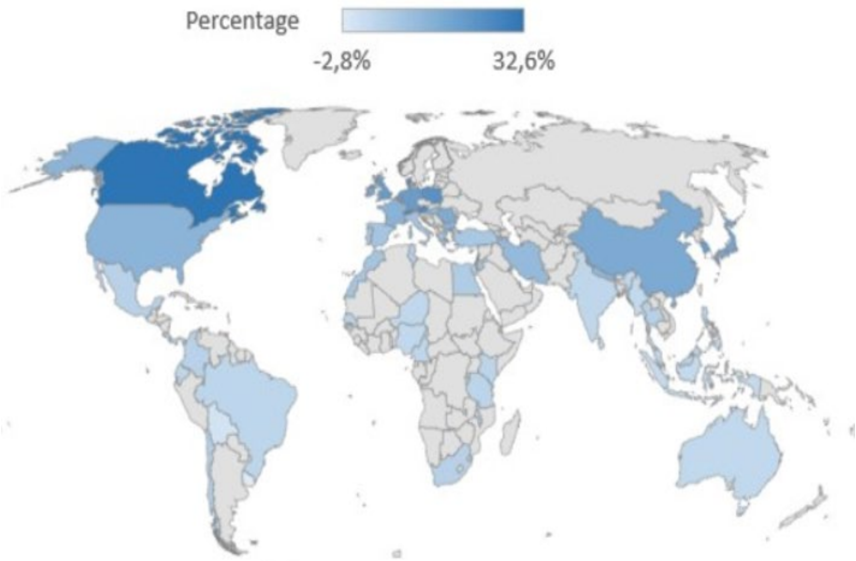
Map 2.1. Average temperature difference in the period 1986–2016 by country.



Map 2.2a. Average temperature difference (in percentage) in the period 1986–2016 by country.



Map 2.2b. Average temperature difference (in percentage) in the period 1986–2016 by country.



Note: Finland, Iceland, Norway and Sweden are excluded.

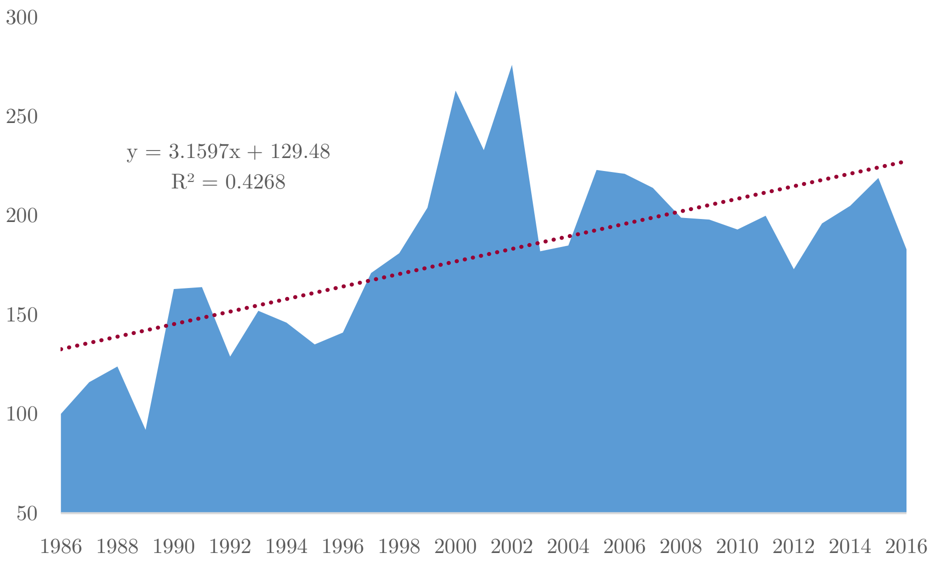
2.4 Global warming and the increase in disastrous climate events

The International Disaster Database (EM-DAT) provides data on extreme climate events or any other type of disaster that may be a consequence of global warming throughout the world. This information has been available since 1900 and comes from a variety of sources (UN agencies, non-governmental organizations, etc.). The Centre for Research on the Epidemiology of Disasters (CRED) distributes these datasets free of charge. For my analysis, I have selected the following events: wildfires, floods, extreme temperatures, insect infestations, epidemics, storms, droughts, and landslides. These events are directly related to climate change. I will proceed in the same way as before. First, I look at the evolution of the events as a whole and then analyze what is important by country and, in this case, by type of event.

Figure 8 shows that the evolution of the total number of events is in line with temperature increase; there is a positive (and significant) trend. On average, the number of events approximately doubled in the period analyzed. However, the coefficient of determination is much lower than that shown in Figure 3, which means that events occur in a less gradual pattern than temperature. In fact, between 1996 and 2002, there is a sudden change in trend (i.e., the slope increases a lot), returning in 2003 to the evolution seen between 1986 and 1995.

The next step is the country analysis. Appendix I shows the total number of events (distributed by types of events) of each country and continent classification. For each country, I have estimated the linear trend equation. I show the graphs of those countries for which this trend is significant (Figures 9 to 12). Contrary to what occurs with temperature, the total observed increase in the event is not generalized. Of the 67 countries, I found only 17 countries with a positive and significant linear trend. Two countries are found in Africa, three in the Americas, eight in Asia, and four in Europe. Therefore, in this case, a concentration (in absolute and relative terms) of events exists in Asia.

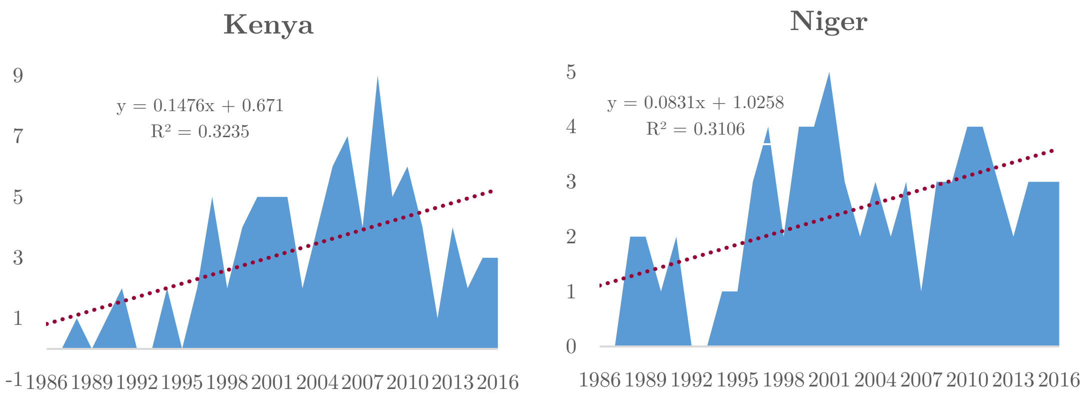
Figure 2.8. Evolution of climate events in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

To analyze the real relevance of the estimated (significant) trend, I first calculated the product of the respective slope of each equation times the corresponding R^2. I have called this the "trend index." The logic of this index is as follows: a given slope will reflect the real evolution of the data to a greater extent as the coefficient of determination increases. If R^2 is one, the value of the slope will fully reflect the real data's evolution. The source literature on this index is from Krause et al. (2005), in which they use this index as one of the alternatives of efficiency criteria. The index value is located at the bottom of the respective figure.

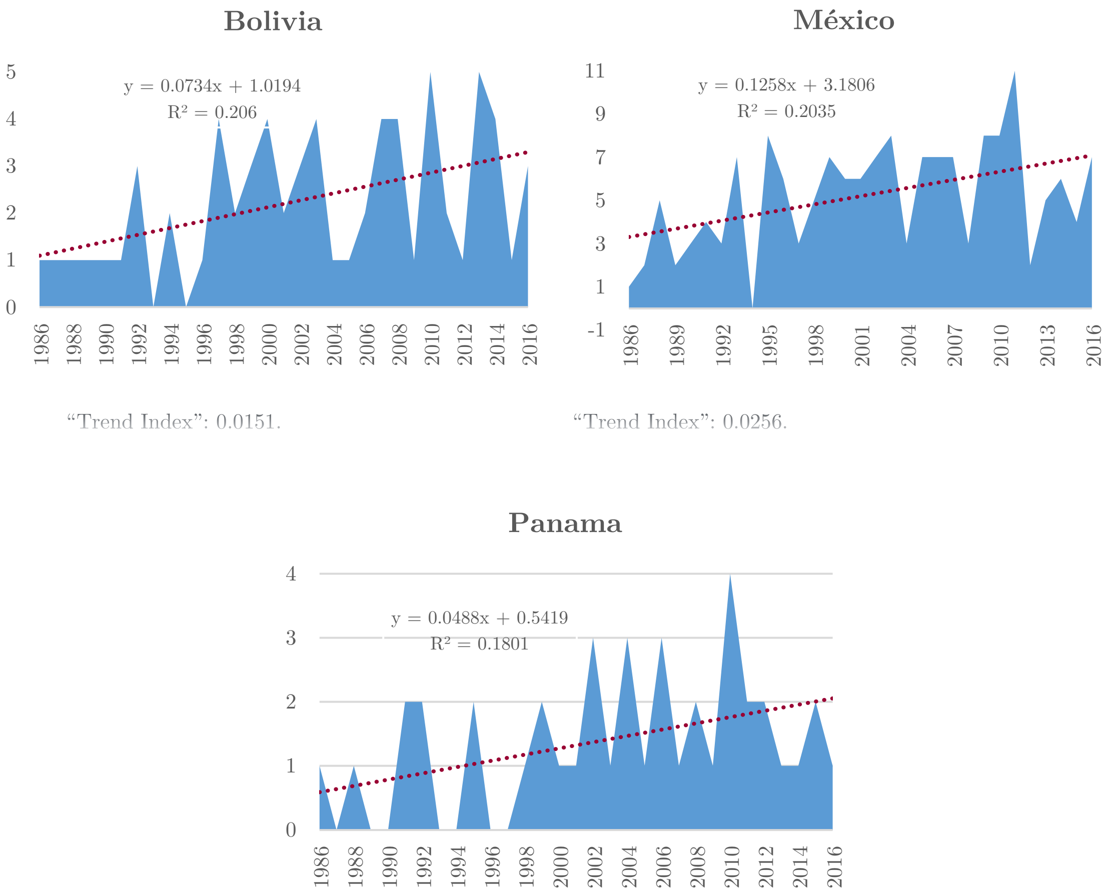
Figure 2.9. Evolution of climate events. Positive trend: Africa.



"Trend Index": 0.0477 "Trend Index": 0.0258

Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.10. Evolution of climate events. Positive trend: the Americas



"Trend Index": 0.0088

Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.11. Evolution of climate events. Positive trend: Asia

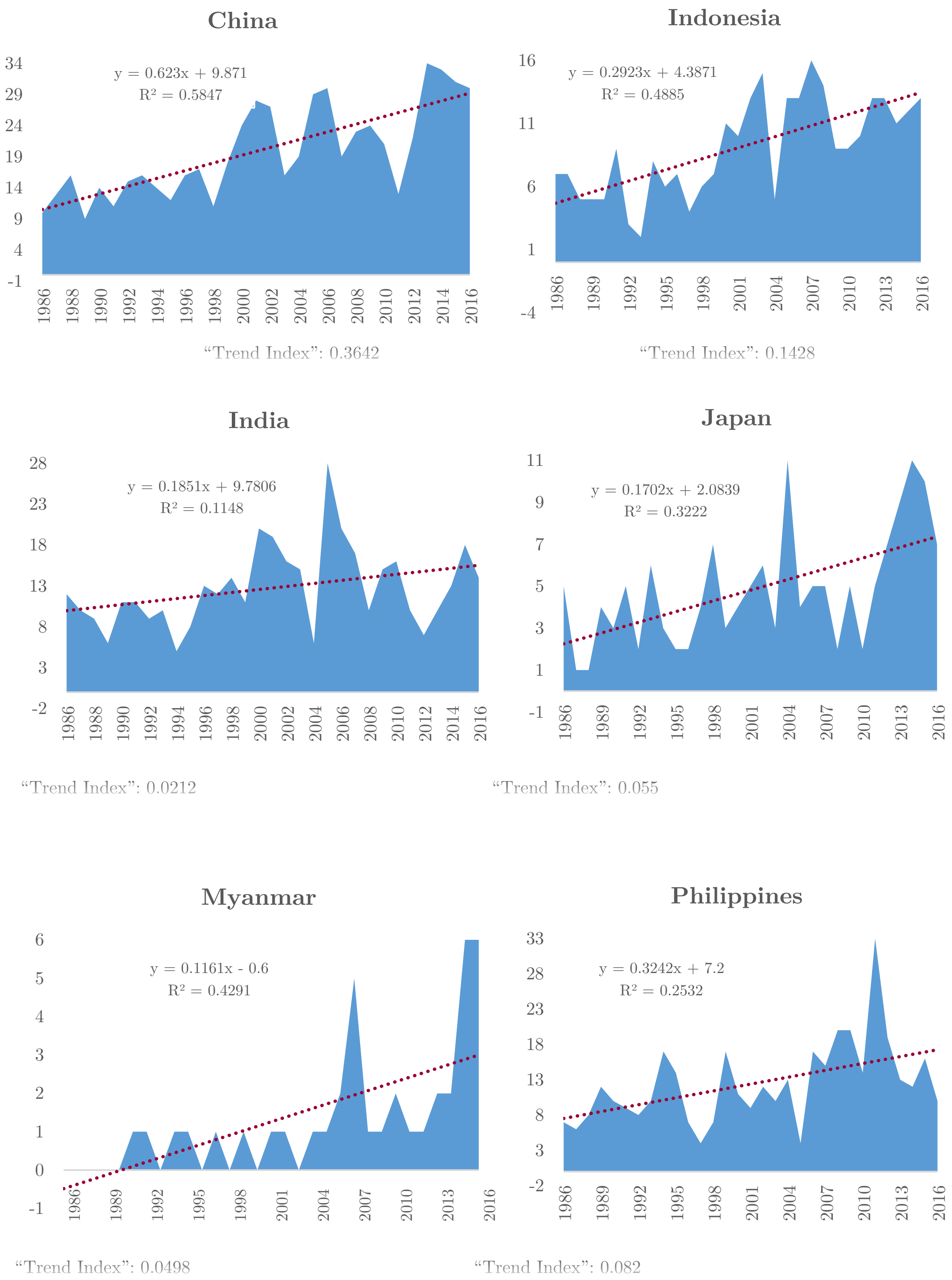
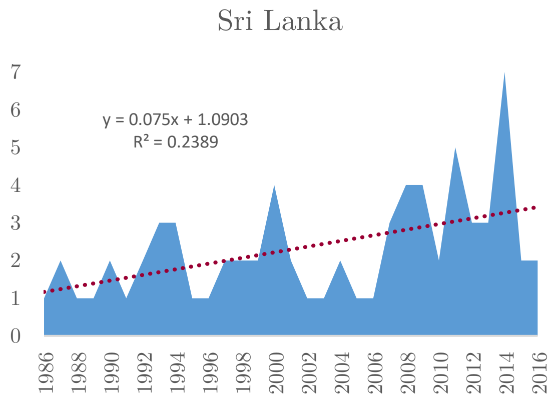
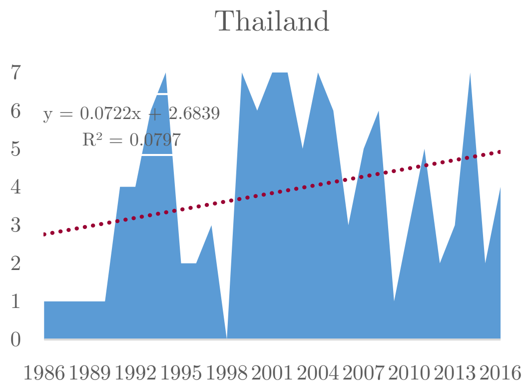


Figure 2.11. Evolution of climate events. Positive trend: Asia (cont.)





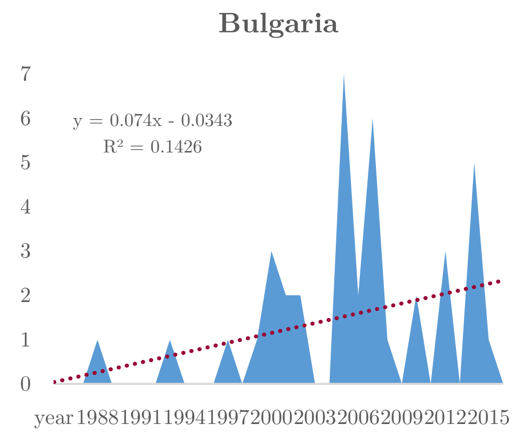
"Trend Index": 0.0179

"Trend Index": 0.0058

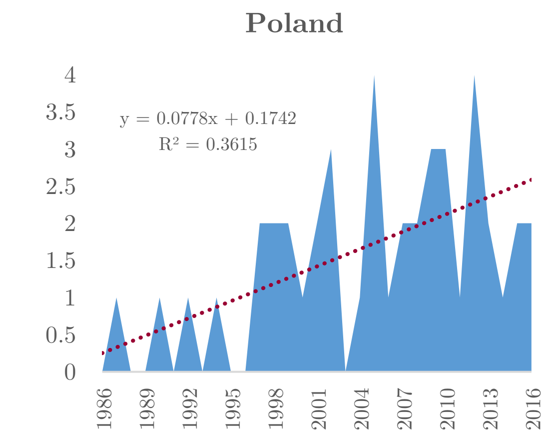
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

According to these figures, one country stands out above the rest: China. This country has a higher slope and R^2 in the trend equations; consequently, China has the highest score in the index. In other words, the world's leading exporter has been the country most affected by climate events, at least concerning its evolution over time. The values of the trend index are shown in Map 3. Another interesting result is that Asia is most affected by these climate disasters. Next, I will examine if this result is generalized across events or if there is a specific relevant event.

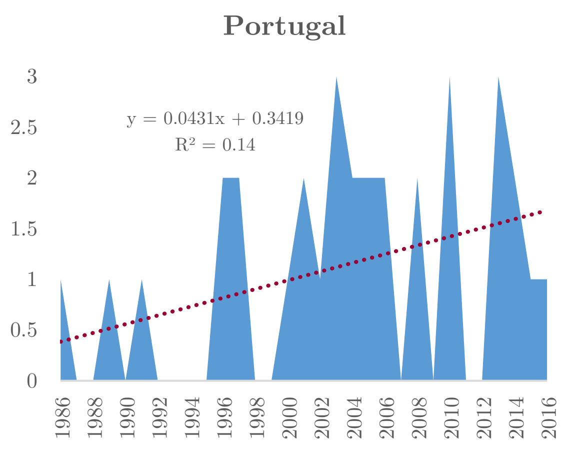
Figure 2.12. Evolution of climate events. Positive trend: Europe



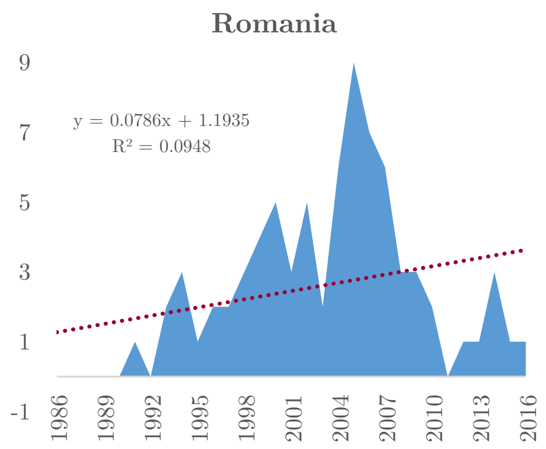
"Trend Index": 0.0106



"Trend Index": 0.0281



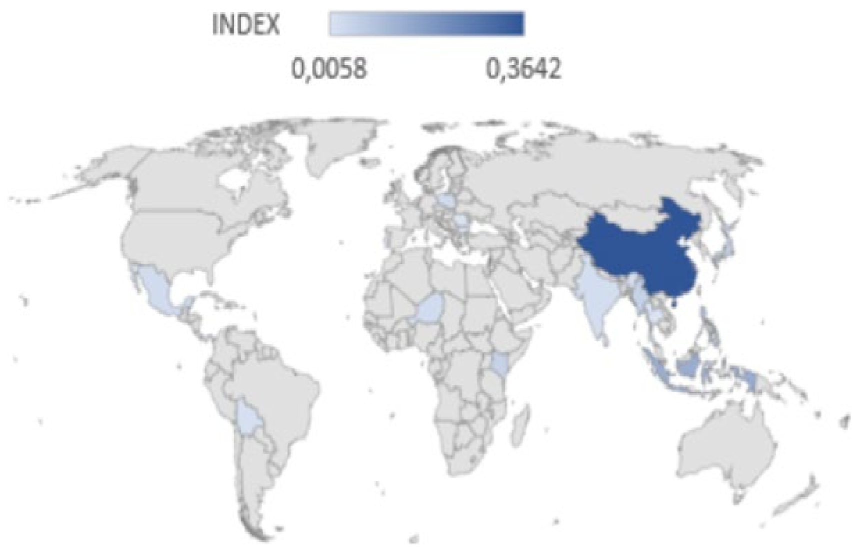
"Trend Index": 0.006



"Trend Index": 0.0075

Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

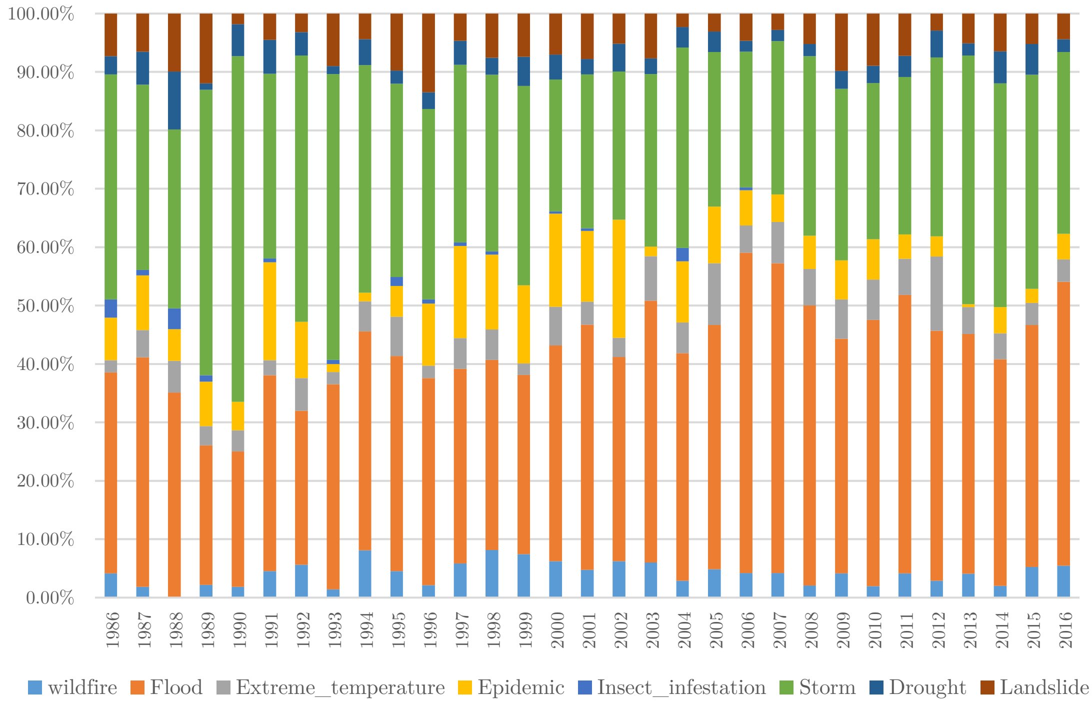
Map 2.3. Trend Index.



2.5. The occurrence of extreme climate events

As Figure 13 shows, two events predominate: storms and floods. In general, both climatic phenomena account for around 80% of the total over time. The relative importance of each one is variable depending on the year, but there is a tendency to reduce the proportion of storms in favor of floods. In any case, both phenomena are at least partly connected and, in some cases (such as China), are highly connected. In any case, since these events as a whole increase over time, this should also be the case for storms and floods, and to a greater extent in the second case compared to the first. Regarding the other event types, I do not find any clear pattern. In the following sections, I analyze the evolution of the different events and the main countries in which they take place.

Figure 2.13. Evolution of the proportion of climate events by type



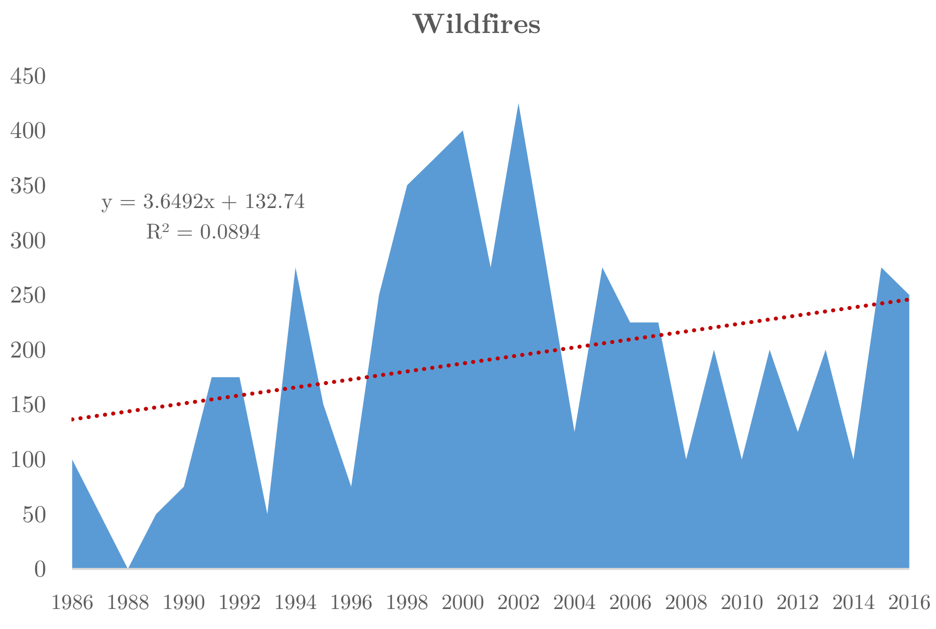
Note: The elaboration is based on data from the International Disasters Database (EM-DAT).

2.5.1. Wildfires

With climate change, the probability of fires increases because higher temperatures and drought create hot, dry conditions that act as fuel for fires. In addition, these fires are becoming more devastating, not only because of drier soils but also because of the increase in winds. The evolution of wildfires in the sample is shown in Figure 14. Although I detected a positive trend in this phenomenon over time, the R^2 is small. There are periods when this event increases (e.g., from 1997 to 2002) and periods when there are only minor fluctuations (approximately since 2004). In this sense, Flannigan et al. (2009) cannot be conclusive about the effect of climate change on fires. Furthermore, these authors cannot predict future trends because they maintain that it is "difficult to determine owing to the complex and non-linear interactions between climate, vegetation and people."

Fires are especially numerous in the United States, Australia, Canada, Chile, and Spain. The rate of fires in these five countries is shown in Figure 15. Only in the case of the US and Australia is the trend positive but with a poor linear fit. This result confirms the previous finding that no clear connection between the incidence of fires and climate change exists.

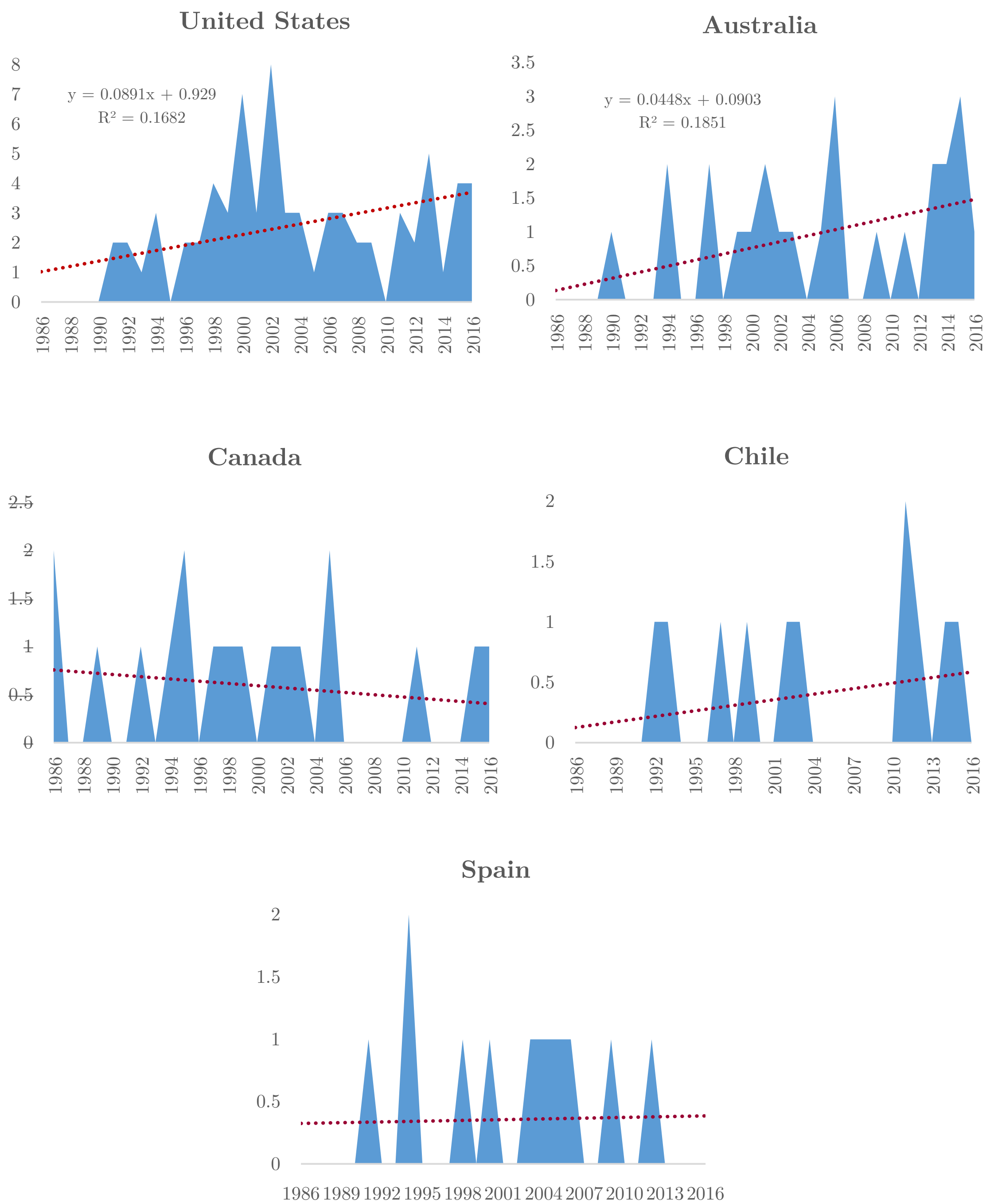
Figure 2.14. Evolution of wildfires in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

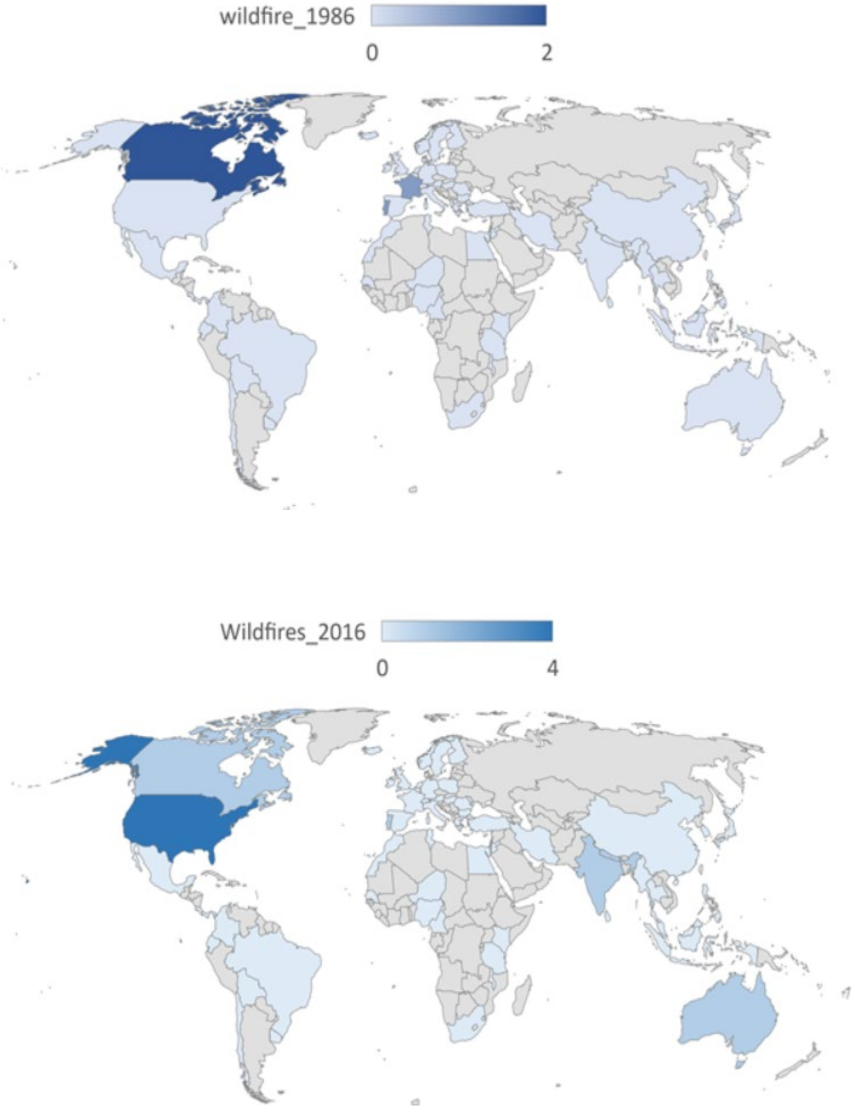
To provide additional information, I present a map of each event around the world during the first and last years of the sample. For wildfires, this appears on Map 4. As shown, the affected countries are essentially different. Therefore, it seems there is no spatial concentration of this event over time.

Figure 2.15. Evolution of wildfires in the top five countries affected by them



Note: The elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.4. Wildfires in 1986 and 2016

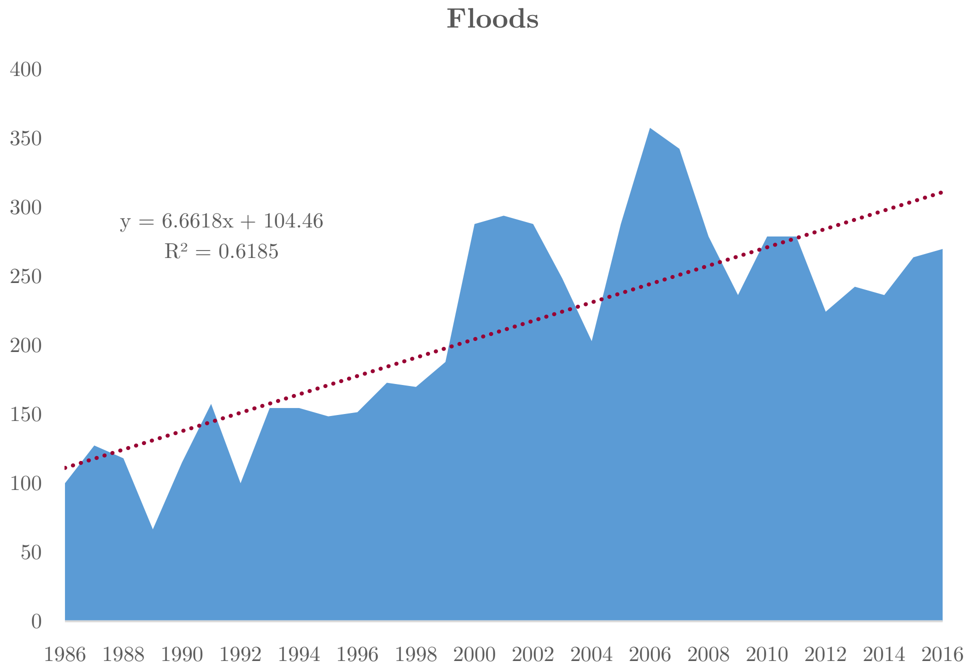


2.5.2. Floods

Concerning floods, it is possible to distinguish those that occur because of rainfall (divided into pluvial, surface or fluvial) and those due to storm surges (e.g., coastal flooding). In the latter case, the disaster could be intensified by rising sea levels and more intense storms.

The general increase in temperature leads to a warming of the atmosphere, which leads to a greater frequency and intensity of precipitation episodes because the air retains more humidity. Cortés et al. (2019) provide evidence of the increase in the probability of this type of event for particular regions of Spain.

Figure 2.16. Evolution of floods in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

The evolution of floods in the sample is presented in Figure 16. As expected, there is a significant increase in these events in the analyzed period. I found a significant positive linear trend with a relatively high goodness of fit. In general, the likelihood of floods is twice as high at the end of the period than at the beginning.

The countries with the highest number of floods are China, India, Indonesia, the United States, and the Philippines. The four Asian countries show a positive trend. This is not the case for the United States. China presents the highest slope and R^2. It is striking that in China, at the end of the period and on average, the floods are five times greater than at the beginning. Map 5 shows how this phenomenon was more concentrated in the Asian giant and its closest neighbors in 2016.

Figure 2.17. Evolution of floods in the top five countries most affected by them

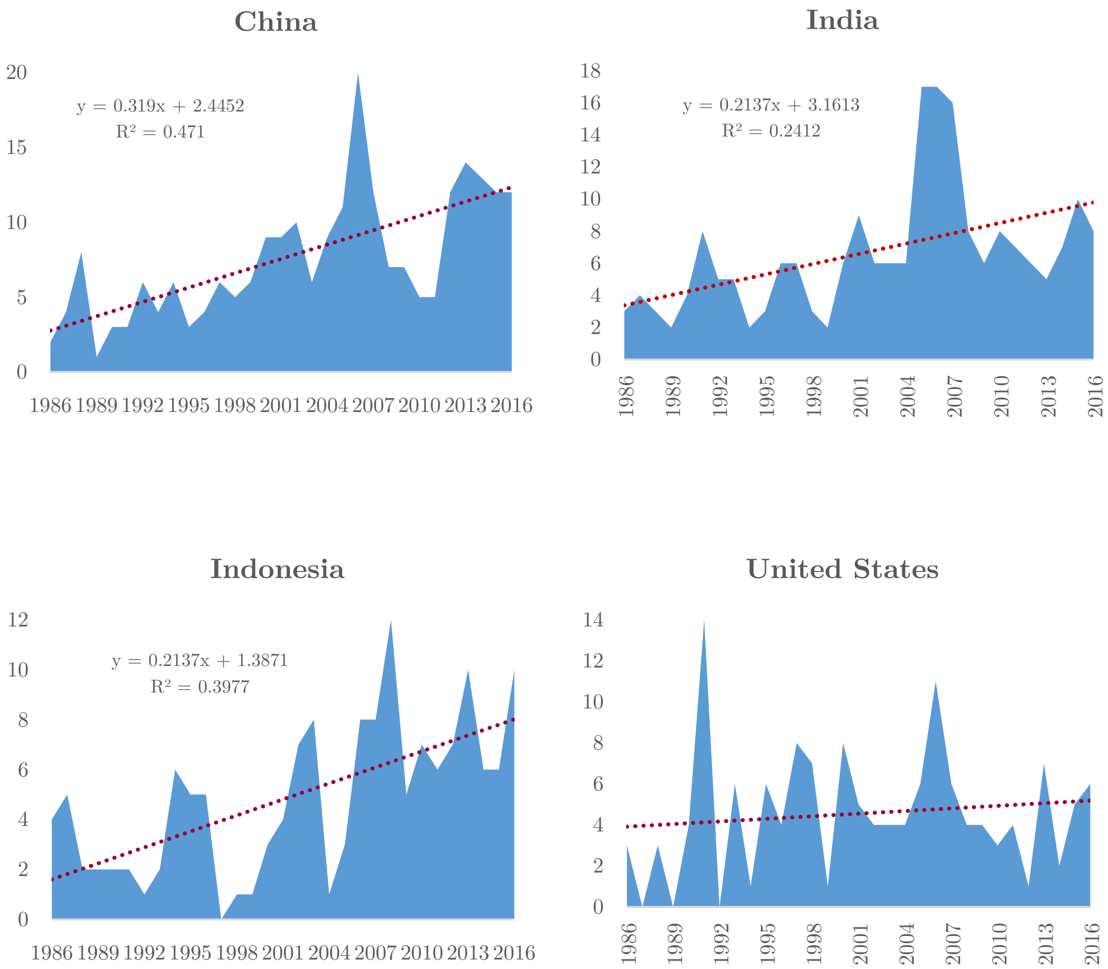
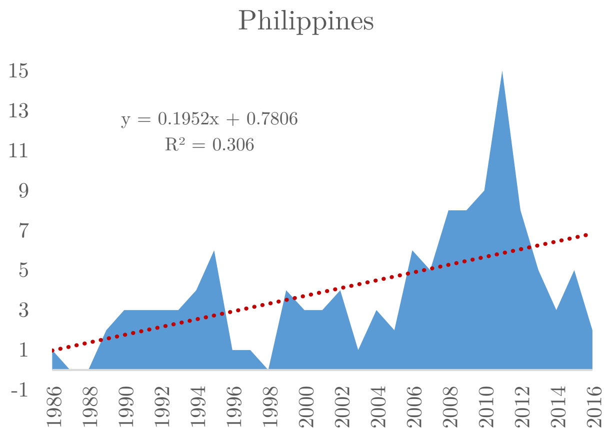
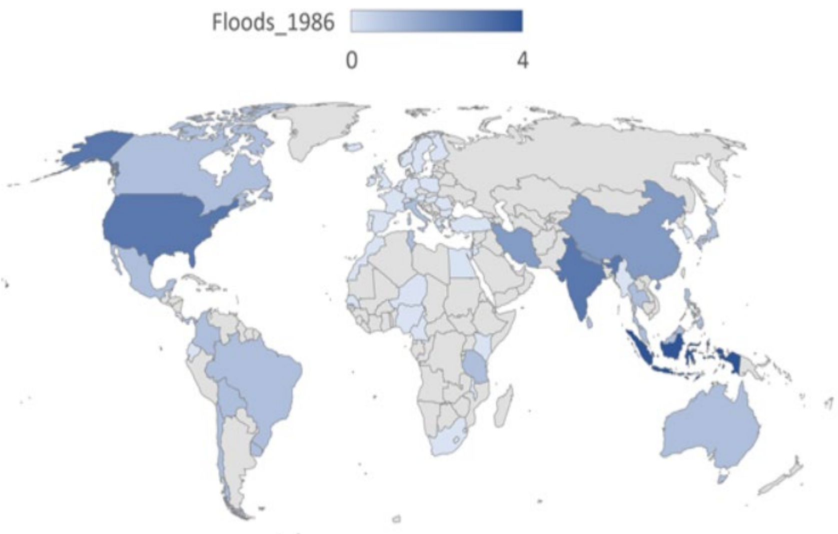


Figure 2.17. Evolution of floods in the top five countries most affected by them (cont.).

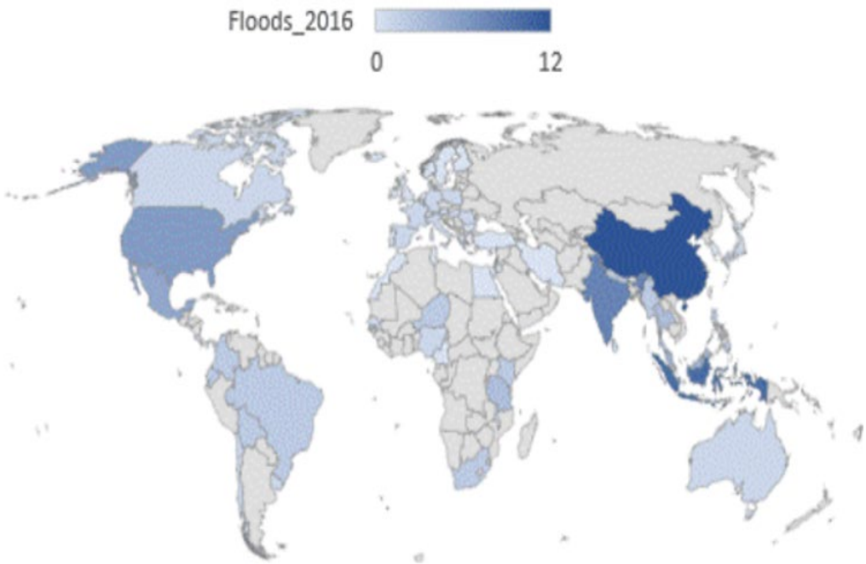


Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.5. Floods in 1986 and 2016



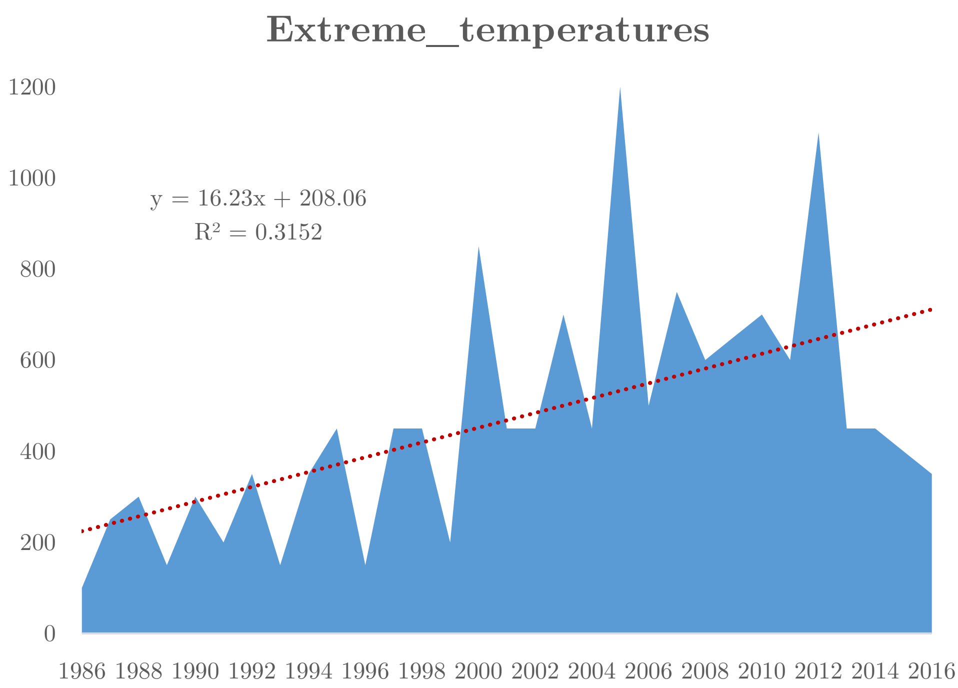
Map 2.5. Floods in 1986 and 2016 (cont.)



2.5.3. Extreme temperatures

According to the Sixth Assessment Report from the Intergovernmental Panel on Climate Change (UN, 2021), there has been a greater frequency and intensity of extreme heat since the 1950s and is widespread in all regions. Heat waves occur more frequently and for longer periods. This report shows that in many parts of the world, temperatures reach 40°C and even 50°C, threatening human health. Interestingly, cold snaps are not usually the focus when considering climate change, although some scientists think that the warming of the Arctic could be the cause of recent events of unusual magnitude (Cohen et al., 2021).

Figure 2.18. Evolution of episodes of extreme temperatures in the sample (67 countries)

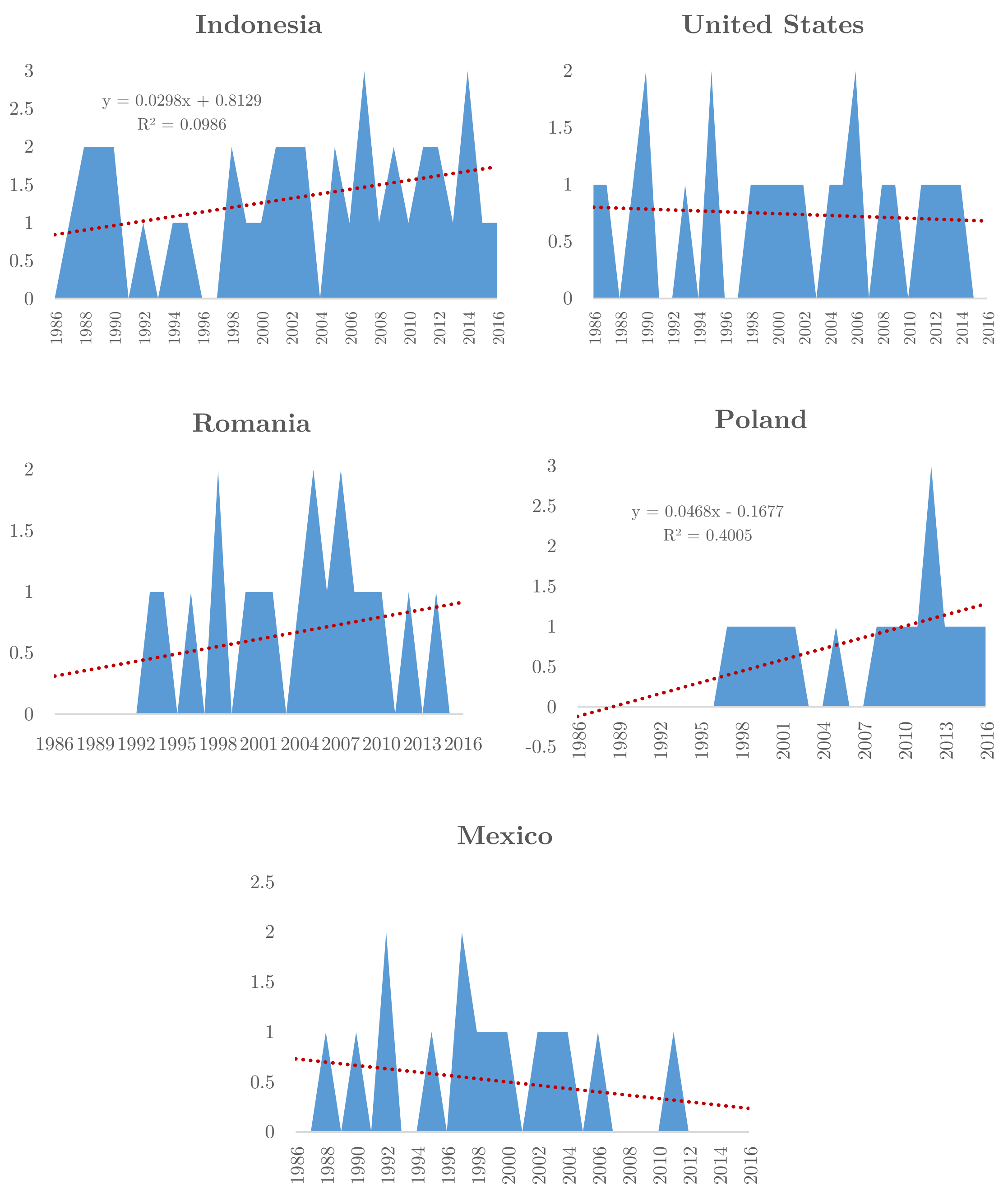


Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

The evolution of the episodes of extreme temperatures (heat and cold waves) can be seen in Figure 18. There is a clear positive trend (with "jumps"), which has been especially intense since 2000. On average, the estimated slope suggests that these events are five times more likely to happen at the end of the sample period than at the beginning. During the sample period, Indonesia, the United States, Romania, Poland, and Mexico are the most affected countries. Only Indonesia and Poland show a positive trend. In Map 6, things become clearer. For Japan, these phenomena predominated at the end of the period. According to

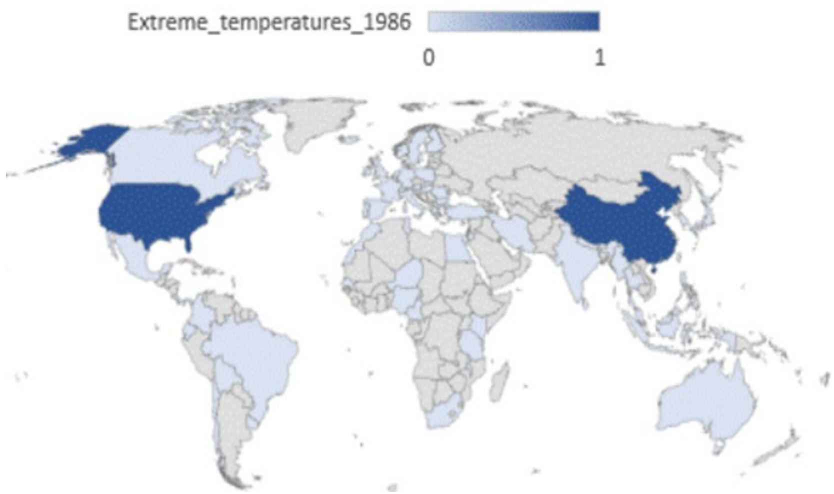
Figure 20, the extreme temperature event appeared for the first time in 2004, and since then, it has been maintained for most of the years, reaching a maximum of three episodes in 2015, thus showing a positive trend throughout the period.

Figure 2.19. Evolution of extreme temperature episodes in the top five countries affected by them



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.6. Extreme temperature events in 1986 and 2016.



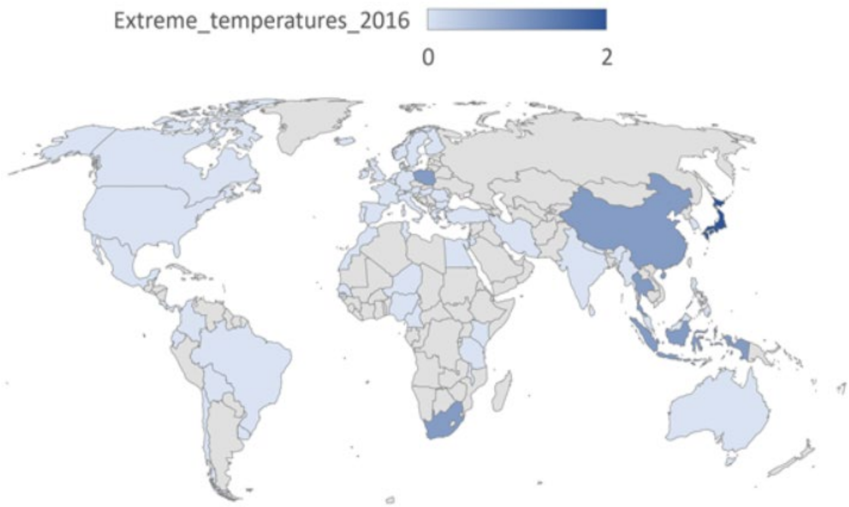
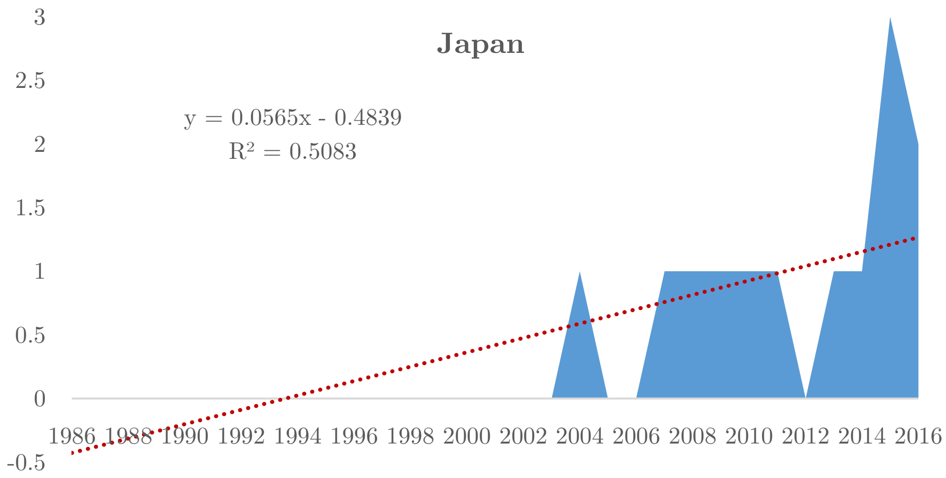


Figure 2.20. Evolution of episodes of extreme temperatures: Japan



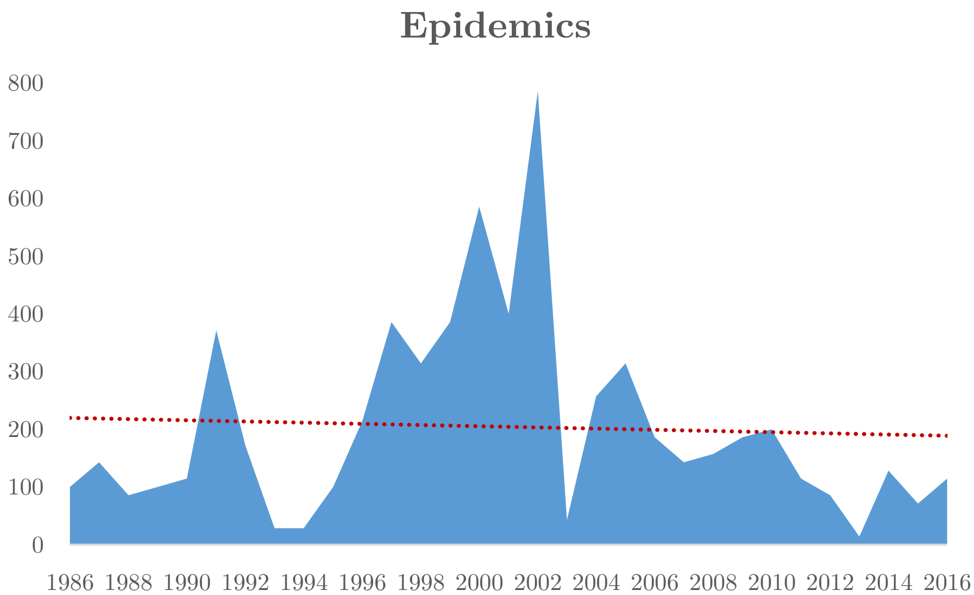
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

2.5.4 Epidemics

The increase in epidemics in some periods is also associated with climate change, for example, the recent episode of COVID-19. Scientists maintain (e.g., Thomas, 2020) that environmental factors (e.g., temperature and rainfall) affect the behavior of disease-causing organisms. The aforementioned environmental factors are, at the same time, greatly influenced by climate change. So, climate change could be related to the increased risk of diseases and their rapid spread.

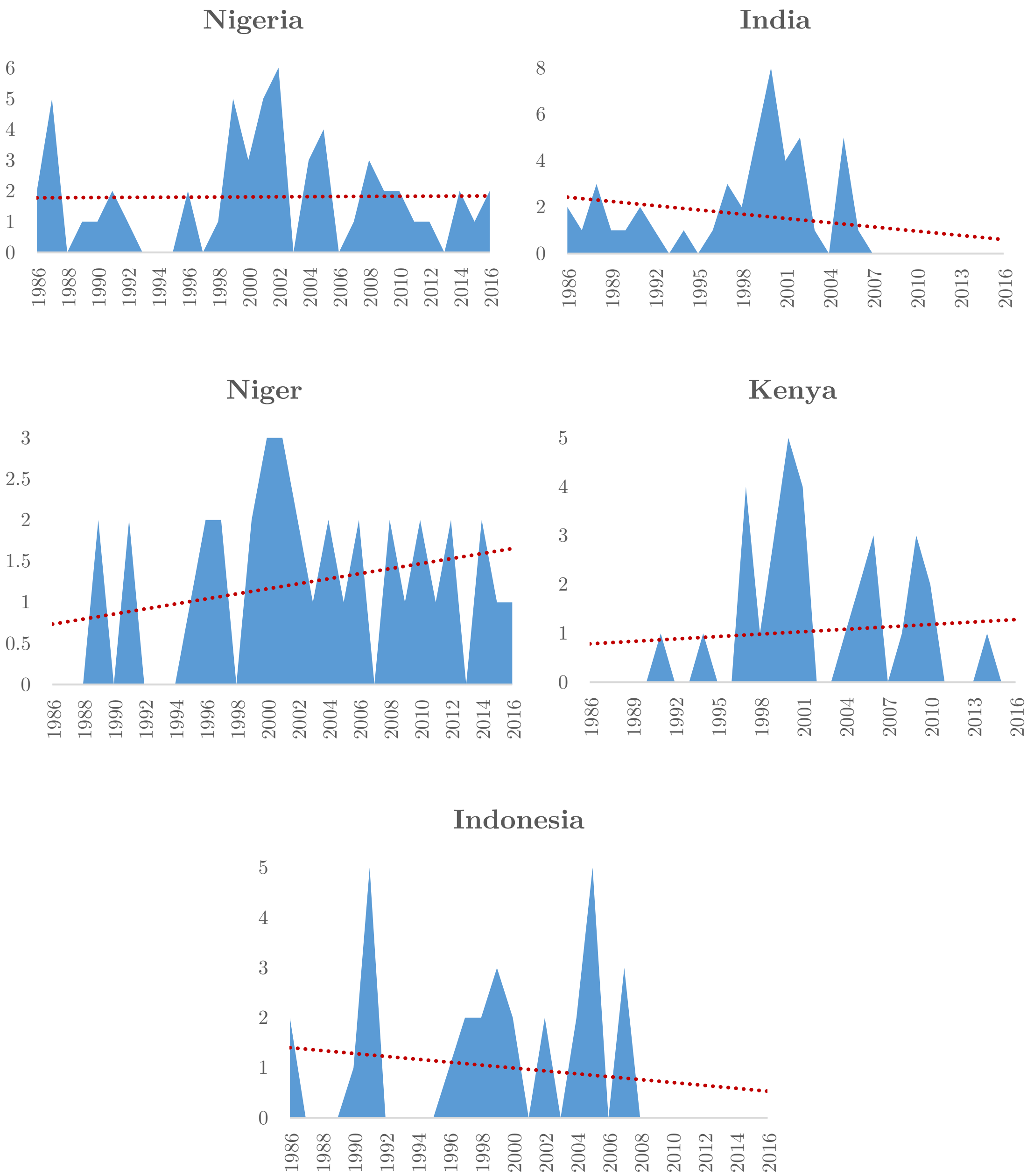
The evolution of epidemics is shown in Figure 21. A non-significant trend is detected. However, there is a clear increase in these events in the period 1994–2002, and since then, there is a clear negative trend. These episodes are mainly concentrated in Africa and Asia throughout the period, as the top five countries hail from these continents: Nigeria, India, Niger, Kenya and Indonesia (Figure 22). In these countries, these events occur in waves, and none of them displays a significant trend. However, as previously stated, what is important is whether the changes in the occurrence of these phenomena are a key variable for the explanation of international trade. However, Map 7 does not offer additional relevant information about this event.

Figure 2.21. Evolution of epidemics in the sample (67 countries).



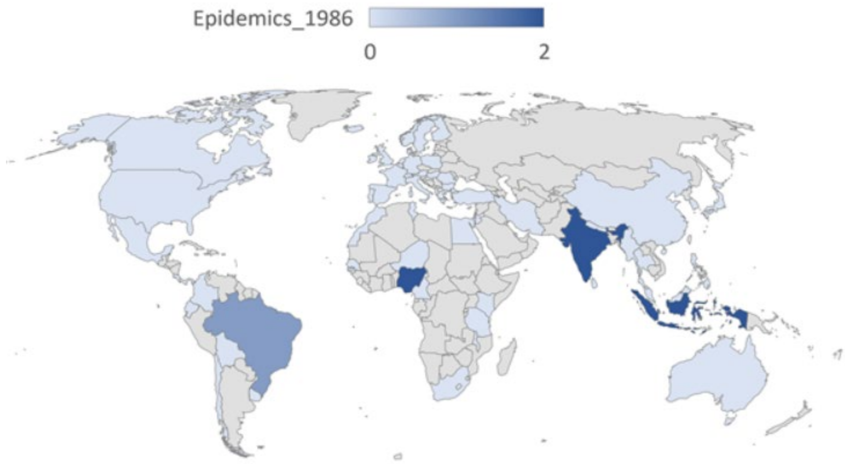
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

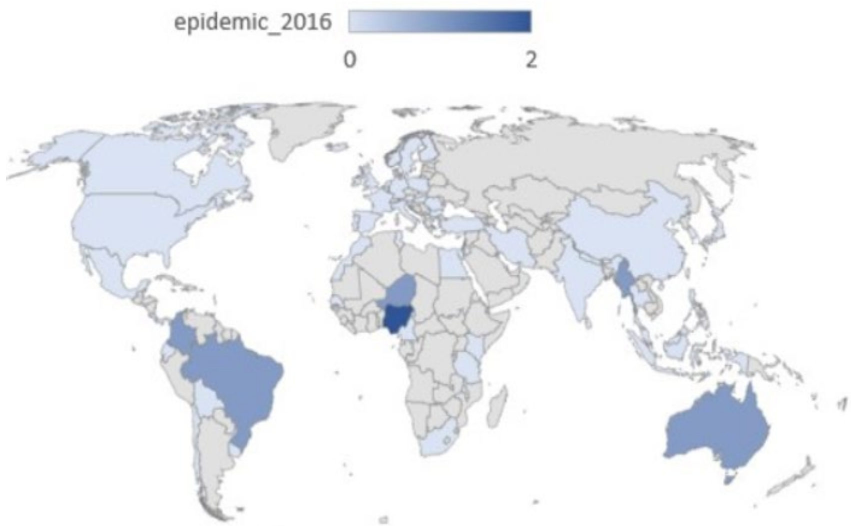
Figure 2.22. Evolution of the epidemics in the top five countries affected by them



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.7. Epidemics in 1986 and 2016





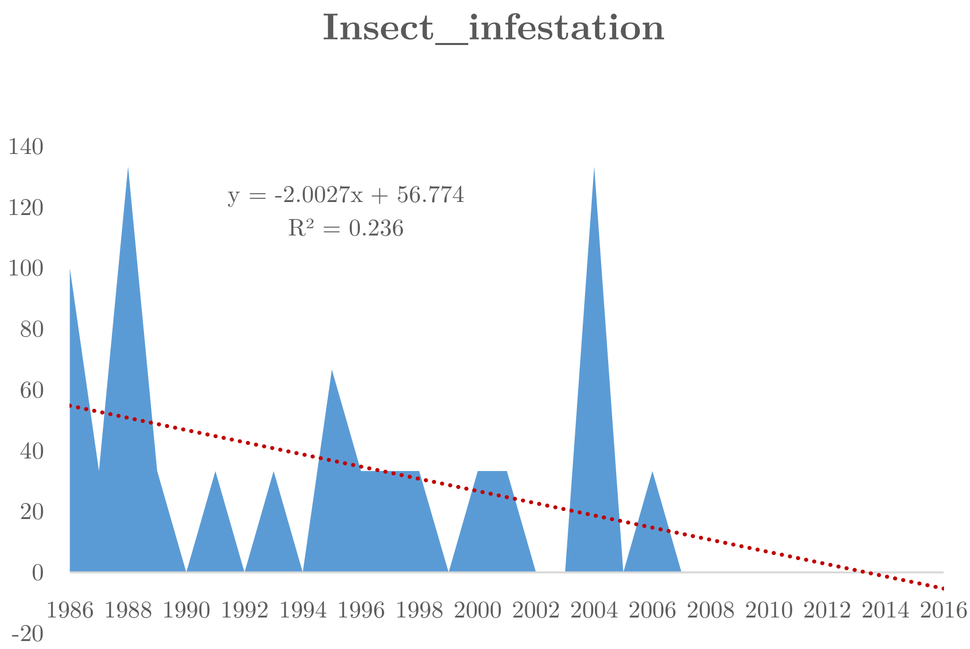
2.5.5 Insect infestation

Climate change can also affect the spread of pests because changing temperatures and rainfall are the main factors increasing insect populations and driving their geographic distribution, which affects the spread of diseases.

Furthermore, insects also threaten agriculture, creating the need for pest management strategies (Skendžić et al. 2021).

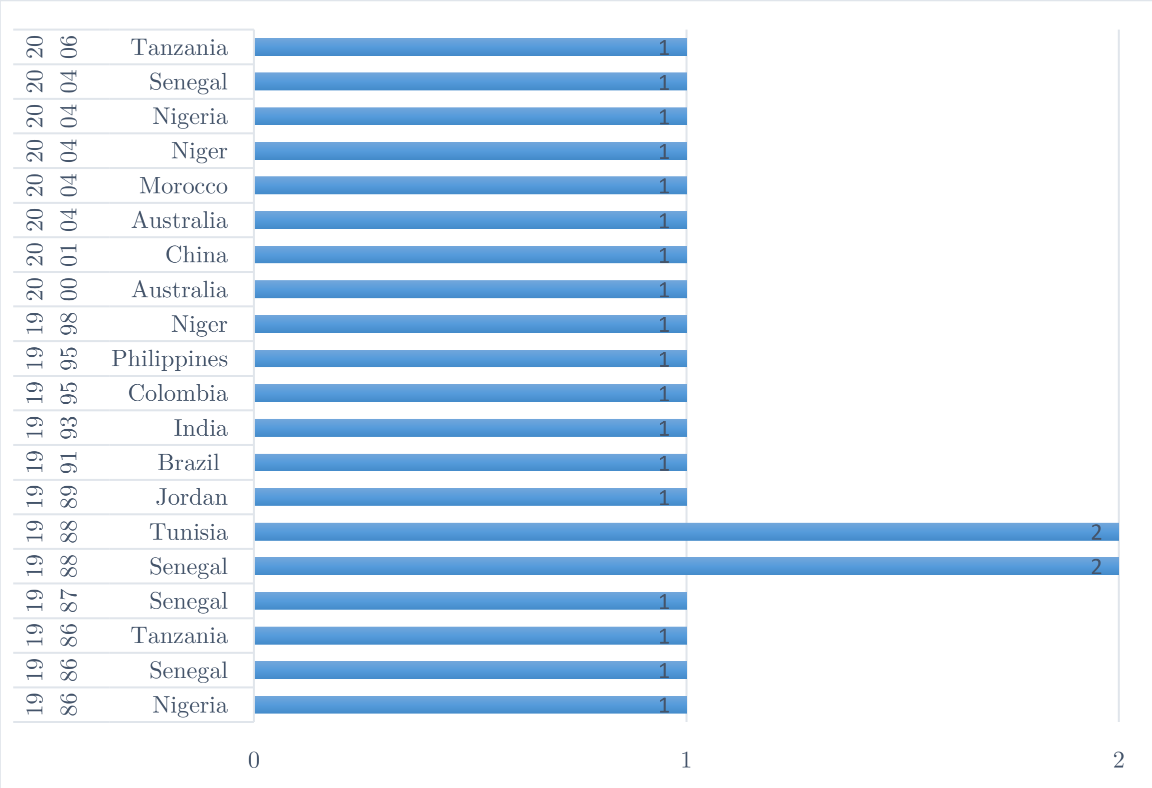
It seems that the data does not support the above concerns. The evolution of insect infestation in the sample has a negative trend (Figure 23) over time, although with some peaks in 1988, 1995, and 2004. After 2007, no episode of insect infestation was reported in the sample. In this case, I have presented all the data information in a graph (Figure 24) because the cases are rare and they are mainly concentrated in Africa Again, although the cases are few, their impact can be high.

Figure 2.23. Evolution of insect infestation in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.24. Cases of insect infestation in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

2.5.6 Storms

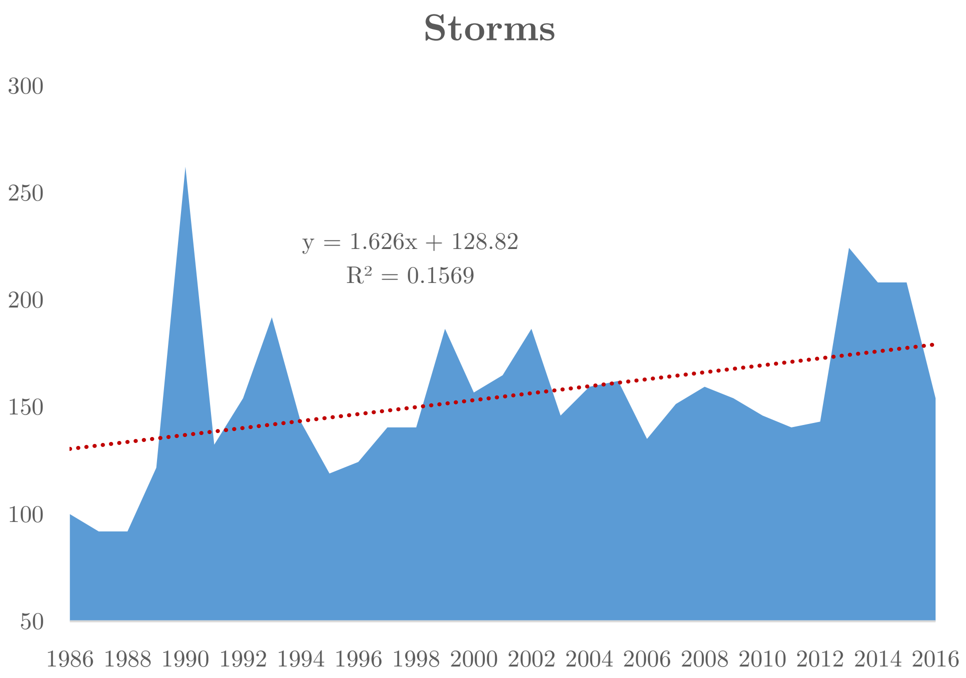
In the data source, the types of storms are tropical, extratropical, and convective. Global warming increases the probability of storms and floods: more evaporation leads to more humidity in the atmosphere, and rainfall intensifies. However, storms are more violent events that are exacerbated by warming oceans. In addition, climate change, due to increased evaporation, can lead to more intense rainfall due to storms.

The cause of a flood could also be a storm. As stated in the guidelines of the database, I distinguish between both phenomena (or other related ones) by classifying them as a "primary" or an "associated" event. Since I use annual data and the same climate conditions drive both phenomena, I must be aware of collinearity problems in the empirical analysis. In the database, the correlation coefficient between variables is close to 0.5.[3]

As shown in Figure 25, the linear trend in the number of storms is positive, as expected, although the adjustment is small due to the existence of "spikes." The most affected countries throughout the sample period (Figure 26) are the United States, China, the Philippines, India, and Japan. The trend is positive in China, the Philippines, and Japan. As with floods, the United States does not display a positive trend concerning storms. China is the country with the largest impact. Map 8 shows that storms are highly concentrated in the United States and China at the end of the period.

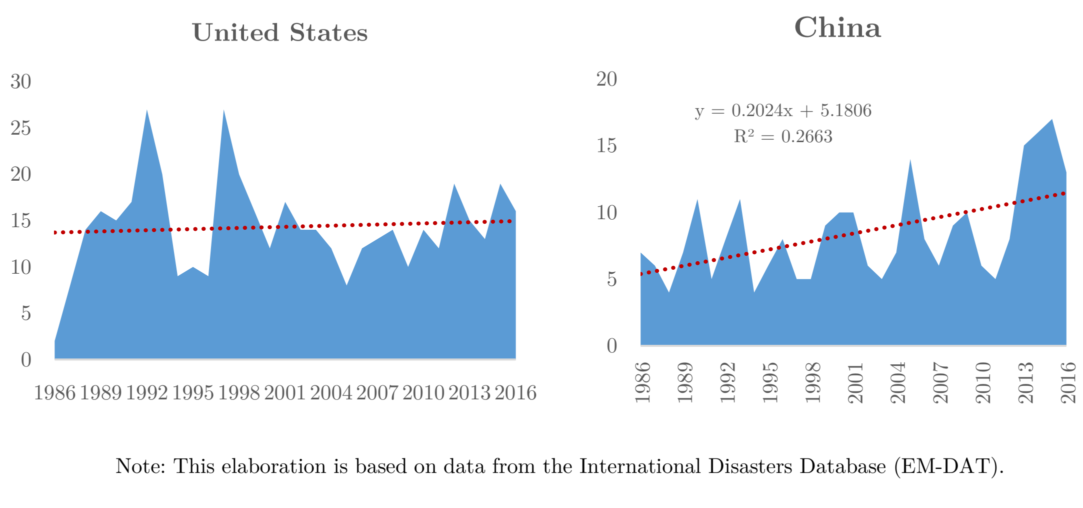
[3] However, in some cases, there are multicollinearity problems, as we will see.

FIGURE 2.25. Evolution of Storms in the sample (67 countries)



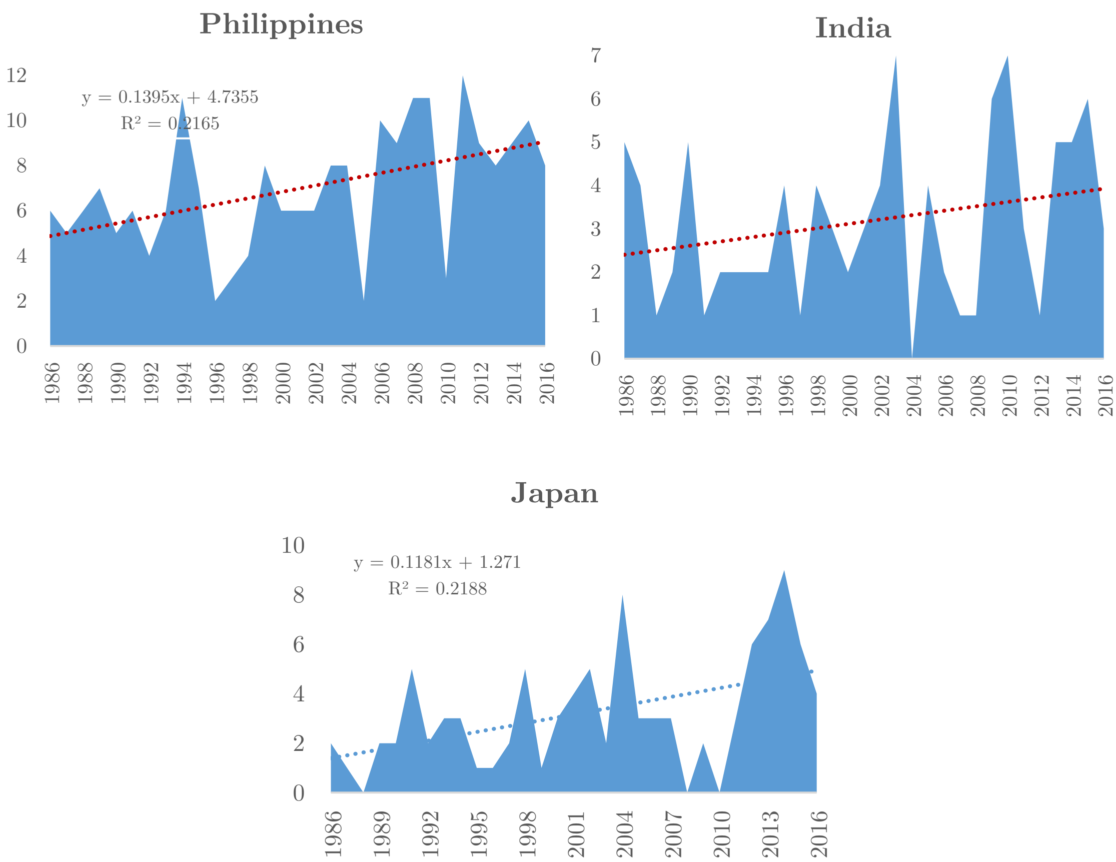
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.26. Evolution of storms in the top five countries affected by them.



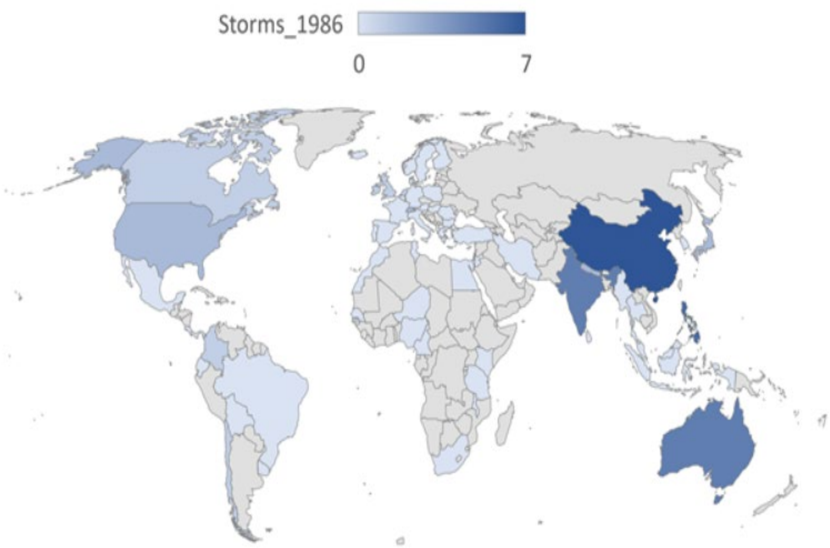
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.26. Evolution of storms in the top five countries affected by them.

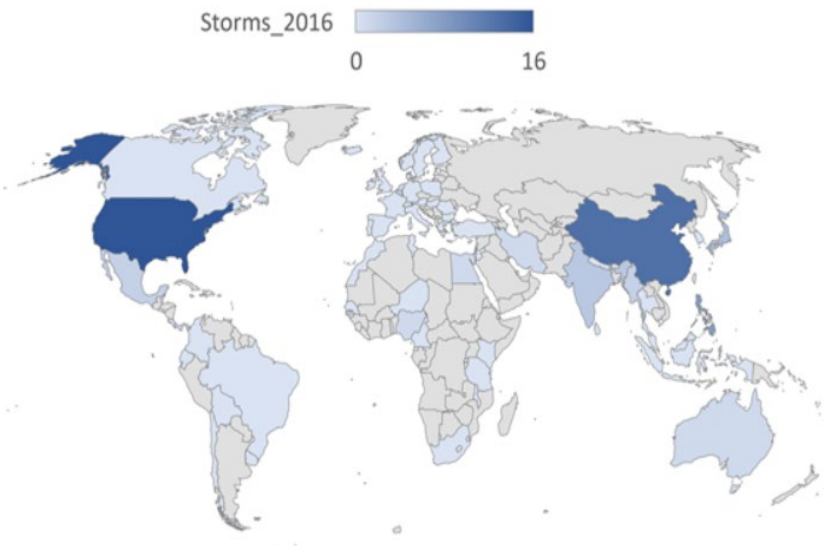


Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.8. Storms in 1986 and 2016



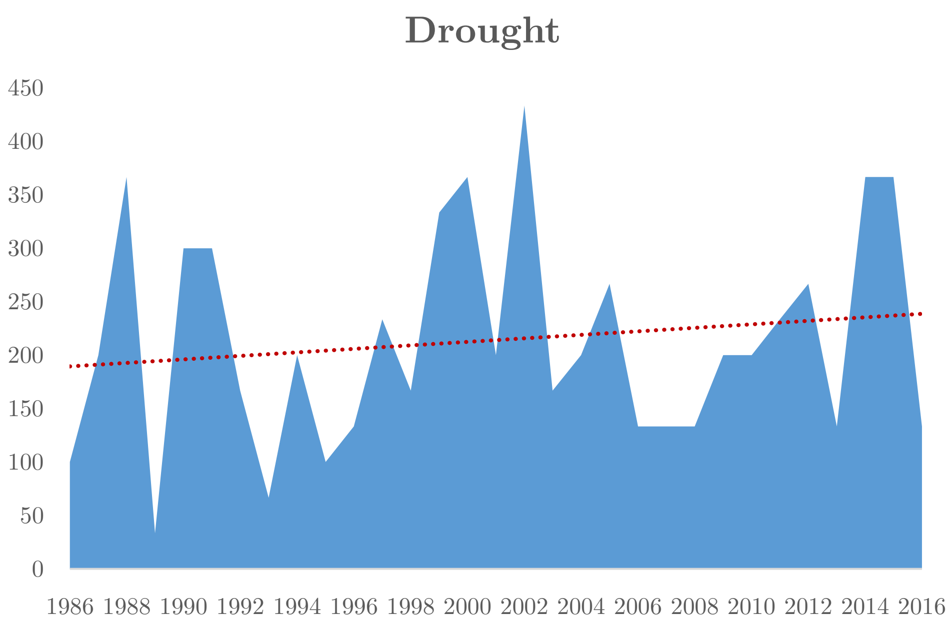
Map 2.8. Storms in 1986 and 2016 (cont.)



2.5.7 Droughts

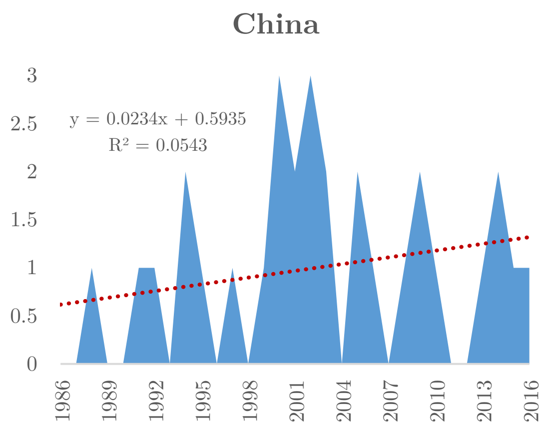
Global warming increases the risk of droughts. Due to the rise in temperatures, evaporation is enhanced, reducing surface water and drying out soils and vegetation. Paradoxically, this evaporation could cause higher humidity in other regions and turn into storms or floods. In the sample, there is no evidence of a positive trend in the number of such events over the sample period, although I observe numerous "spikes" (Figure 27). The countries most affected by these events are China, Brazil, Thailand, Malawi, and India (Figure 28). Only China and Thailand have positive trends. Map 9 does not provide additional relevant information.

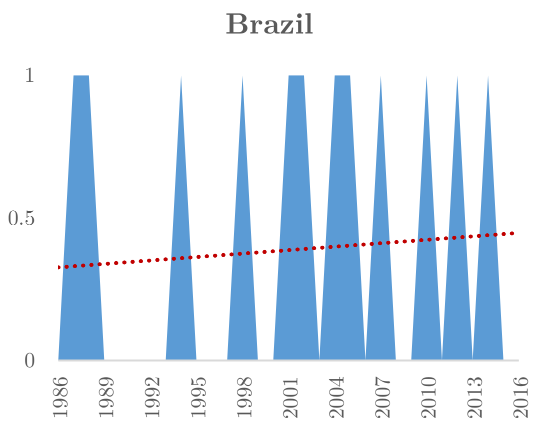
Figure 2.27. Evolution of droughts in the sample (67 countries)



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

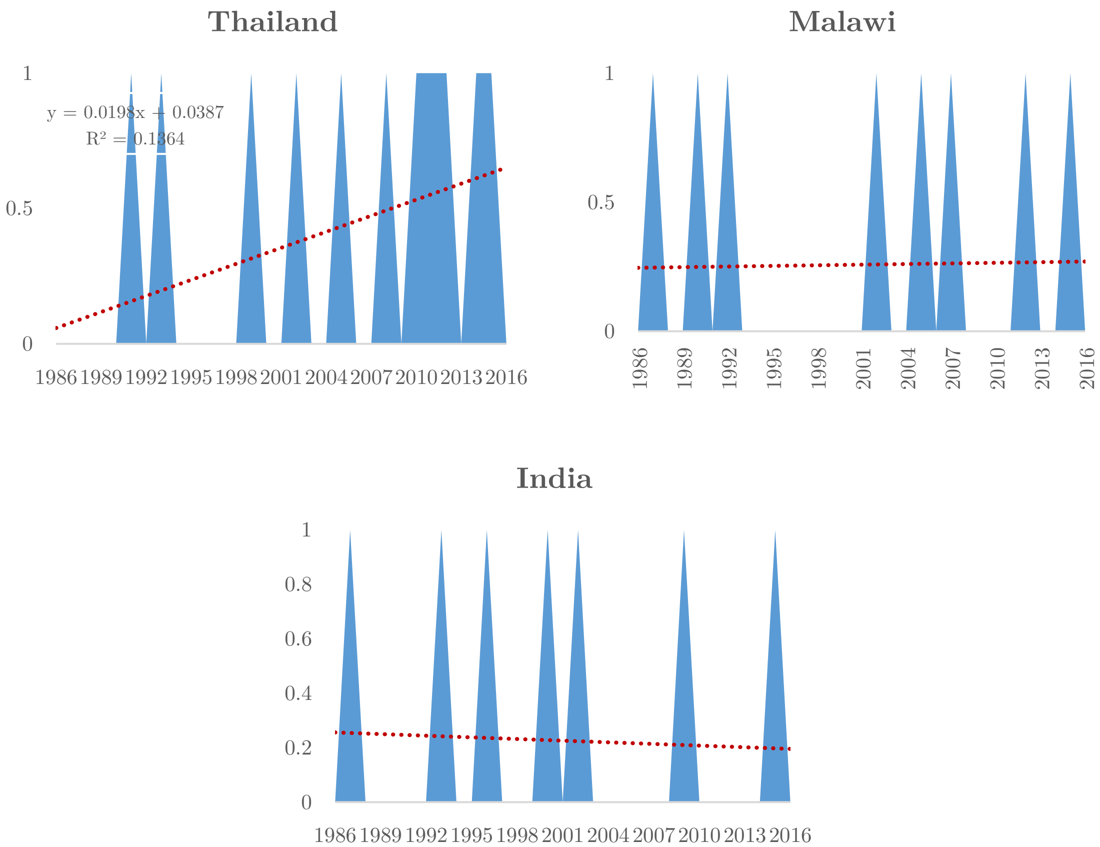
Figure 2.28. Evolution of droughts in the top five countries affected by them





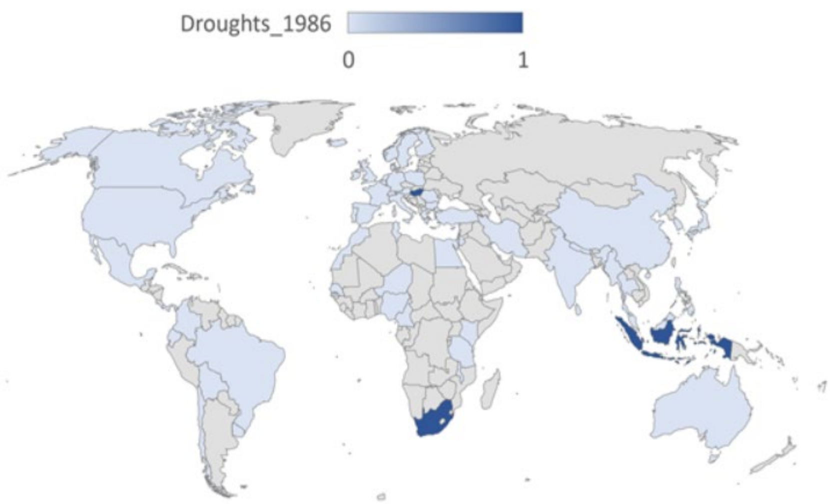
Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Figure 2.28. Evolution of droughts in the top five countries affected by them (cont.)

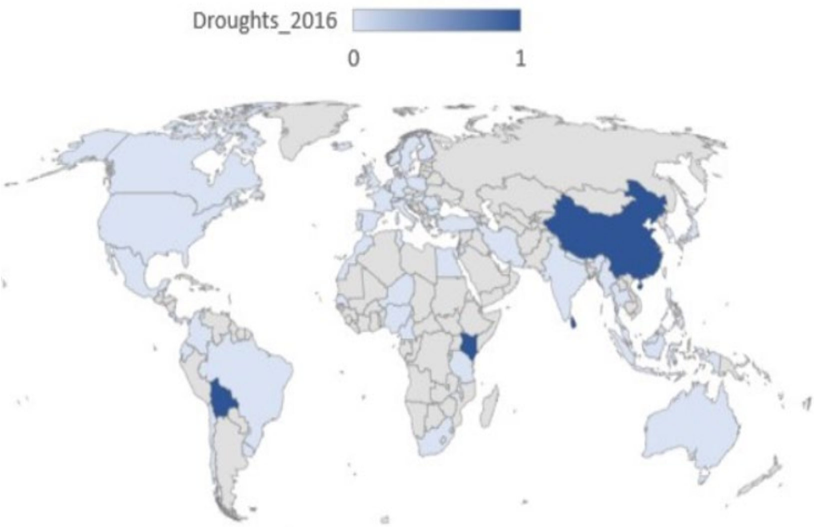


Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.9. Droughts in 1986 and 2016



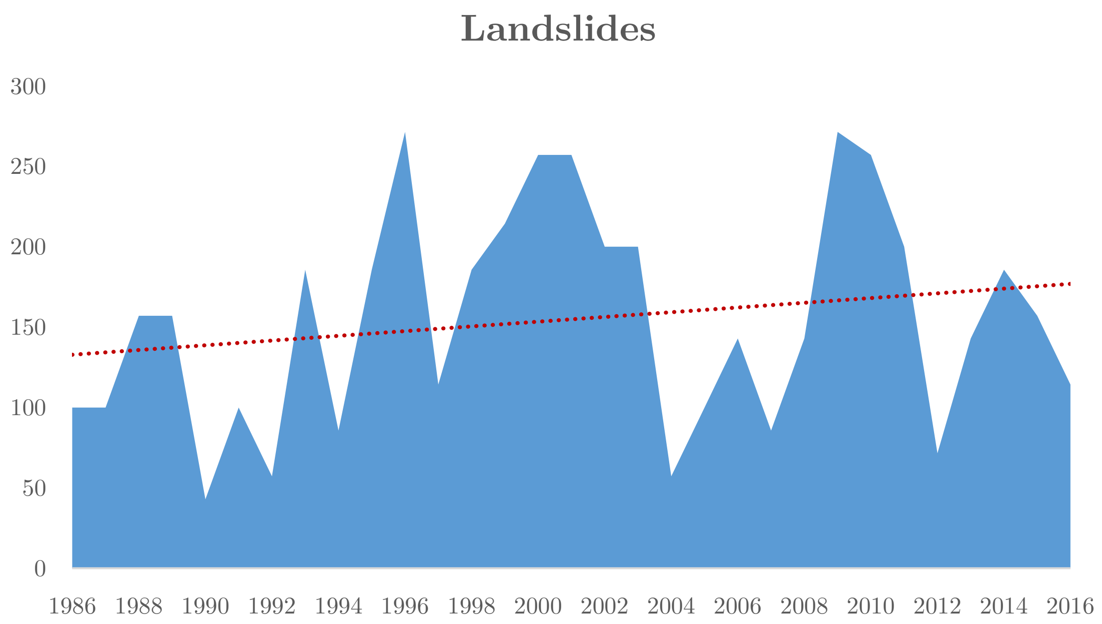
Map 2.9. Droughts in 1986 and 2016. (cont.)



2.5.8. Landslides

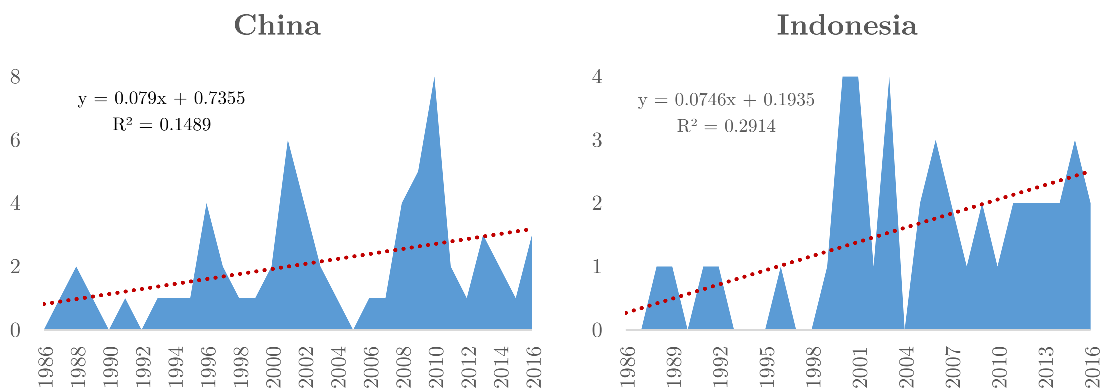
The combination of rising sea levels, recurring heavy rains, and more frequent droughts and wildfires increase the probability of landslides (Gariano and Guzzetti, 2016; Picarelli and Lacasse, 2021). In the sample, I cannot state that the number of landslides worldwide has increased significantly (Figure 29). However, this trend is positive (again) in China, an area with a robust increase in floods, storms, and droughts. This trend is also positive in Indonesia but not in India, Colombia, and the Philippines, the other countries with a high prevalence of landslides (Figure 30). Map 10 shows that these events are mainly concentrated in Asia, especially China.

Figure 2.29. Evolution of landslides in the sample (67 countries)



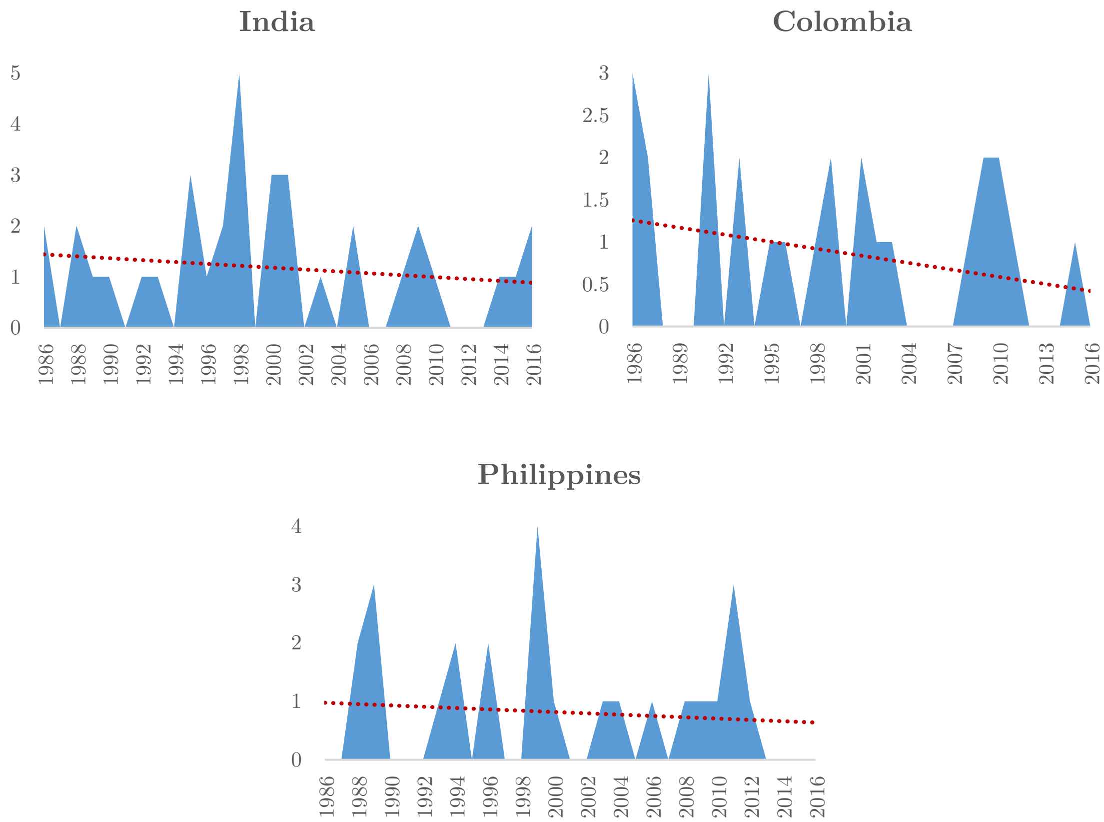
Note: This elaboration is based on data from the "International Disasters Database" (EM-DAT).

Figure 2.30. Evolution of landslides in the top five countries affected by them



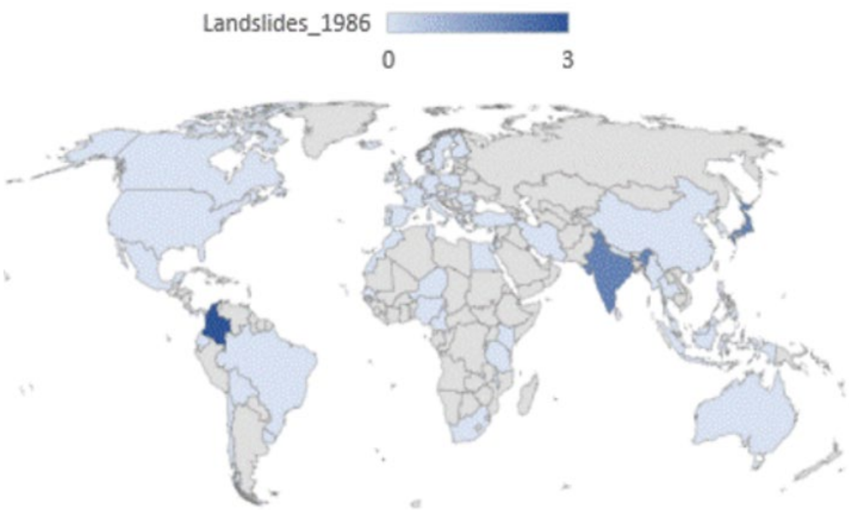
Note: This elaboration is based on data from the "International Disasters Database" (EM-DAT).

Figure 2.30. Evolution of landslides in the top five countries affected by them (cont.).

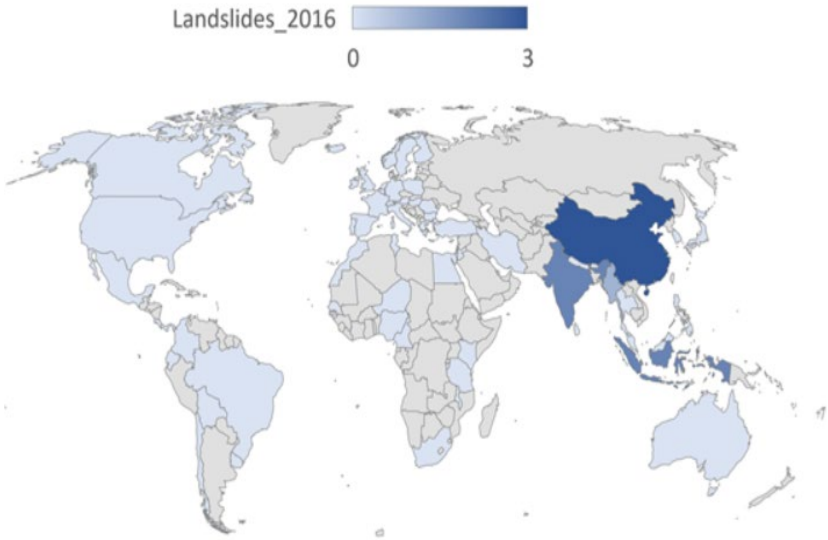


Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

Map 2.10. Landslides in 1986 and 2016



Map 2.10. Landslides in 1986 and 2016 (cont.)



2.6 Conclusions

In this chapter, I have performed an in-depth descriptive analysis of the sample data measuring climate change: rising temperatures and global warming–related disasters (i.e., wildfires, floods, extreme temperatures, epidemics, insect infestations, storms, droughts and landslides). To determine if the variables of interest reflect climate change, regression analysis has been carried out to see the relationship between CO_2 emissions and temperatures and meteorological (and biological) disasters, concluding that the variables of interest adequately represent this phenomenon. Subsequently, to carry out the in-depth analysis, I studied the evolution of these phenomena over time as a whole and by country, grouping them by continent to discern whether there has been a geographical bias in the occurrence of these climatic effects.

The results obtained, on average, suggest that the general increase in temperature in most countries is indisputable and that the impact in relative terms is concentrated in the countries of Northern Europe. Regarding extreme climate events, although the general evolution also reflects a strong increase in the number of cases, I cannot assess that they are generalized across countries or events. This study shows that floods and storms have been most common in Asia, most particularly China, the big exporter. In the next chapter, I examine what the consequences of these findings are through an econometric approach.

2.7 References

Cohen, J., Agel, L., Barlow, M., Garfinkel, C. and White, I. (2021). Linking Arctic variability and change with extreme winter climate in the United States. *Science*, 373(6559), pp. 1116–1121.

Cortès, M., Turco, M., Ward, P., Sánchez-Espigares, J. A., Alfieri, L. and Llasat, M. C. (2019). Changes in flood damage with global warming on the eastern coast of Spain. *Nat. Hazards Earth Syst. Sci.*, 19, pp. 2855–2877.

Dellink, R., Hwang, H., Lanzi, E. and Chateau, J. (2017). International trade consequences of climate change. OECD Trade and Environment Working Papers 2017/01.

Etheridge, D., Luhar, A., Loh, Z., Leuning, R., Spencer, D., Steele, P., Zegelin, S., Allison, C., Krummel, P., Leist, M., and van der Schoot, M. (2011): "Atmospheric monitoring of the CO2CRC Otway Project and lessons for large scale CO2 storage projects". *Energy Procedia*, 4, pp. 3666-3675.

Flannigan, M. D. Krawchuk, M. A., de Groot, W. J, B., Wotton. B. M. and Gowman, L. M. (2009). Implications of changing climate for global wildland fire. *International Journal of Wildland Fire*, 18(5), pp. 483–507.

Gariano, S. F. and Guzzetti, F. (2016). Landslides in a changing climate. *Earth-Science Reviews*, 162, pp. 227-252.

Krause, P., Boyle, D. P. and Base, F. (2005). Comparison of different efficiency criteria for hydrological model assessment. *Adv. Geosci.*, 5, pp. 89–97.

Lüthi, D., Le Floch, M.; Bereiter, B, Blunier, T, Barnola, J.-M., Siegenthaler, U., Raynaud, D., Jouzel, J., Fischer, H., Kawamura, K., Stocker, T. F. (2008). CO2 record from the EPICA Dome C 1999 (EDC99) ice core (Antarctica) covering 650 to 800 kyr BP measured at the University of Bern, Switzerland. PANGAEA. https://doi.org/10.1594/PANGAEA.710901. In supplement to: Lüthi, D et al. (2008): High-resolution carbon dioxide concentration record 650,000 - 800,000 years before present. *Nature*, 453, pp. 379-382, https://doi.org/10.1038/nature06949.

IPCC, 2013: Climate Change 2013. The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lacis, A. A., Schmidt, G. A., Rind, D., & Ruedy, R. A. (2010). Atmospheric CO2: Principal control knob governing Earth's temperature. *Science*, 330 (6002), 356–359.

Martínez-Zarzoso, I. (2018). Assessing the effectiveness of environmental provisions in regional trade agreements: An empirical analysis, OECD Trade and Environment Working Papers 2018/02.

Our World in Data. https://ourworldindata.org/

Picarelli, L., Lacasse, S. and Ho, K.K.S. (2021). The impact of climate change on landslide hazard and risk. In: Sassa, K., Mikoš, M., Sassa, S., Bobrowsky, P.T., Takara, K., Dang, K. (eds) Understanding and reducing landslide disaster risk. WLF 2020. ICL contribution to landslide disaster risk reduction. Springer, Cham. https://doi.org/10.1007/978-3-030-60196-6_6. "Sixth assessment report from the Intergovernmental Panel on Climate Change" (UN, 2021), available at https://www.un.org/en/climatechange.

Skendžić, S., Zovko, M., Živković, I. P., Lešić, V. and Lemić, D. (2021). The impact of climate change on agricultural insect pests, *Insects*, 12(5), p. 440.

Thomas M.B. (2020). Epidemics on the move: Climate change and infectious disease. *PLoS Biol*, 18(11). https://doi.org/10.1371/journal.pbio.3001013.

OECD (2017). OECD economic outlook, volume 2017 issue 2, available at https://www.oecd-ilibrary.org/economics/oecd-economic-outlook-volume-2017-issue-2_eco_outlook-v2017-2-en.

Van Hassel, H. (2017). Climate change and trade policy interaction: Implications of regionalism. OECD trade and environment working papers 2017/03.

World Bank (2010). World development report: Development and climate change. Washington, DC.

World Trade Organization (2021). Trading patterns: Global and regional perspectives. Available at https://www.wto.org/english/res_e/statis_e/wts2017_e/

WTO and UNEP report (2009). Trade and climate change. WTO Publications, Switzerland.

Yamaguchi, S. (2021). International trade and circular economy. Policy alignment. OECD Trade and Environment Working Papers 2021/02.

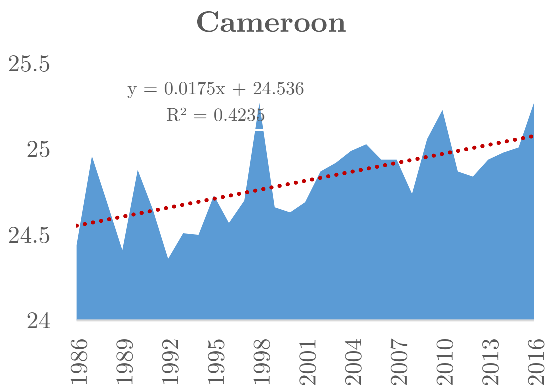
Yotov, Y.V., Piermartini, R., Monteiro, J. A. and Larch, M. (2016). An advanced guide to trade policy analysis: The structural gravity model. United Nations and World Trade Organization. http://vi.unctad.org/tpa/index.html.

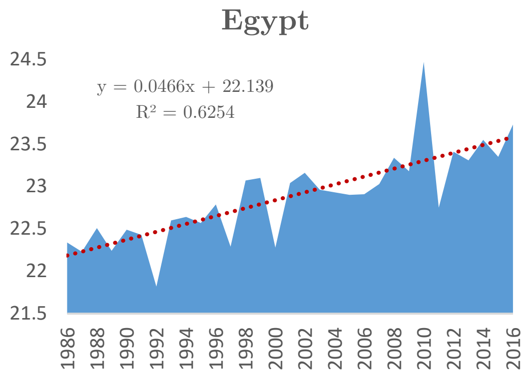
2.8 APPENDIX

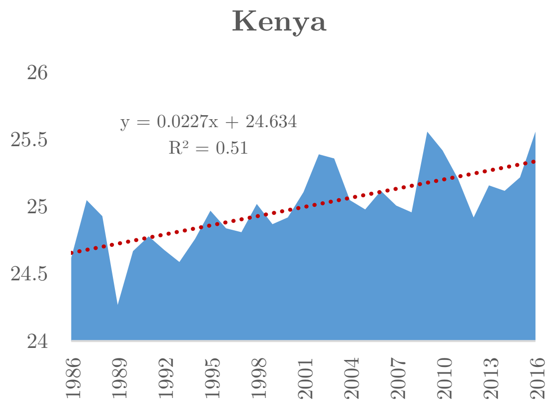
APPENDIX I

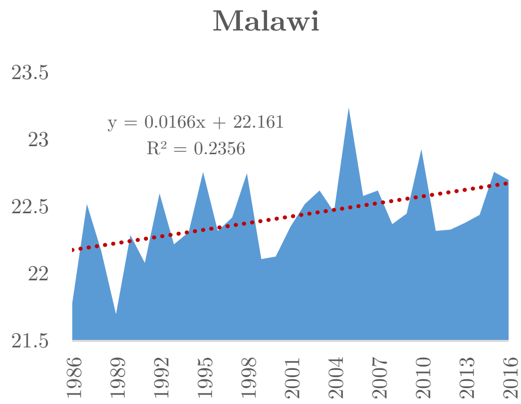
EVOLUTION OF TEMPERATURES

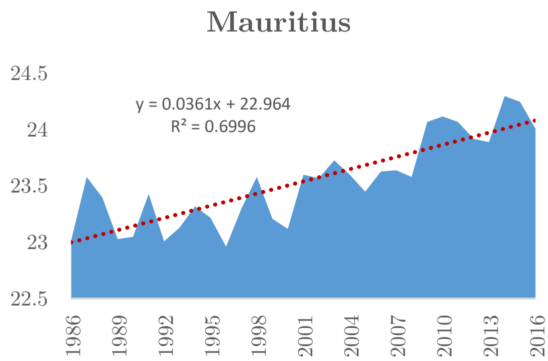
AFRICA

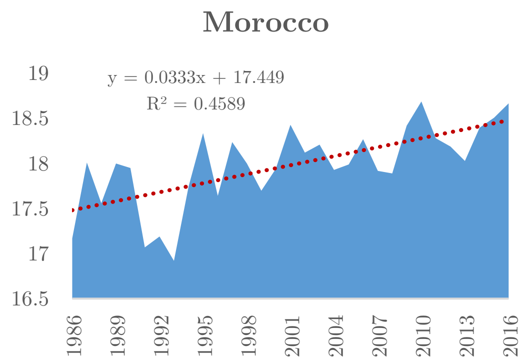

Cameroon
y = 0.0175x + 24.536
R^2 = 0.4235

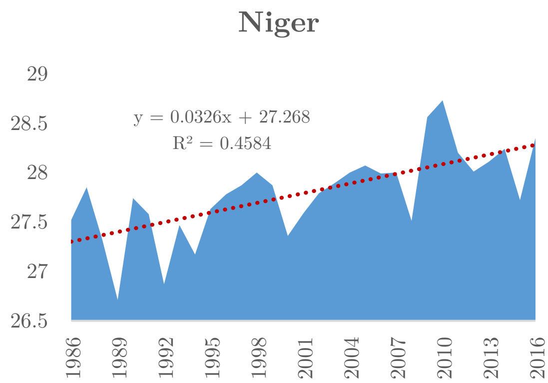

Egypt
y = 0.0466x + 22.139
R^2 = 0.6254

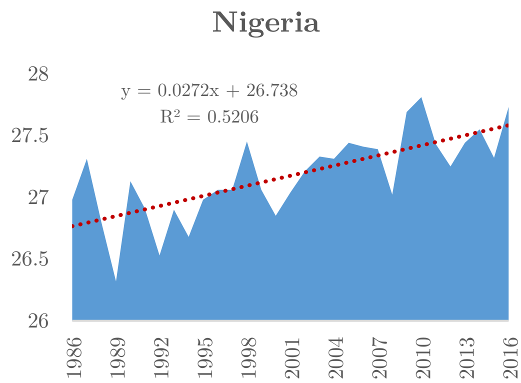

Kenya
y = 0.0227x + 24.634
R^2 = 0.51


Malawi
y = 0.0166x + 22.161
R^2 = 0.2356

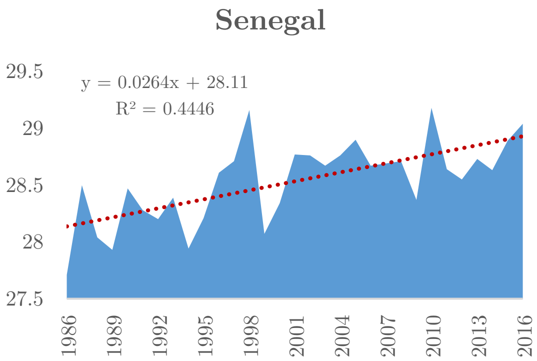

Mauritius
y = 0.0361x + 22.964
R^2 = 0.6996

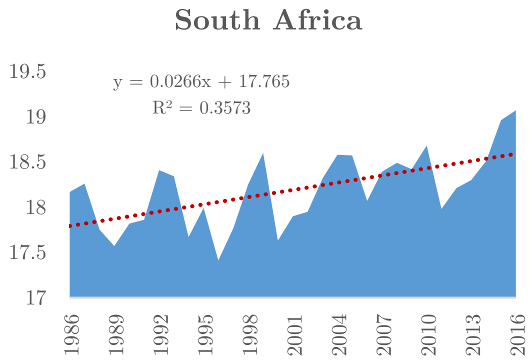

Morocco
y = 0.0333x + 17.449
R^2 = 0.4589

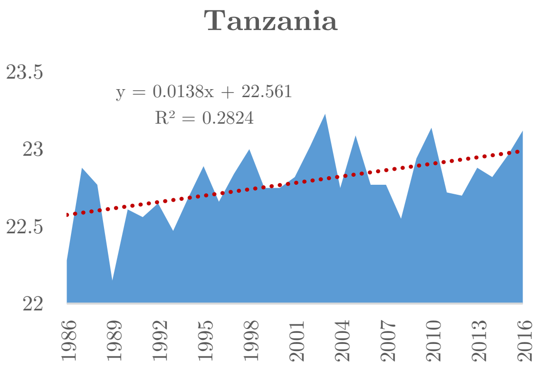

Niger
y = 0.0326x + 27.268
R^2 = 0.4584

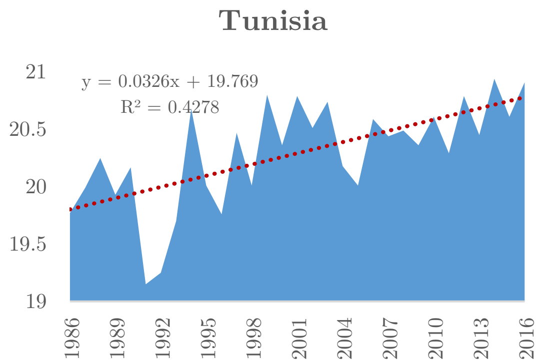

Nigeria
y = 0.0272x + 26.738
R^2 = 0.5206

AFRICA (cont.)

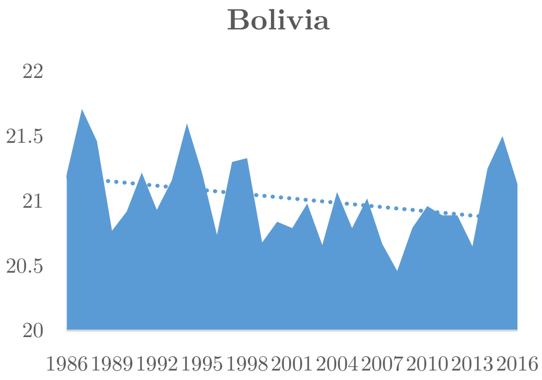

Senegal
y = 0.0264x + 28.11
R² = 0.4446
29.5
29
28.5
28
27.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

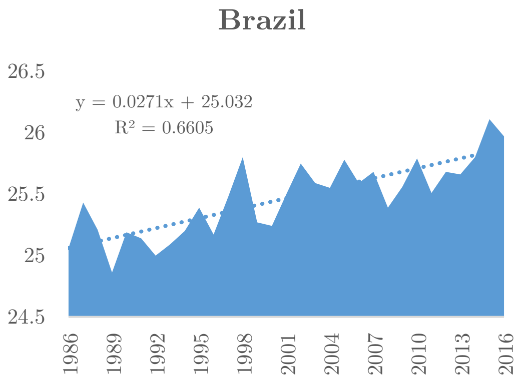

South Africa
y = 0.0266x + 17.765
R² = 0.3573
19.5
19
18.5
18
17.5
17
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

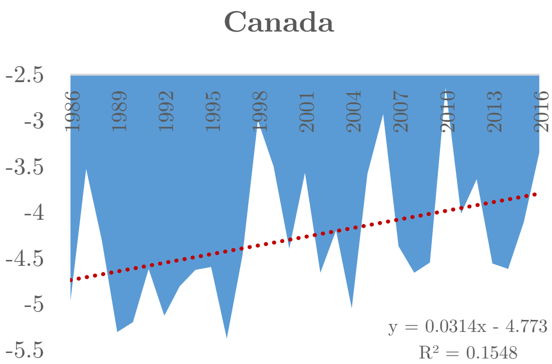

Tanzania
y = 0.0138x + 22.561
R² = 0.2824
23.5
23
22.5
22
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

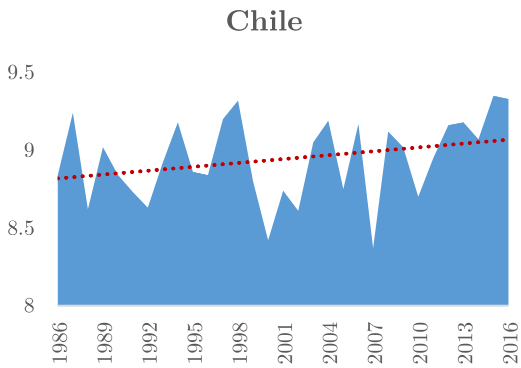

Tunisia
y = 0.0326x + 19.769
R² = 0.4278
21
20.5
20
19.5
19
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

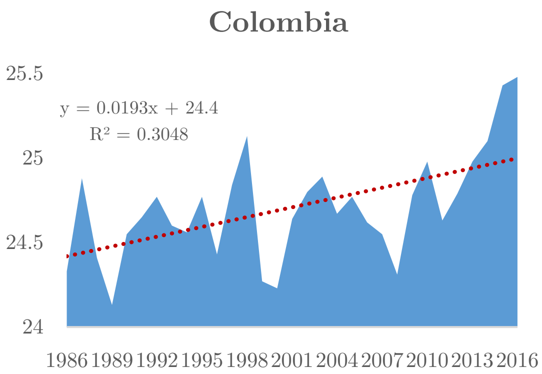
AMERICA

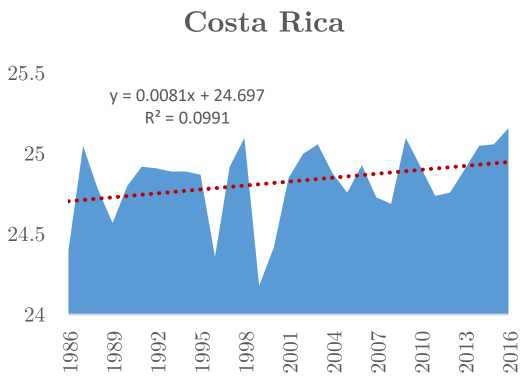

Bolivia

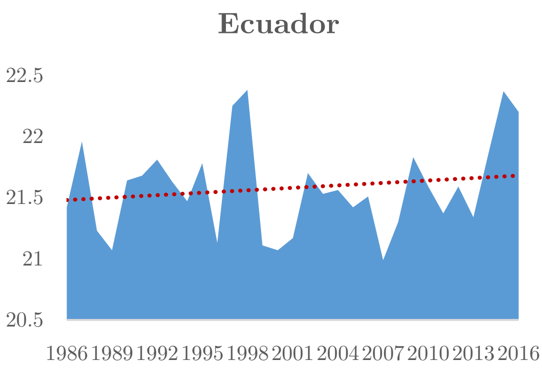

Brazil
y = 0.0271x + 25.032
R² = 0.6605

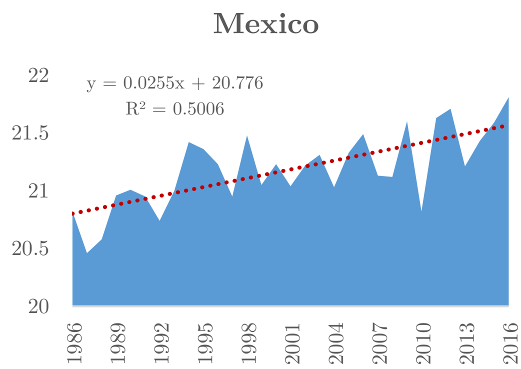

Canada
y = 0.0314x - 4.773
R² = 0.1548


Chile

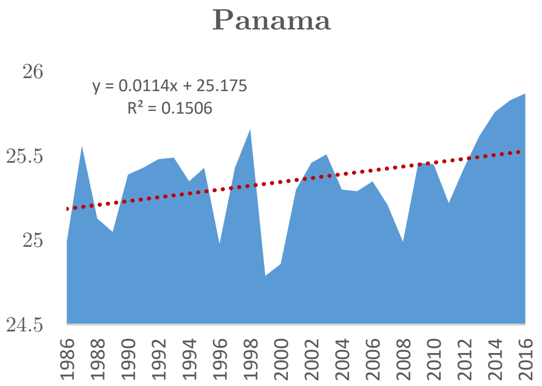

Colombia
y = 0.0193x + 24.4
R² = 0.3048

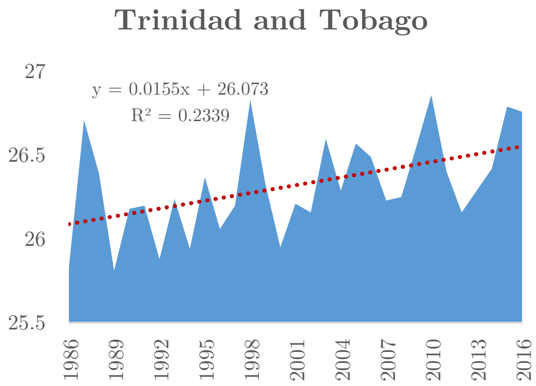

Costa Rica
y = 0.0081x + 24.697
R² = 0.0991

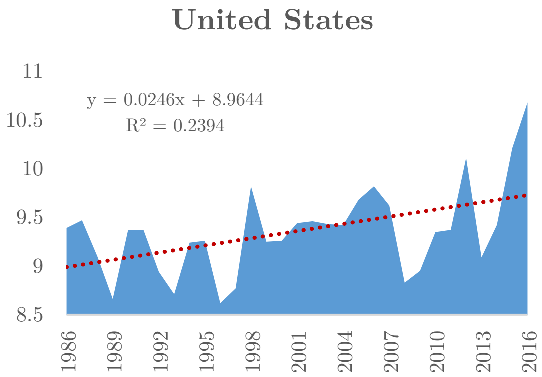

Ecuador

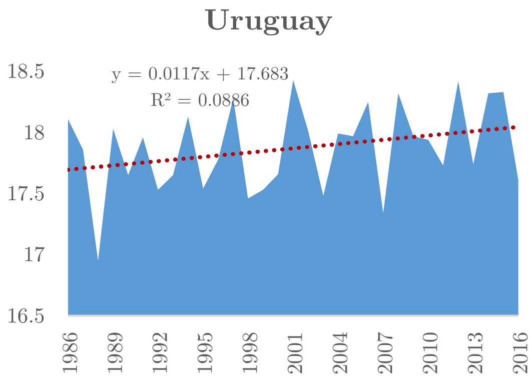

Mexico
y = 0.0255x + 20.776
R² = 0.5006

AMERICA (cont.)

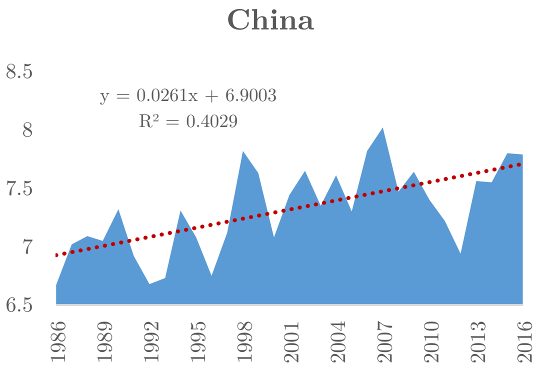


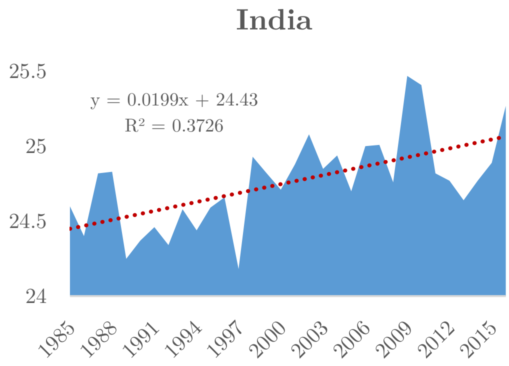


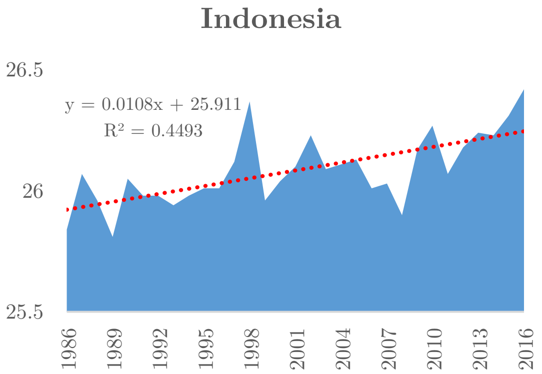


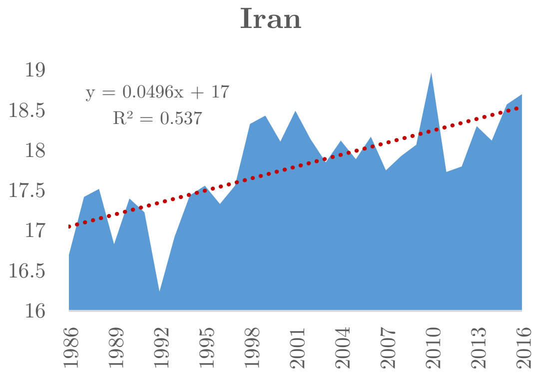


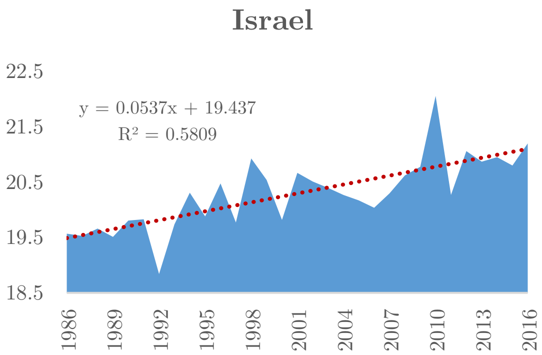
ASIA

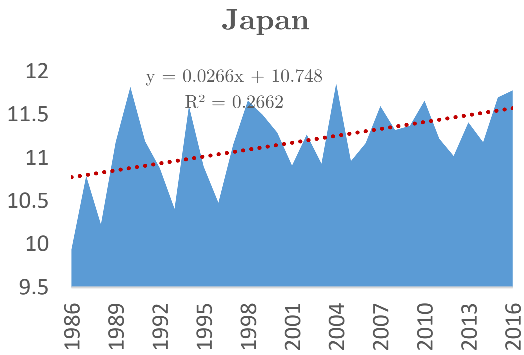

China
y = 0.0261x + 6.9003
R^2 = 0.4029
8.5
8
7.5
7
6.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

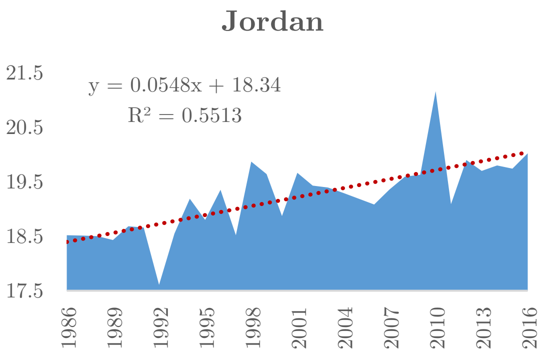

India
y = 0.0199x + 24.43
R^2 = 0.3726
25.5
25
24.5
24
1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015

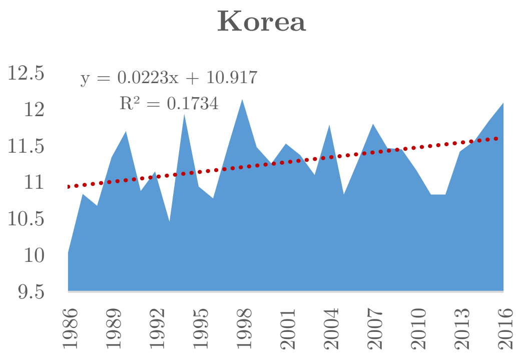

Indonesia
y = 0.0108x + 25.911
R^2 = 0.4493
26.5
26
25.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016


Iran
y = 0.0496x + 17
R^2 = 0.537
19
18.5
18
17.5
17
16.5
16
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

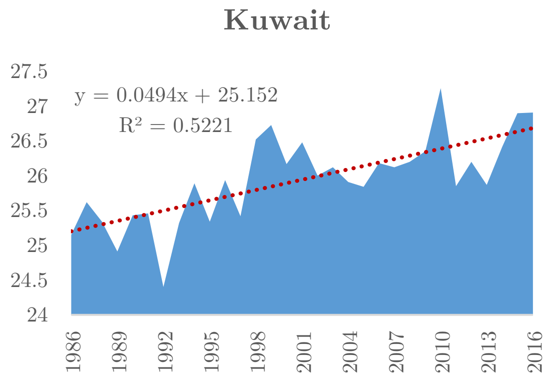

Israel
y = 0.0537x + 19.437
R^2 = 0.5809
22.5
21.5
20.5
19.5
18.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

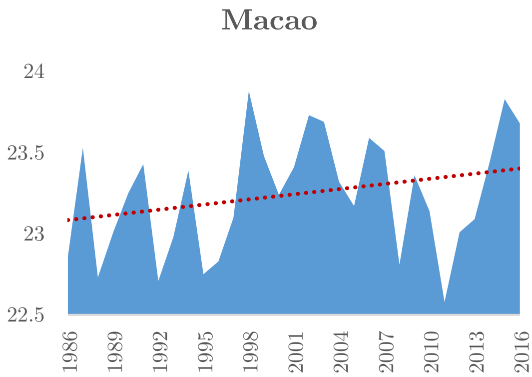

Japan
y = 0.0266x + 10.748
R^2 = 0.2662
12
11.5
11
10.5
10
9.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

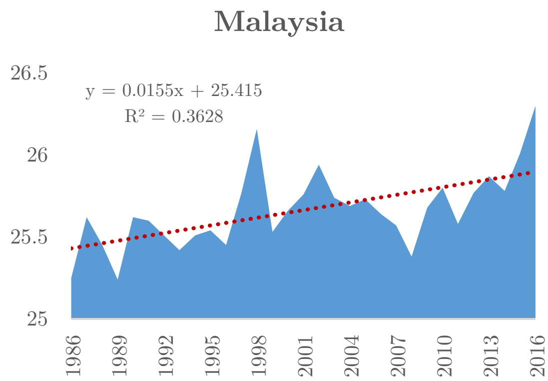

Jordan
y = 0.0548x + 18.34
R^2 = 0.5513
21.5
20.5
19.5
18.5
17.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

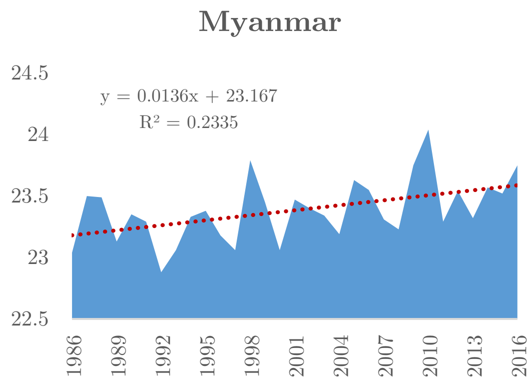

Korea
y = 0.0223x + 10.917
R^2 = 0.1734
12.5
12
11.5
11
10.5
10
9.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

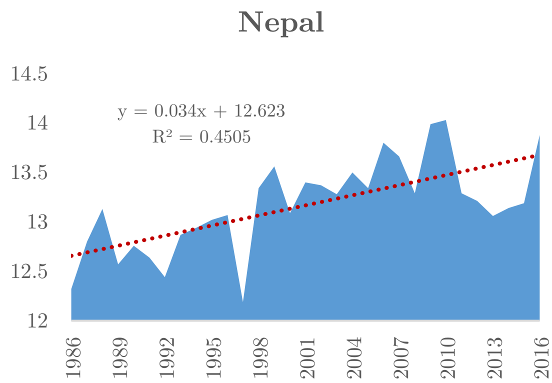
ASIA (cont.)

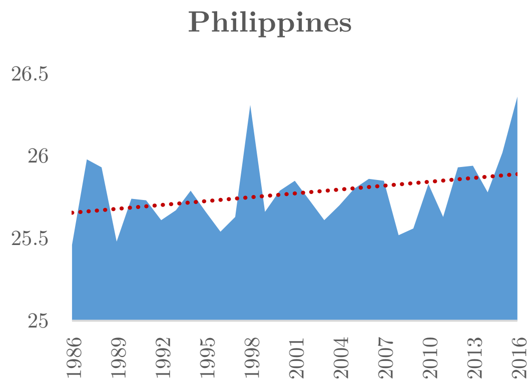

Kuwait
y = 0.0494x + 25.152
R² = 0.5221
27.5
27
26.5
26
25.5
25
24.5
24
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

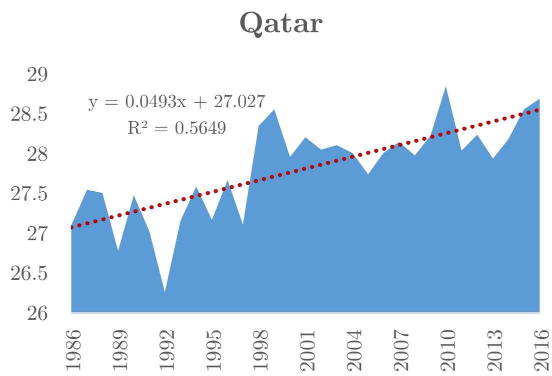

Macao
24
23.5
23
22.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

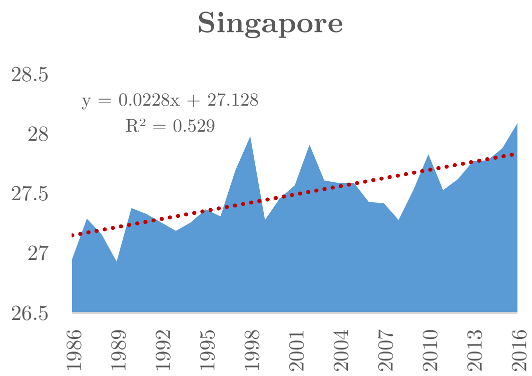

Malaysia
y = 0.0155x + 25.415
R² = 0.3628
26.5
26
25.5
25
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016


Myanmar
y = 0.0136x + 23.167
R² = 0.2335
24.5
24
23.5
23
22.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

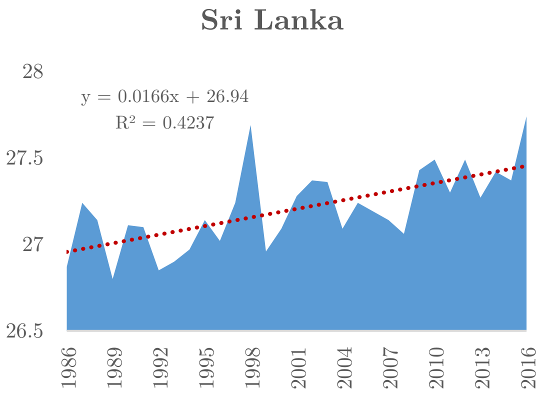

Nepal
y = 0.034x + 12.623
R² = 0.4505
14.5
14
13.5
13
12.5
12
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016


Philippines
26.5
26
25.5
25
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

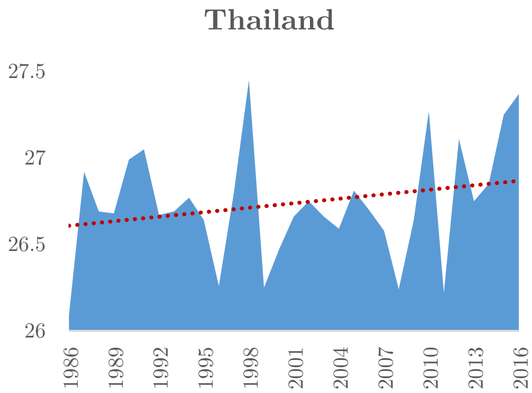

Qatar
y = 0.0493x + 27.027
R² = 0.5649
29
28.5
28
27.5
27
26.5
26
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016


Singapore
y = 0.0228x + 27.128
R² = 0.529
28.5
28
27.5
27
26.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

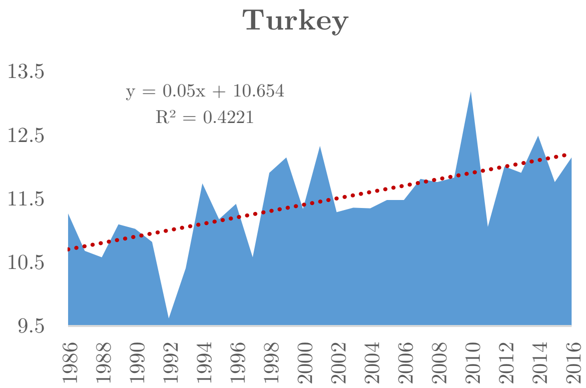
ASIA (cont.)



Sri Lanka
28
27.5
27
26.5
y = 0.0166x + 26.94
R² = 0.4237
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

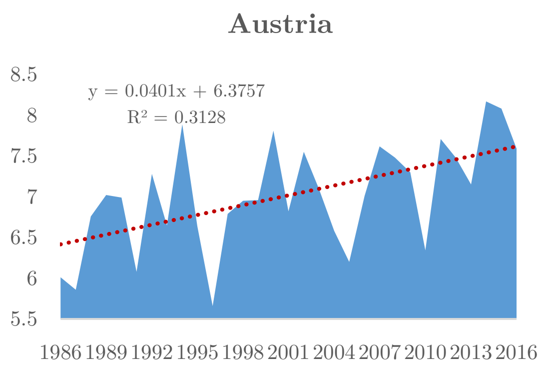


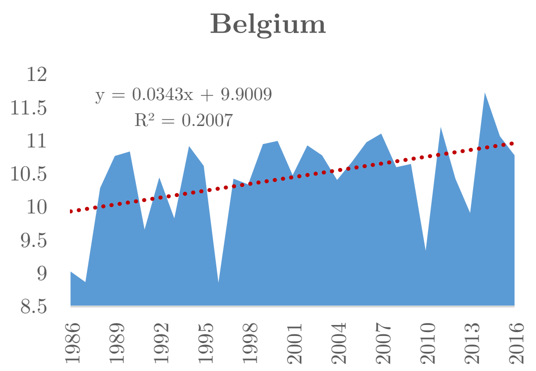
Thailand
27.5
27
26.5
26
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

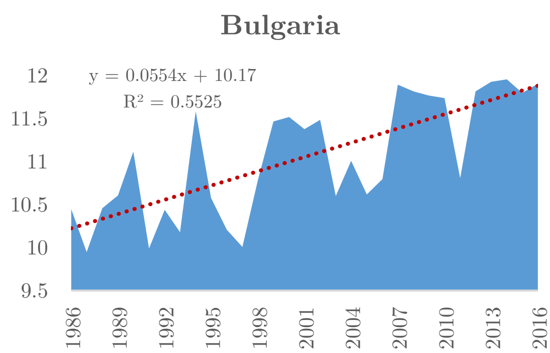


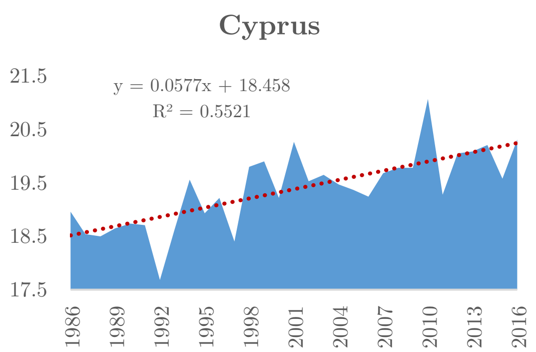
Turkey
13.5
12.5
11.5
10.5
9.5
y = 0.05x + 10.654
R² = 0.4221
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

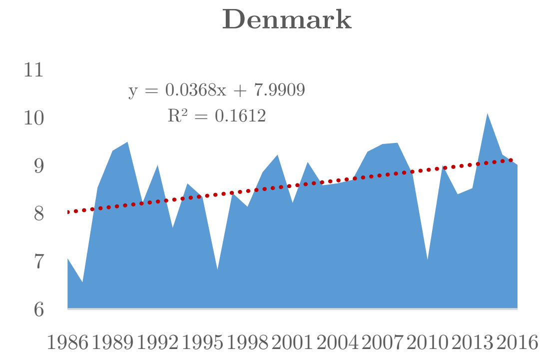
EUROPE

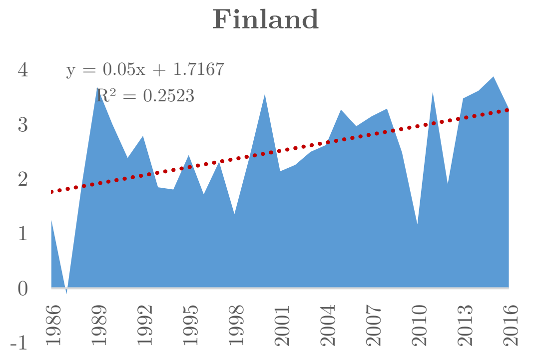

Austria
y = 0.0401x + 6.3757
R² = 0.3128
8.5 8 7.5 7 6.5 6 5.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

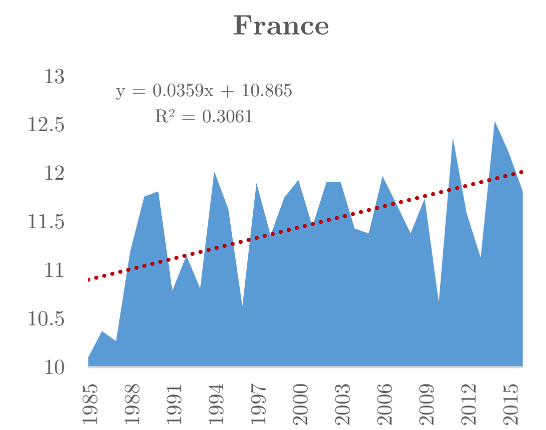

Belgium
y = 0.0343x + 9.9009
R² = 0.2007
12 11.5 11 10.5 10 9.5 9 8.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

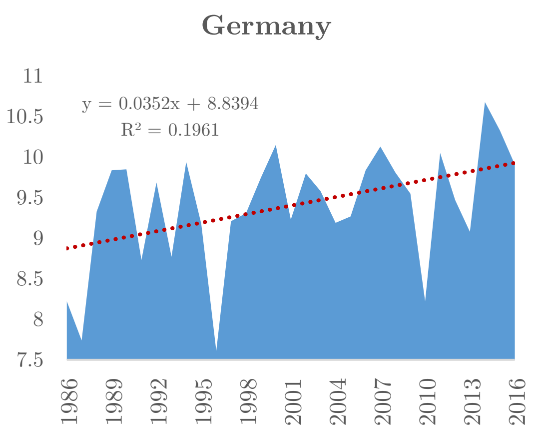

Bulgaria
y = 0.0554x + 10.17
R² = 0.5525
12 11.5 11 10.5 10 9.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016


Cyprus
y = 0.0577x + 18.458
R² = 0.5521
21.5 20.5 19.5 18.5 17.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

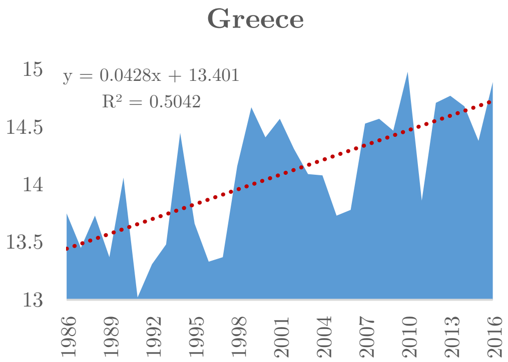

Denmark
y = 0.0368x + 7.9909
R² = 0.1612
11 10 9 8 7 6
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

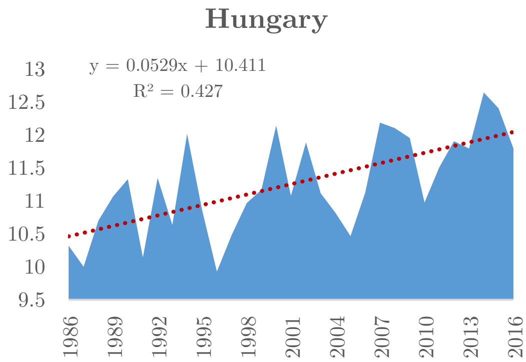

Finland
y = 0.05x + 1.7167
R² = 0.2523
4 3 2 1 0 -1
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

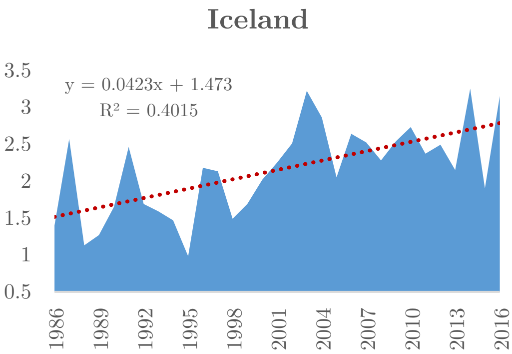

France
y = 0.0359x + 10.865
R² = 0.3061
13 12.5 12 11.5 11 10.5 10
1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015

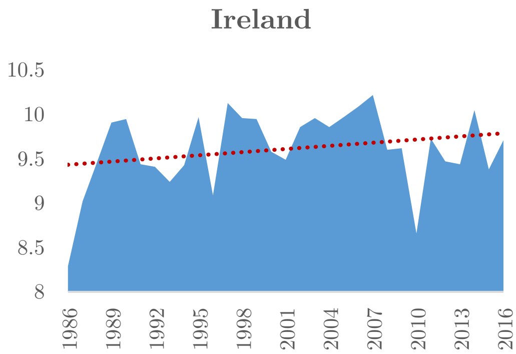

Germany
y = 0.0352x + 8.8394
R² = 0.1961
11 10.5 10 9.5 9 8.5 8 7.5
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016

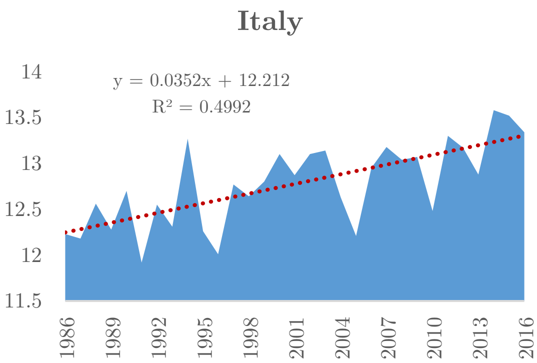
EUROPE (cont.)

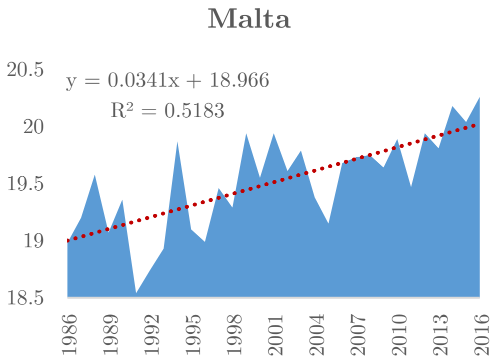

Greece
y = 0.0428x + 13.401
R² = 0.5042

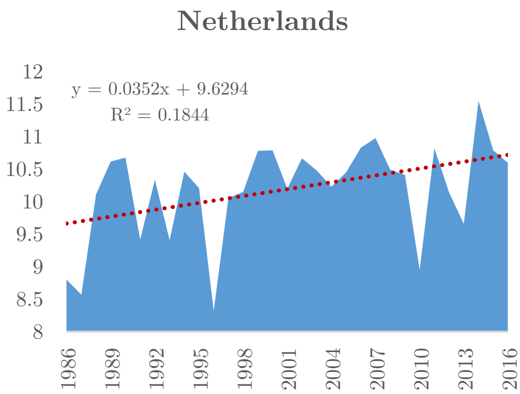

Hungary
y = 0.0529x + 10.411
R² = 0.427

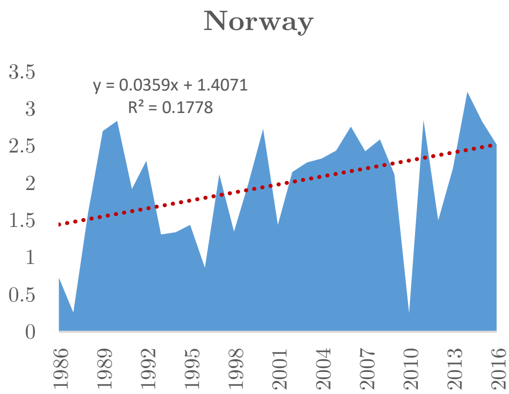

Iceland
y = 0.0423x + 1.473
R² = 0.4015


Ireland

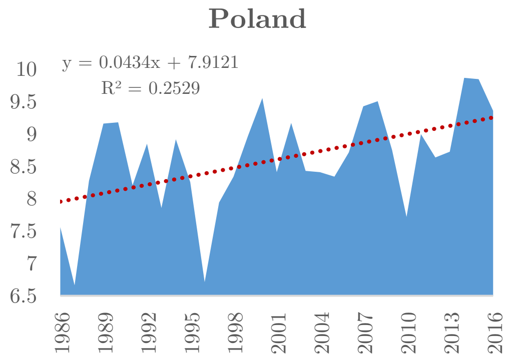

Italy
y = 0.0352x + 12.212
R² = 0.4992

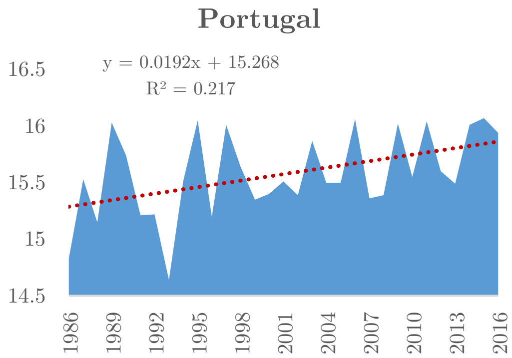

Malta
y = 0.0341x + 18.966
R² = 0.5183

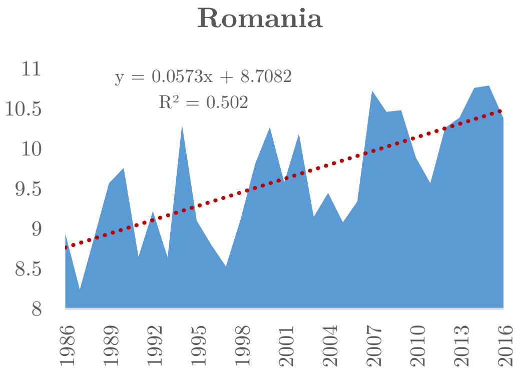

Netherlands
y = 0.0352x + 9.6294
R² = 0.1844

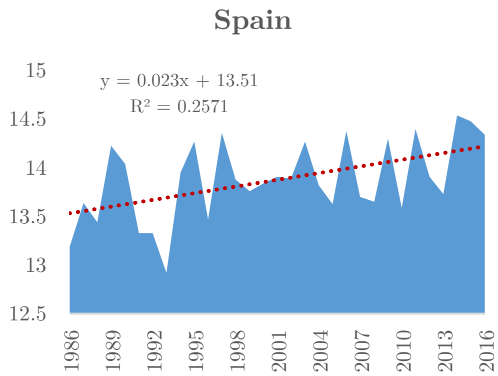

Norway
y = 0.0359x + 1.4071
R² = 0.1778

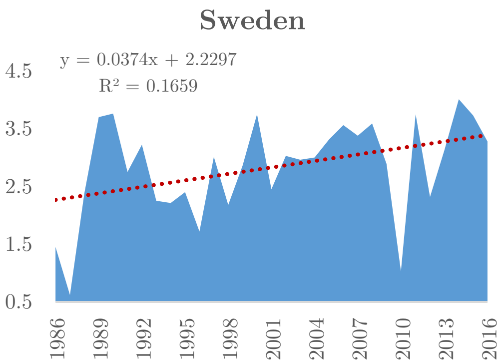
EUROPE (cont.)

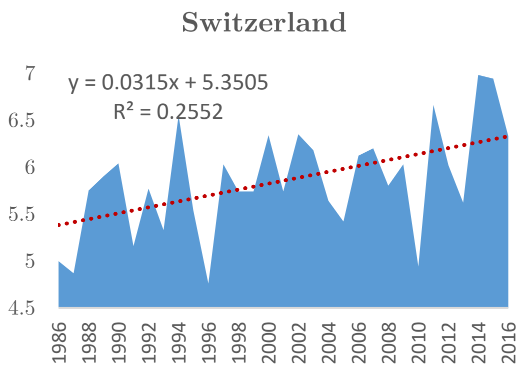

Poland
y = 0.0434x + 7.9121
R² = 0.2529
10
9.5
9
8.5
8
7.5
7
6.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

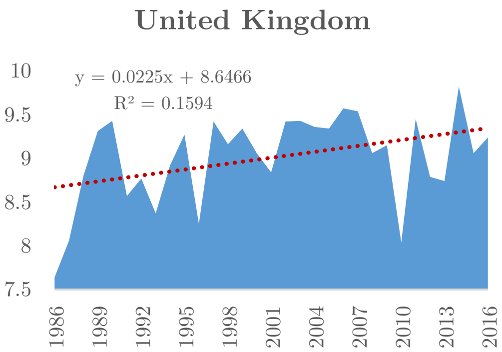

Portugal
y = 0.0192x + 15.268
R² = 0.217
16.5
16
15.5
15
14.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016


Romania
y = 0.0573x + 8.7082
R² = 0.502
11
10.5
10
9.5
9
8.5
8
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

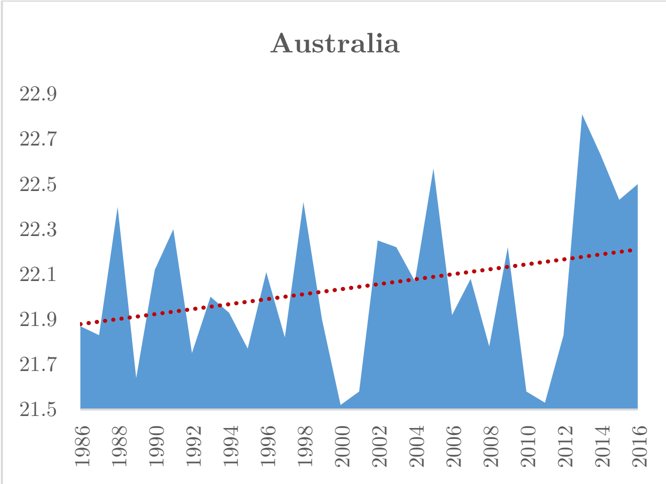

Spain
y = 0.023x + 13.51
R² = 0.2571
15
14.5
14
13.5
13
12.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016


Sweden
y = 0.0374x + 2.2297
R² = 0.1659
4.5
3.5
2.5
1.5
0.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016


Switzerland
y = 0.0315x + 5.3505
R² = 0.2552
7
6.5
6
5.5
5
4.5
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


United Kingdom
y = 0.0225x + 8.6466
R² = 0.1594
10
9.5
9
8.5
8
7.5
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016

OCEANIA

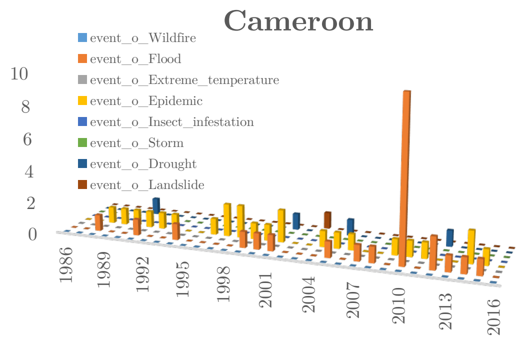


Note: The elaboration is based on data from Climate change knowledge Portal (World Bank).

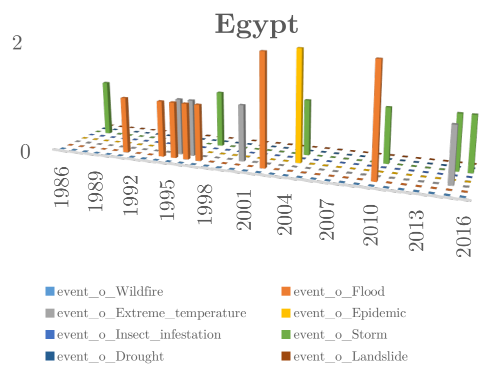
APPENDIX II

EVOLUTION OF EVENTS

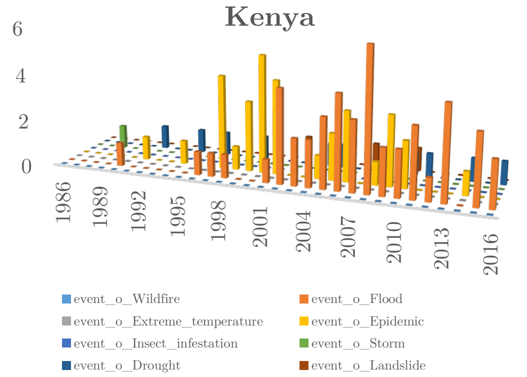
AFRICA



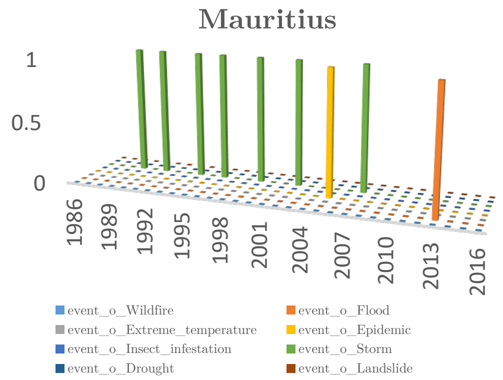
Cameroon
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide
10
8
6
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016



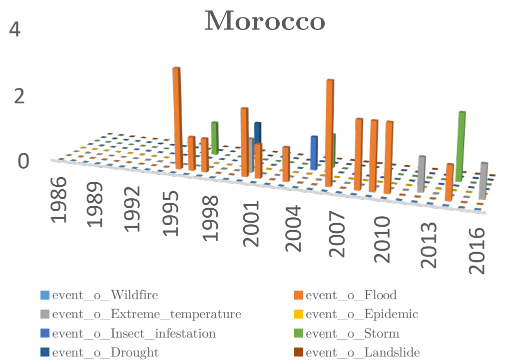
Egypt
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide



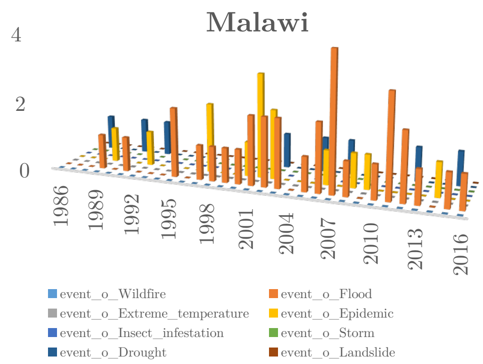
Kenya
6
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide



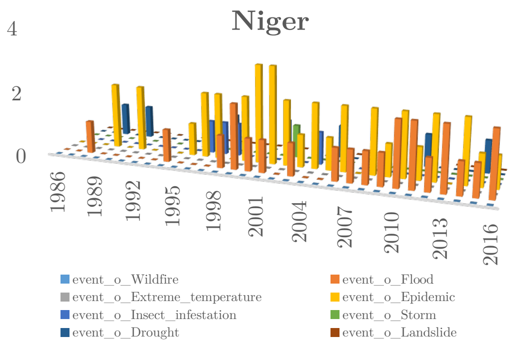
Mauritius
1
0.5
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide



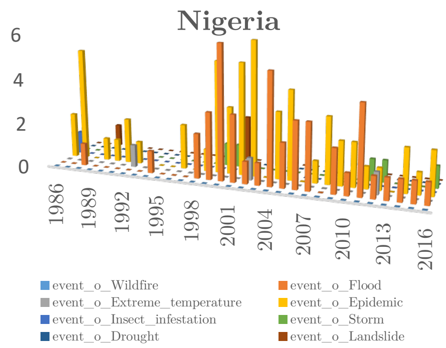
Morocco
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide



Malawi
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

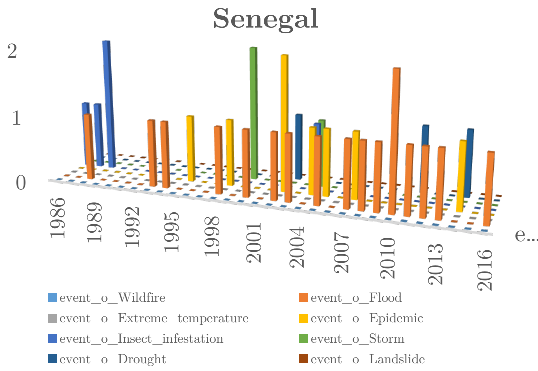


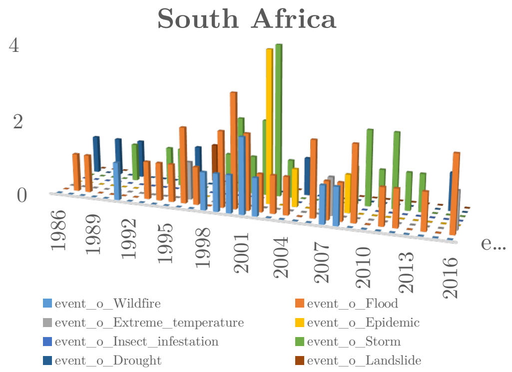
Niger
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

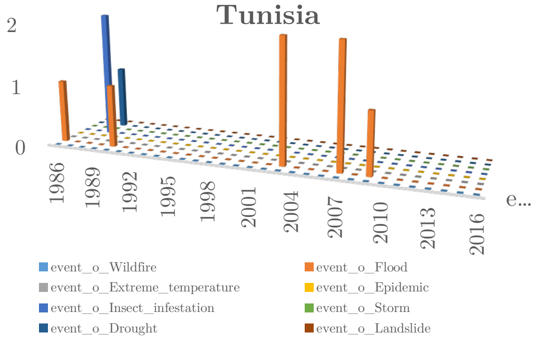


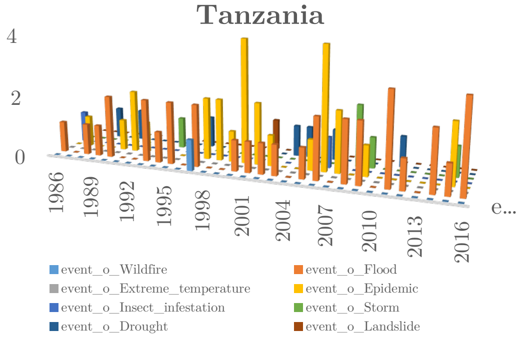
Nigeria
6
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

AFRICA (cont.)

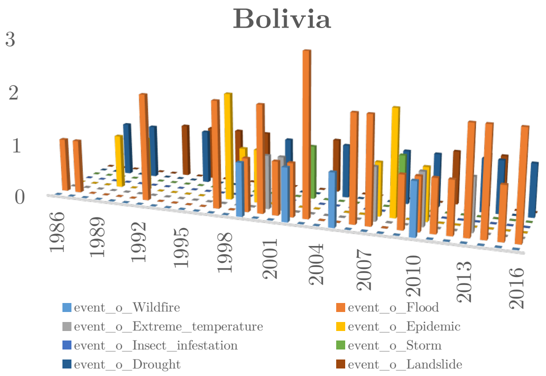

Senegal
2
1
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
e...
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

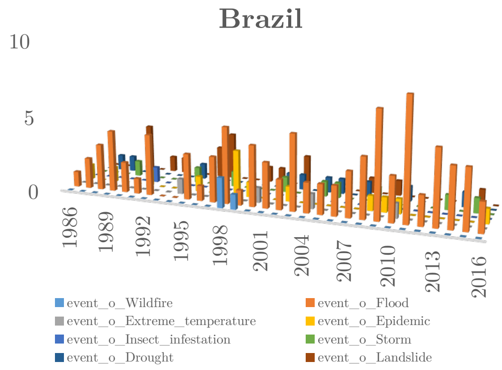

South Africa
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
e...
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Tunisia
2
1
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
e...
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Tanzania
4
2
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
e...
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

AMERICA


Bolivia
3
2
1
0
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


Brazil
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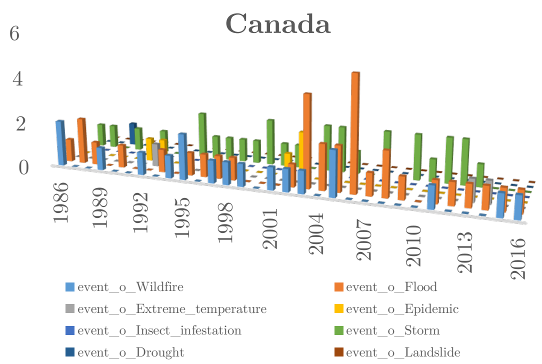
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


Canada
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
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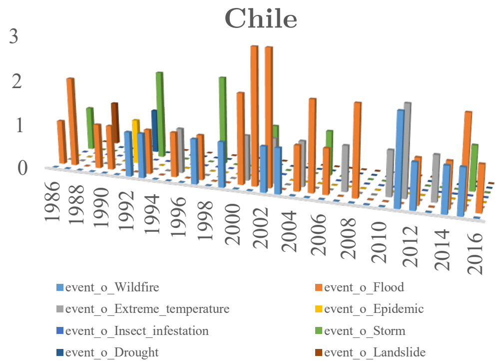
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


Chile
3
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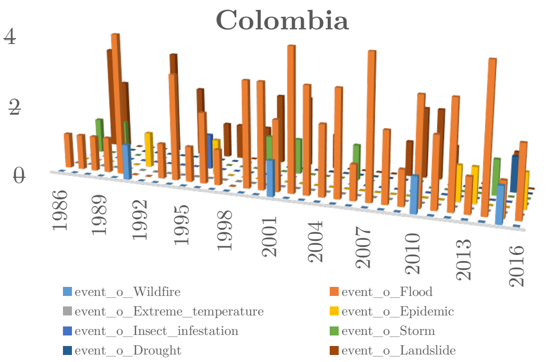
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


Colombia
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
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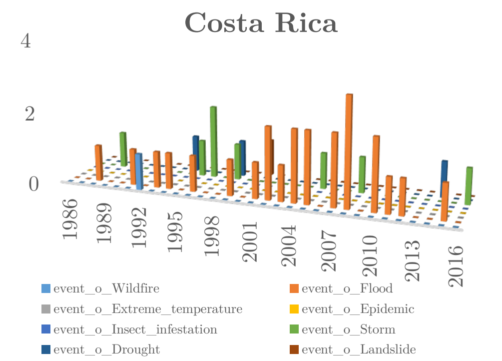
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


Costa Rica
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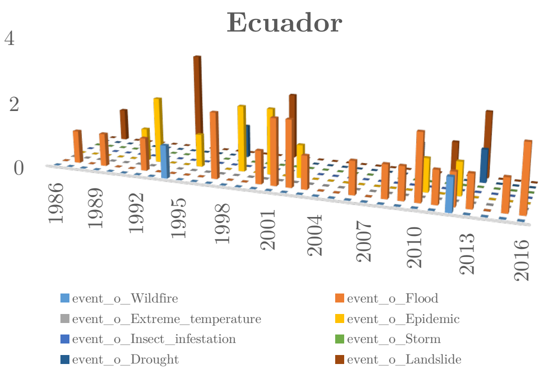
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide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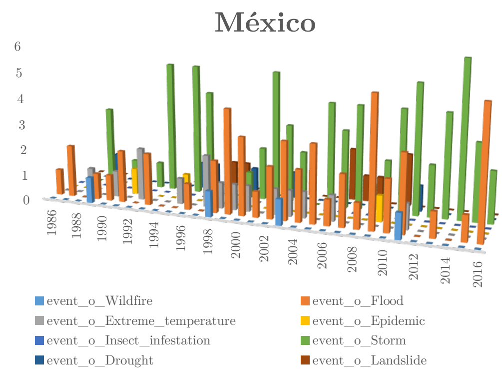
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide


México
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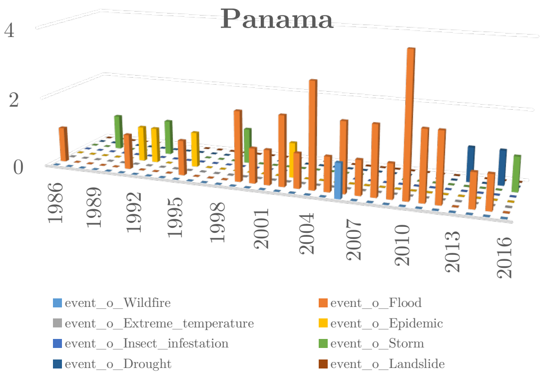
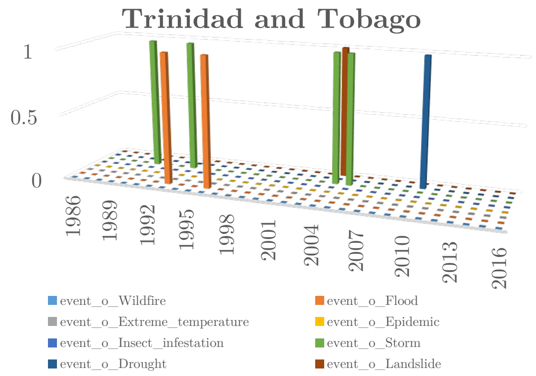
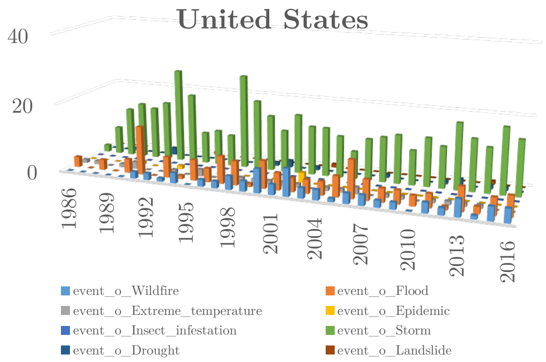
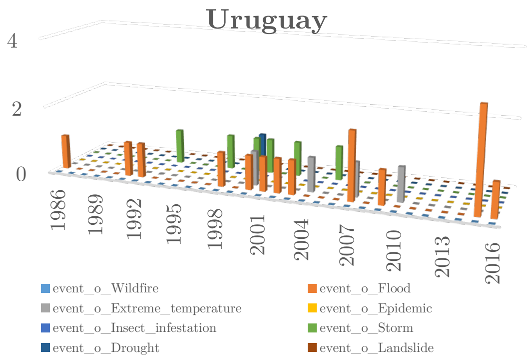
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
event_o_Wildfire
event_o_Extreme_temperature
event_o_Insect_infestation
event_o_Drought
event_o_Flood
event_o_Epidemic
event_o_Storm
event_o_Landslide

AMERICA (cont.)

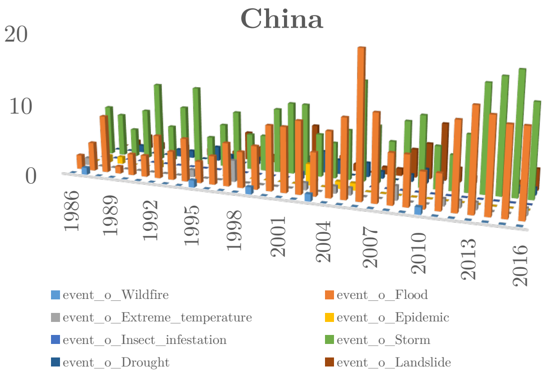








ASIA


China
20
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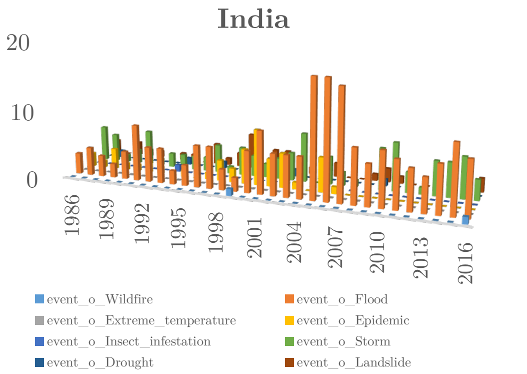
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


India
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
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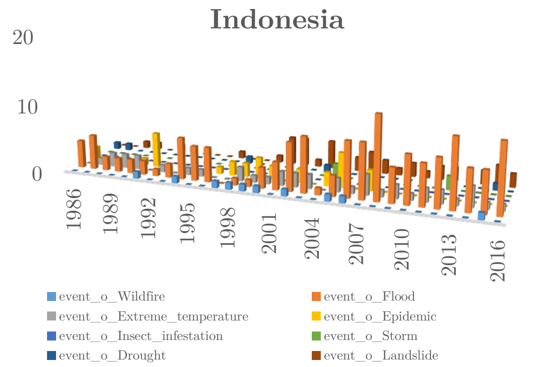
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Indonesia
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
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event_o_Flood
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event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
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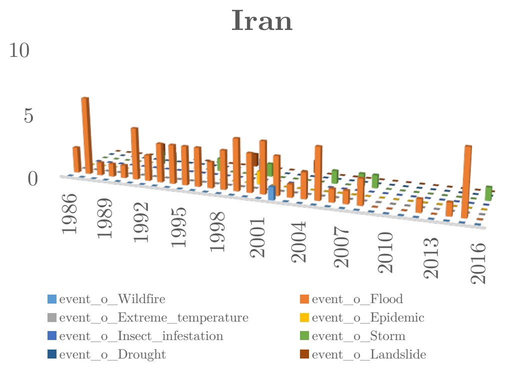
event_o_Landslide


Iran
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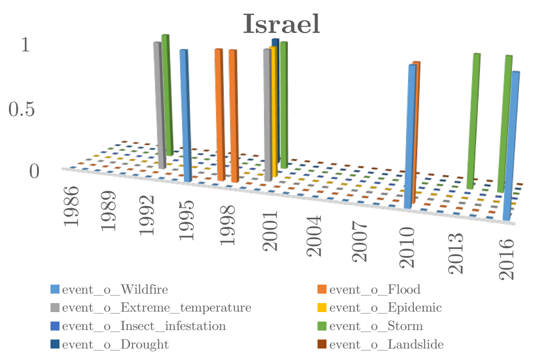
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Israel
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
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event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
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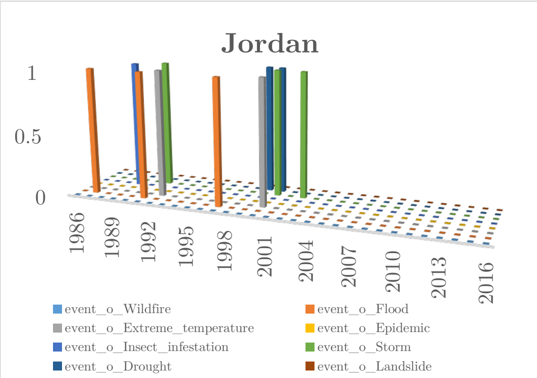
event_o_Landslide


Jordan
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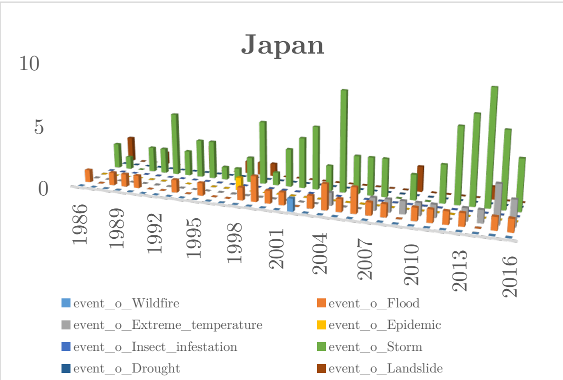
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Japan
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1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
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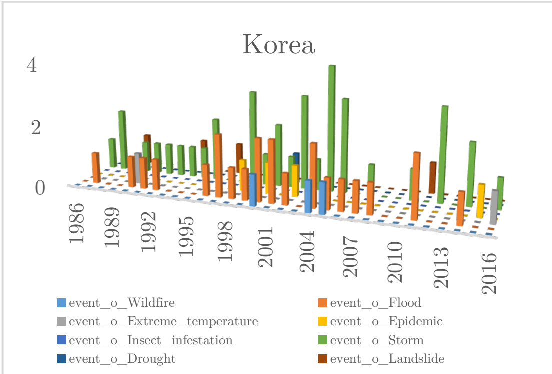
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Korea
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2
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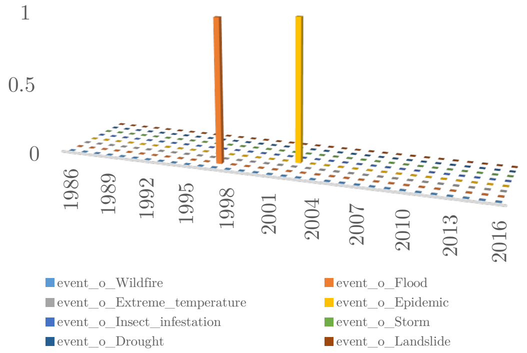
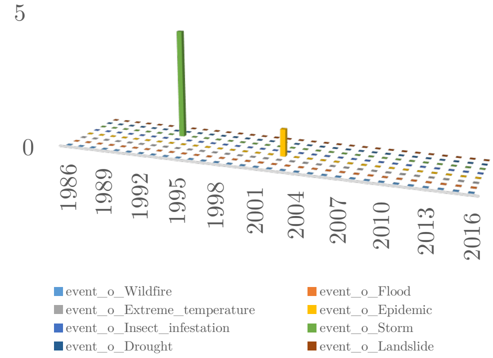
1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

ASIA (cont.)

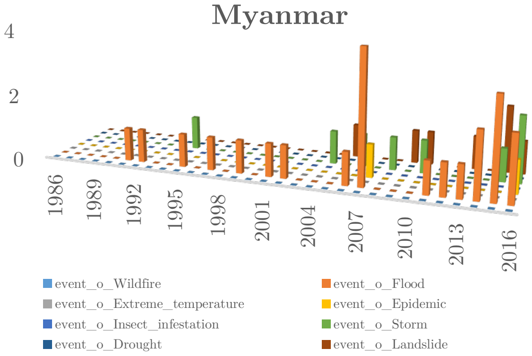
Kuwait



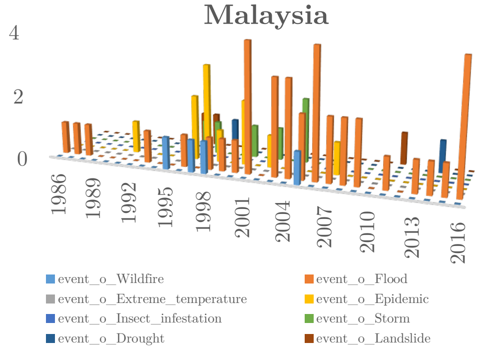
Macao



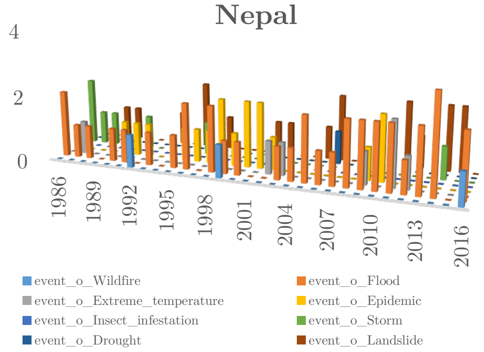
Myanmar



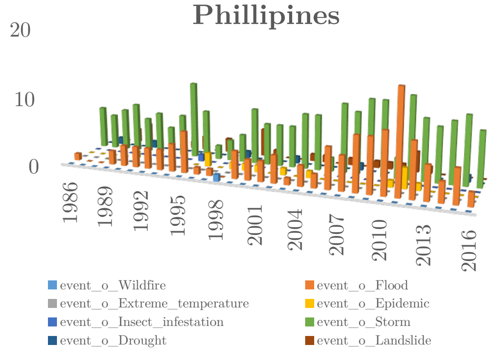
Malaysia



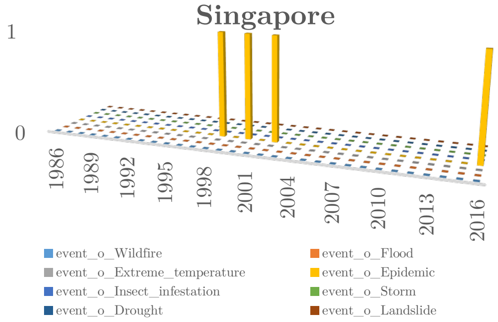
Nepal



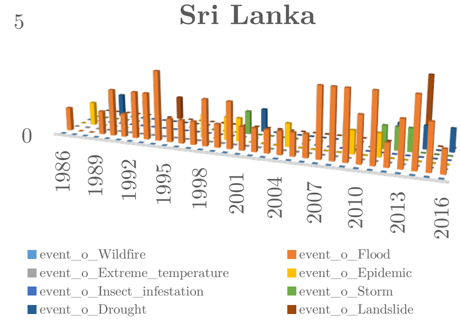
Phillipines



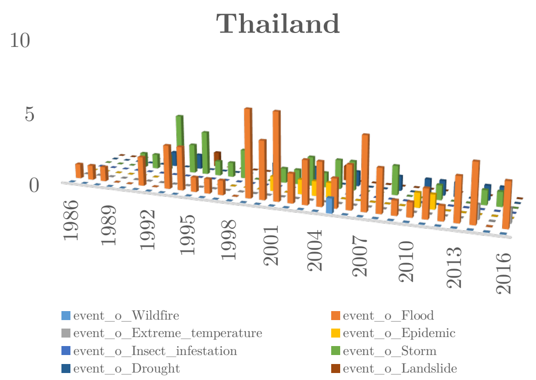
Singapore



Sri Lanka



ASIA (cont.)


Thailand
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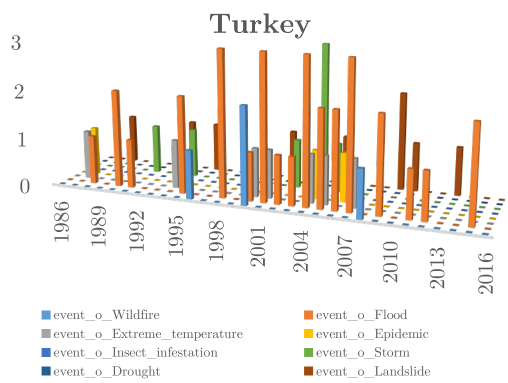
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Turkey
3
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1986
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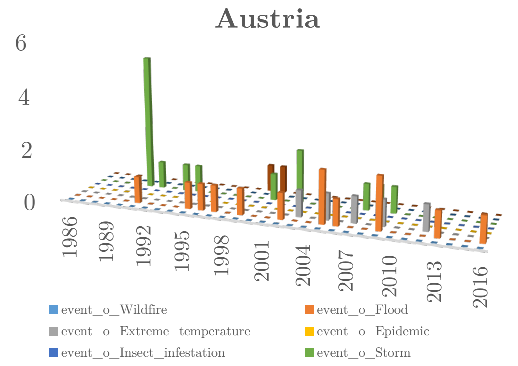
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

EUROPE


Austria
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1986
1989
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2001
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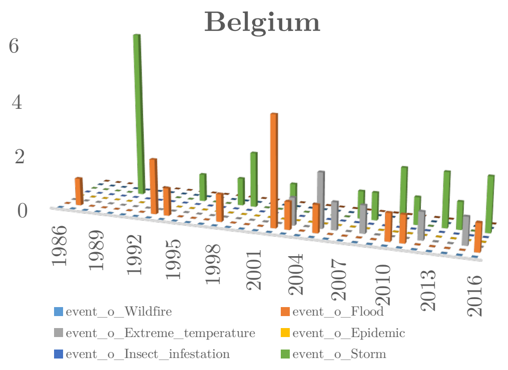
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm


Belgium
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1986
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event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
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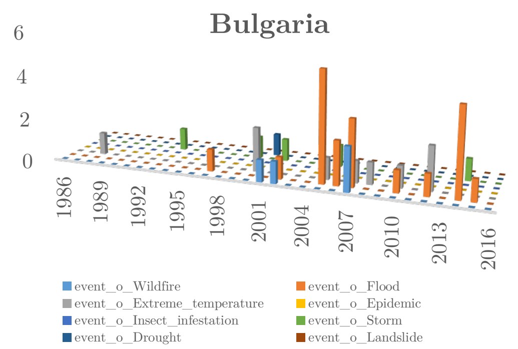
event_o_Storm


Bulgaria
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1986
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2013
2016
event_o_Wildfire
event_o_Flood
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event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
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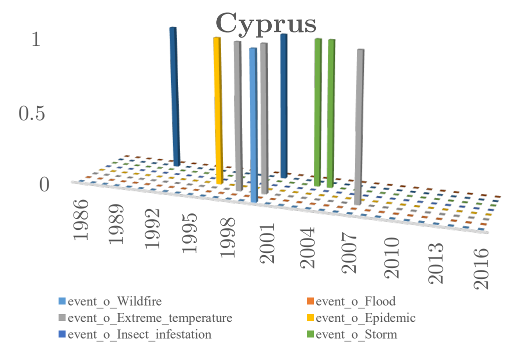
Cyprus
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1986
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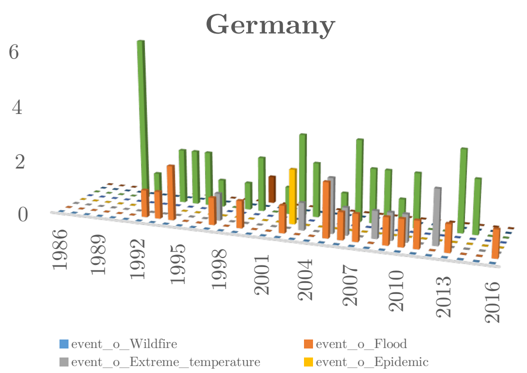
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm


Germany
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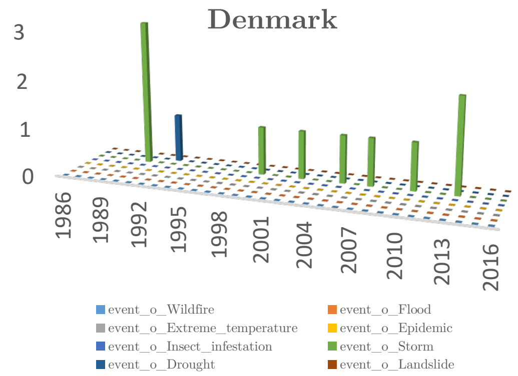
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic


Denmark
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2016
event_o_Wildfire
event_o_Flood
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event_o_Insect_infestation
event_o_Storm
event_o_Drought
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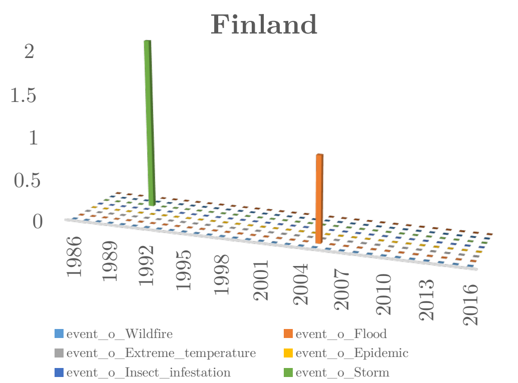
Finland
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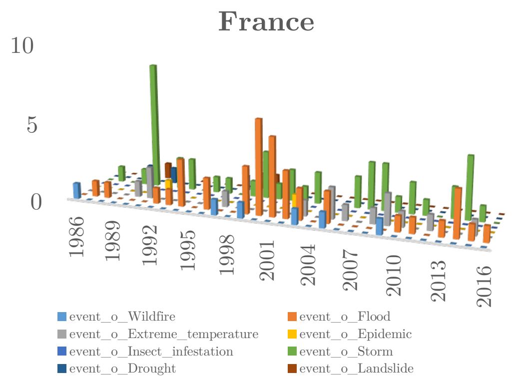
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm


France
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1986
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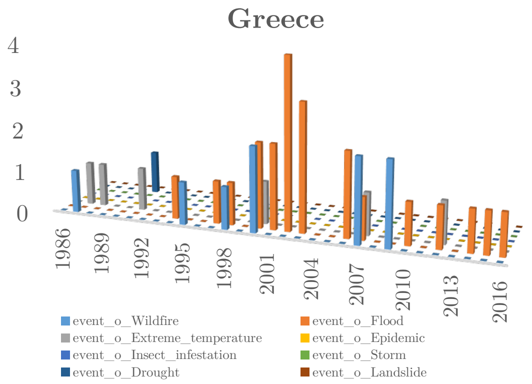
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

EUROPE (cont.)


Greece
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event_o_Wildfire
event_o_Flood
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event_o_Insect_infestation
event_o_Storm
event_o_Drought
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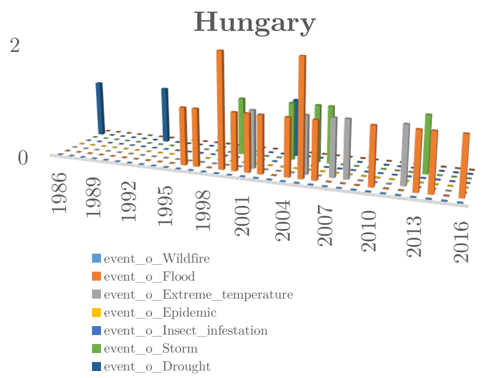
Hungary
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event_o_Epidemic
event_o_Insect_infestation
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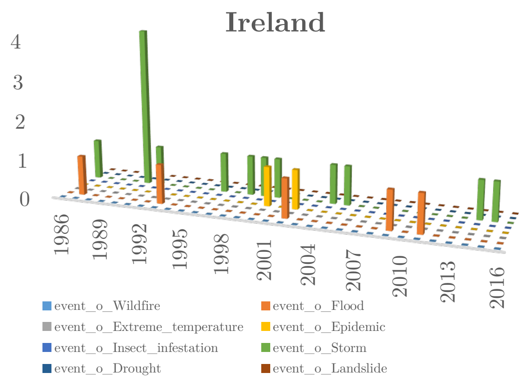
event_o_Drought


Ireland
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event_o_Wildfire
event_o_Flood
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event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
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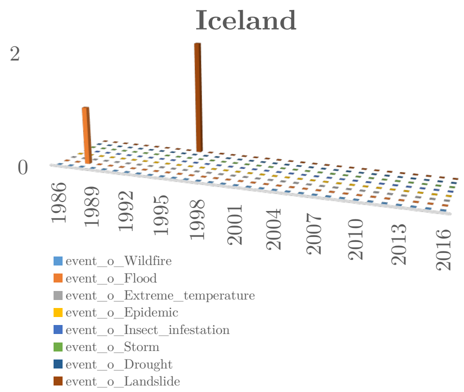
Iceland
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event_o_Wildfire
event_o_Flood
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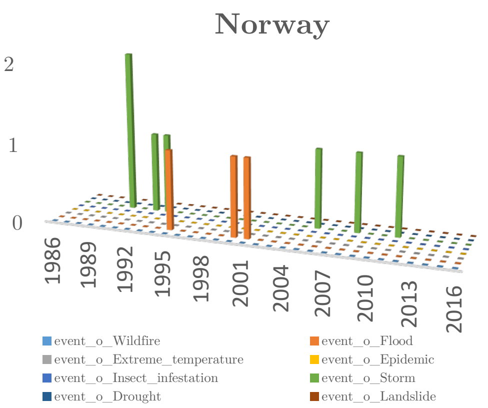
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Norway
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event_o_Wildfire
event_o_Flood
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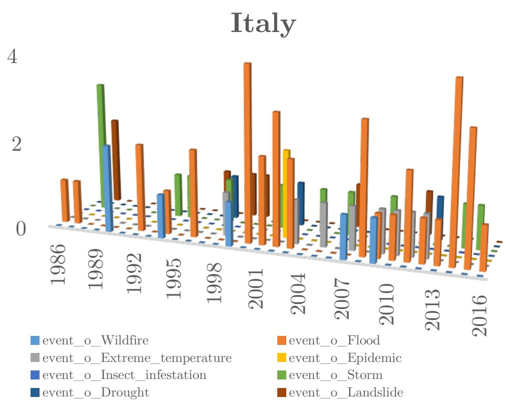
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Italy
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event_o_Wildfire
event_o_Flood
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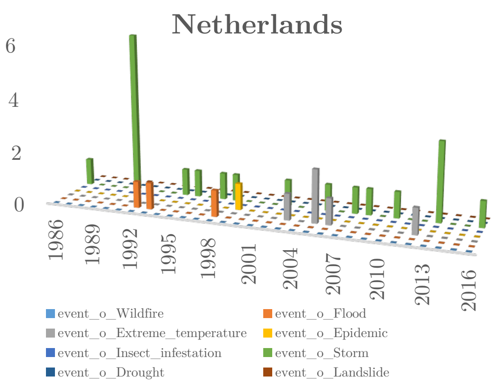
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Netherlands
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1986
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2016
event_o_Wildfire
event_o_Flood
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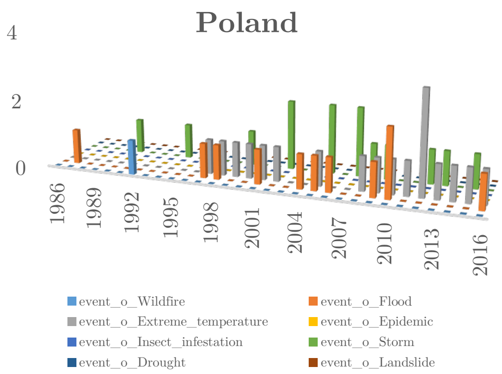
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Poland
4
2
0
1986
1989
1992
1995
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2013
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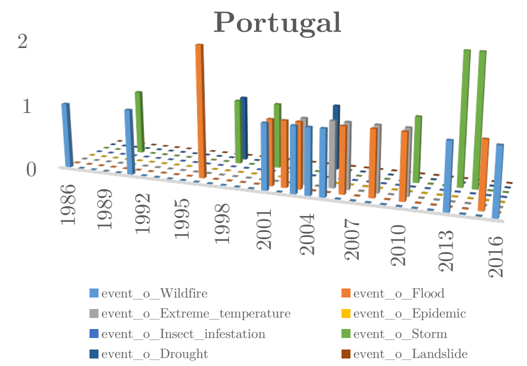
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

EUROPE (cont.)


Portugal
2
1
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1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
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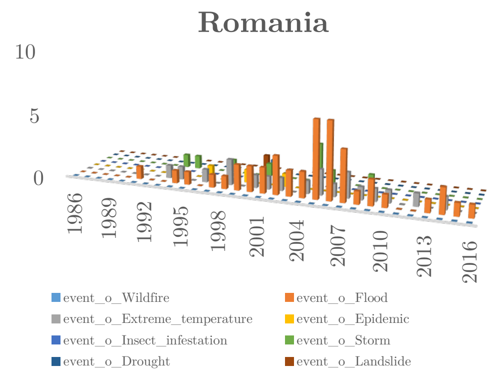
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Romania
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1986
1989
1992
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1998
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2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
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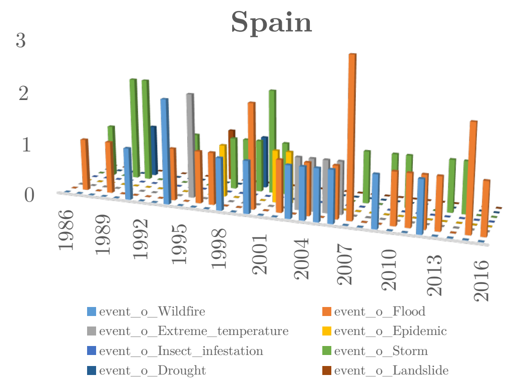
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Spain
3
2
1
0
1986
1989
1992
1995
1998
2001
2004
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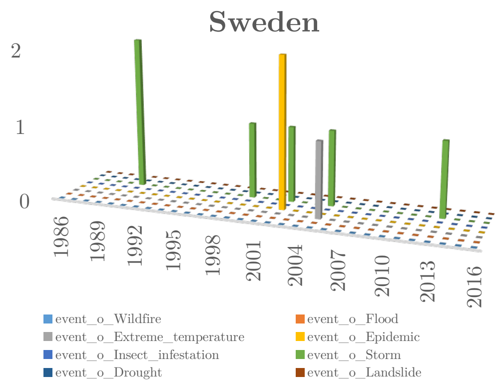
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Sweden
2
1
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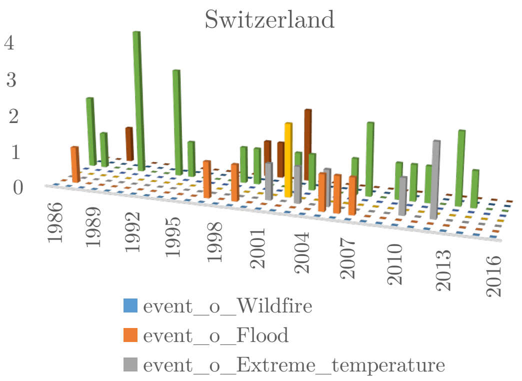
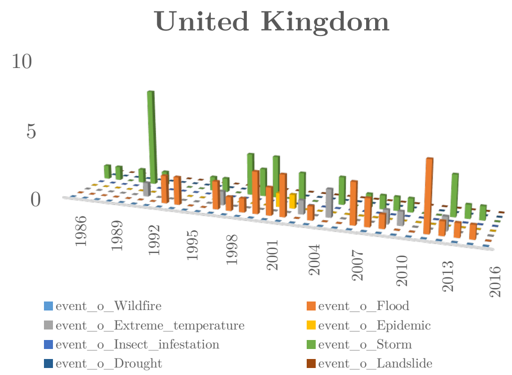
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide


Switzerland
4
3
2
1
0
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature


United Kingdom
10
5
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1986
1989
1992
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1998
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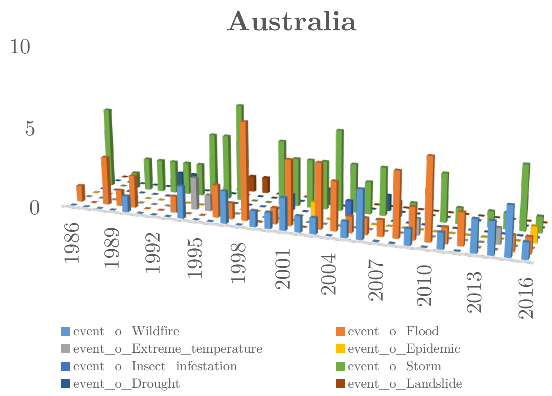
2004
2007
2010
2013
2016
event_o_Wildfire
event_o_Flood
event_o_Extreme_temperature
event_o_Epidemic
event_o_Insect_infestation
event_o_Storm
event_o_Drought
event_o_Landslide

OCEANIA



Note: This elaboration is based on data from the International Disasters Database (EM-DAT).

APPENDIX III

TABLE A.1.

TOTAL NUMBER OF EVENTS BY COUNTRY

OVER THE SAMPLE PERIOD

	Wildfires		Floods		Extreme Temperature		Epidemics		Insect Infestations		Storms		Droughts		Landslides
USA	73	China	234	Indonesia	40	Nigeria	56	Senegal	5	USA	444	China	30	China	62
Australia	25	India	204	USA	23	India	47	Niger	4	China	261	Brazil	12	Indonesia	43
Canada	18	Indonesia	149	Romania	19	Niger	37	Australia	2	Philippines	216	Thailand	11	India	36
Chile	11	USA	141	Poland	18	Kenya	32	Nigeria	**2**	India	98	Malawi	8	Colombia	26
Spain	11	Philippines	121	Mexico	15	Indonesia	30	Tanzania	2	Japan	98	India	7	Philippines	25
Indonesia	10	Brazil	92	China	14	Tanzania	27	Tunisia	2	Mexico	73	Tanzania	7	Nepal	19
Greece	9	Iran	66	France	14	Cameroon	24	Brazil	1	Australia	71	Mexico	6	Brazil	17
South Africa	9	Thailand	66	Japan	13	Nepal	17	China	1	France	46	Philippines	6	Japan	11
Portugal	8	Colombia	60	Bulgaria	9	Brazil	14	Colombia	1	Germany	40	South Africa	6	Ecuador	9
France	6	Mexico	51	Chile	9	Malawi	14	India	1	South Korea	37	Sri Lanka	6	Mexico	9
Italy	6	Sri Lanka	49	Italy	8	Philippines	14	Jordan	1	United Kingdom	34	Indonesia	5	Turkey	9
China	5	Australia	48	United Kingdom	8	Ecuador	11	Morocco	1	Thailand	30	Australia	4	Bolivia	8
Bolivia	4	Kenya	46	Belgium	7	Malaysia	11	Philippines	1	Canada	29	Cameroon	4	Italy	7
Bulgaria	4	Nigeria	43	Nepal	7	Bolivia	10			Switzerland	24	Costa Rica	3	Myanmar	7
Colombia	4	Romania	43	Turkey	7	China	8			South Africa	22	Ecuador	3	Switzerland	5
Malaysia	4	France	38	Australia	6	Senegal	8			Belgium	21	France	3	Kenya	4
Mexico	4	Malaysia	38	Greece	6	South Africa	7			Netherlands	20	Hungary	3	Malaysia	4
Turkey	4	Nepal	36	Spain	6	Sri Lanka	7			Spain	17	Italy	3	South Korea	4
Brazil	3	Italy	35	Switzerland	6	Thailand	6			Austria	14	Senegal	3	Sri Lanka	4
Israel	3	Canada	34	Austria	5	Canada	5			Ireland	14	Colombia	2	France	3
Nepal	3	Tanzania	33	Bolivia	5	Colombia	5			Italy	14	Cyprus	2	Iran	3
South Korea	3	Malawi	31	Hungary	5	United States	5			Poland	14	Jordan	2	Nigeria	3
Ecuador	2	Turkey	31	Netherlands	5	Panama	4			Brazil	10	Malaysia	2	Thailand	3
India	2	United Kingdom	31	Portugal	5	Singapore	4			Denmark	10	Nepal	2	United States	3
Costa Rica	1	Panama	30	Brazil	4	South Korea	4			Iran	9	Panama	2	Australia	2
Cyprus	1	Bolivia	29	Egypt	4	Mexico	3			Romania	9	Portugal	2	Austria	2
Iran	1	South Africa	29	Uruguay	4	Romania	3			Chile	8	Spain	2	Chile	2

	Wildfires		Floods		Extreme Temperature		Epidemics		Insect Infestations		Storms		Droughts		Landslides
Japan	1	Chile	27	Canada	3	Spain	3			Costa Rica	8	Bulgaria	1	Iceland	2
Panama	1	Japan	25	Cyprus	3	Turkey	3			Myanmar	8	Canada	1	Cameroon	1
Philippines	1	Cameroon	24	Morocco	3	Australia	2			Portugal	8	Chile	1	Costa Rica	1
Poland	1	Costa Rica	24	Nigeria	3	Egypt	2			Mauritius	7	Denmark	1	Germany	1
Tanzania	1	Niger	23	South Africa	3	France	2			Nepal	7	Greece	1	Romania	1
Thailand	1	South Korea	23	Israel	2	Germany	2			Norway	7	Iran	1	South Africa	1
		Ecuador	22	Jordan	2	Ireland	2			Turkey	7	Israel	1	Spain	1
		Greece	22	South Korea	2	Italy	2			Colombia	6	Morocco	1	Tanzania	1
		Myanmar	22	Thailand	2	Myanmar	2			Egypt	6	Romania	1	Trinidad and Tobago	1
		Spain	20	Sweden	1	Sweden	2			Malaysia	6	South Korea	1		
		Bulgaria	19			Switzerland	2			Sweden	6	Trinidad and Tobago	1		
		Morocco	19			United Kingdom	2			Uruguay	6	Tunisia	1		
		Senegal	17			Chile	1			Bulgaria	5	Uruguay	1		
		Germany	16			Cyprus	1			Hungary	5				
		Hungary	15			Iran	1			Nigeria	5				
		Uruguay	15			Israel	1			Sri Lanka	5				
		Belgium	14			Japan	1			Tanzania	5				
		Austria	13			Kuwait	1			Indonesia	4				
		Poland	11			Macao	1			Israel	4				
		Egypt	9			Mauritius	1			Macao	4				
		Portugal	9			Netherlands	1			Morocco	4				
		Tunisia	7							Panama	4				
		Switzerland	6							Trinidad and Tobago	4				
		Ireland	5							Jordan	3				
		Israel	3							Senegal	3				
		Jordan	3							Bolivia	2				
		Netherlands	3							Cyprus	2				
		Norway	3							Finland	2				

Wildfires		Floods		Extreme Temperature		Epidemics		Insect Infestations		Storm		Droughts		Landslides	
		Trinidad and Tobago	2							Kenya	1				
		Finland	1							Niger	1				
		Iceland	1												
		Kuwait	1												
		Mauritius	1												

CHAPTER 3

THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE

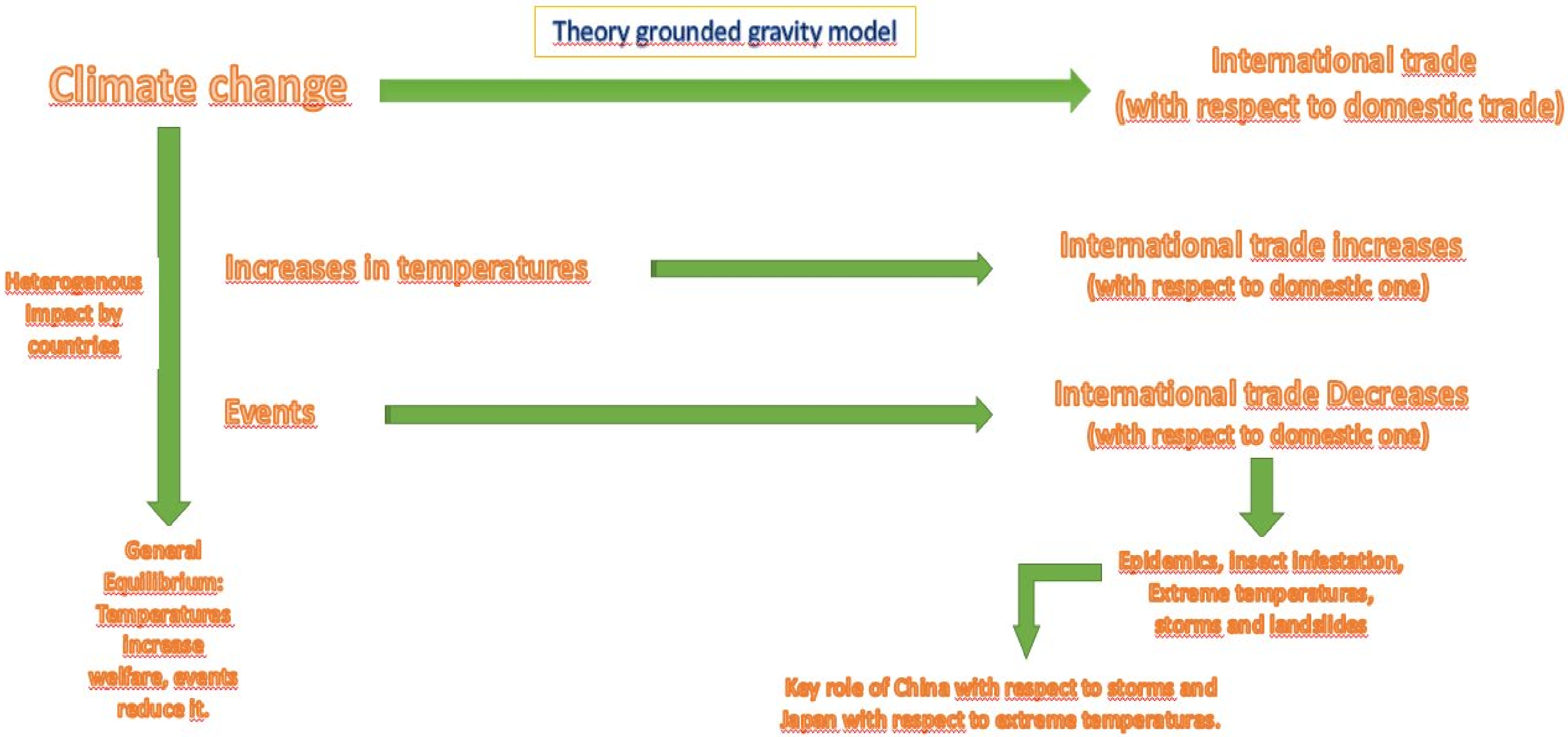
CHAPTER 3

THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE

Abstract

In this chapter, I analyse the impact of climate change on bilateral trade flows. For this purpose, I estimate a theory-based gravity model using bilateral trade flows in a sample of 67 countries over the period 1986-2016. I use temperatures and extreme climate events as indicators of climate change. In general, I find that international trade increases relative to domestic trade with rising temperatures, while the opposite occurs with extreme events. However, there is a clear heterogeneity across countries and types of events. In particular, the results suggest that biological events (*epidemics* and *insect infestation*), *extreme temperatures*, *storms,* and *landslides* have a negative impact on international flows relative to internal ones. Interestingly, the influence of China and Japan on the global result is decisive, especially for *storms* in the first case and *extreme temperatures* in the second. Finally, my General Equilibrium estimations suggest a more detrimental impact of *insect infestation* and *extreme temperatures* on welfare than the rest of events.

GRAPHICAL ABSTRACT



CHAPTER 3
THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE

3.1. Introduction

Nowadays, climate change is one of the biggest concerns in the world and it is becoming more and more important over time. The socioeconomic consequences of this phenomenon are certainly very broad and diverse, and will undoubtedly have a substantial impact on the well-being of citizens. In this Chapter, I focus on the impact of climate change on international trade, an area of great institutional interest but lacking rigorous studies in the academic field; to the contrary, many studies have examined the effect of international trade on climate change.

As noted by Grossman and Krueger (1992) and Copeland and Taylor (2003), international trade can influence climate change through three main channels: the "scale effect" (the increase in GDP of countries derived from the trade expansion induces more polluting emissions), the "composition effect" (in those countries with lower environmental standards, trade liberalization may lead to excessive specialization in pollution-intensive activities) and, finally, the "technique effect" (trade allows less developed countries to gain access to cleaner technologies that will generate less pollution and a more efficient use of resources).

Antweiler et al. (2001) find that the first and third channels are relevant, but not the second, which mainly depends on the specific characteristics of the countries, such as their abundance of capital or environmental standards.

Additionally, international awareness of climate change has led countries to increasingly consider the environmental consequences of their actions. This is the reason why more and more environmental provisions are included in the negotiations of preferential trade agreements (deep agreements). The argument is that trading partners can take actions to mitigate the damaging impact of international trade flows on the environment. The literature on this area is scarce. For instance, Baghdad et al. (2013) evaluate the effectiveness of these provisions in reducing emissions and conclude that only those regional trade agreements (RTAs) with environmental harmonization policies manage to reduce pollution in absolute and relative levels. Monteiro (2016) establishes a typology of this kind of provision, while Clive and Shunta (2018) analyse the extent of its implementation in RTAs. Trade integration agreements improve environmental quality with or without environmental provisions in the analysis of Martinez-Zarzoso (2018). More recently, Yamaguchi (2020a,b) studies the practices available to promote these provisions in integration agreements, while Abman et al. (2021) find that environmental provisions are capable of limiting deforestation in tropical developing countries. Finally, Bellmann and Bulatnikova (2022) show

how RTAs can serve as a mechanism to regulate and promote international trade related to environmental services.

However, climate change could also affect trade through three main channels: damage to infrastructure and lower productivity growth of factors of production on the negative side, and the possibility of opening up new trade routes on the positive one. The first of these channels arises as a consequence of extreme climate events (such as tornados, tropical cyclones, convective storms, river floods, forest fires, etc.) as well as sea level rise. The second channel, in the short or medium term, derives from the first: it deals with the effects on labor productivity and biological consequences such as insect infestation or the spread of viruses (for example, COVID-19). Lastly, the thaw (derived from global warming) can facilitate the opening of new routes for maritime transport.

The objective of this chapter is to analyse the impact of climate change on international trade flows. To this end, we estimate a theory-grounded gravity equation using data from a sample covering 67 countries over the period 1986-2016. Our estimation strategy takes into account all best practices in the estimation of gravity equations (Yotov et al., 2016), including the use of panel data techniques (to account for unobserved bilateral heterogeneity and endogeneity), the inclusion of controls for multilateral resistance terms, the use of the PPML estimator (to deal with the econometric problems resulting from heteroscedastic residuals and the prevalence of zeros in bilateral trade flows), and the use of domestic trade flows (in addition to international ones).

I make two contributions to the literature on trade and climate change. I examine for the first time (to my knowledge) the effect of climate change on trade using the gravity equation taking into account all known biases.[1] Second, I focus directly on an output measure of climate change rather than an input-based measure. With the exception of the paper by Abman et al. (2021) that focuses on deforestation, the rest of the works in this context use emissions as the variable of interest. More specifically, the United Nations defines "Climate change" as "long-term shifts in temperatures and climate patterns". Additionally, it states that the main responsible for this are "human activities" …. "primarily due to burning fossil fuels like coal, oil and gas" that "…. generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures". Based on these definitions, we can conclude that greenhouse gas emissions, the commonly used variable, are the input to produce a harmful environment, while rising temperatures and other climate events are the output. Hence, this is my second main contribution: my climate change output measure consists of temperature increases and extreme climate events measured

[1] Gassebner, et al. (2010) analyse the impact of disasters (technological and natural) on international trade. They find that disasters have a detrimental impact on the poorest and least democratic countries. The authors do not include country-year fixed effects that allow multilateral resistance to vary over time, nor do they consider domestic trade flows.

(as shown in Chapter 1) with data collected from the Climate Change Knowledge Portal (World Bank) for temperatures and the "International Disasters Database" (EM-DAT) for extreme natural events, respectively.

To preview the results, I find that gradually rising temperatures increase international trade relative to domestic trade, while extreme meteorological events decrease international trade relative to domestic one. However, there are non-trivial differences in these relationships across countries and events. Regarding the increase in temperatures, among the affected countries that drive the general result (in which international trade costs are falling compared to domestic ones) due to being large traders are Germany, the United Kingdom and the Netherlands (among others). Most of them, Europeans. Regarding events, our results suggest that biological events (*epidemics* and *insect infestation*), *extreme temperatures, storms* and *landslides* have a negative impact on international flows relative to internal ones. The country analysis reveals that China (the largest exporter) together with Japan (the fifth) mainly drive the overall result. An in-depth analysis shows that *storms*, in the case of China, and *extreme temperature* events, in the case of Japan, are especially relevant. As I showed in the previous chapter, the increase in extreme events is concentrated in Asia and, very particularly, in China. In addition, I have also pointed out the great shock suffered by Japan, a large exporter, in the final part of the period regarding extreme temperatures.

3.2. How can climate change affect international trade?

Rising temperatures and climate events (wildfires, floods, extreme temperatures, epidemics, insect infestation, storms, droughts and landslides) may affect international trade through three different channels: infrastructure damage, reduced labor productivity and opening new routes.

First of all, the aforementioned meteorological events could damage infrastructures directly related to international trade such as ports, airports, roads, etc. In addition, indirect effects could also appear because these events may require a more frequent maintenance of these infrastructures or have a negative impact on the operation of electronic devices related to international trade. Dellink et al. (2017) provide an in-depth analysis of the material consequences of climate change.

Second, climate change may reduce the productivity growth of the factors of production and, in particular, the productivity of the labor input. International trade, as an economic activity, could also be affected by this fact. The connection between high temperatures and the productivity of labor has been previously analysed in the literature. Heat stress affects human performance (Hancock et al., 2007) and, among other things, has a detrimental impact on labor productivity "involving office, factory, or outdoor workers" (Federspiel et al., 2002). In this sense, Gosling et al. (2018) estimate up to 10-15% loss of productivity for the countries of Southern Europe and between 2-4% for those of the North in the most adverse scenario of non-mitigation and adaptation, being the impact greater for the outdoor activities. Deryugina and Hsiang (2014), for the US, estimate a loss of labor productivity of around 1.7% for each degree Celsius increase in average daily temperature above 15 degrees Celsius and a cost of around 20 dollars per person if the temperature exceeds 30 degrees Celsius. An additional negative consequence of climate change on labor productivity comes from abnormally high temperatures that cause various biological effects, such as *insect infestation* or the spread of viruses. However, as we will see in the next chapter of this thesis, the increase in temperatures also has a positive effect on improving energy efficiency, especially in cold countries.

Third, the general increase in temperatures accelerates the melting of the Arctic, facilitating the opening of new routes, such as the Arctic seaways: The Northeast Passage, also called the Northern Sea Route (NSR), the Northwest Passage (North of Canada) and the Polar Route. These new routes could reduce shipping distances by 20 to 40% compared to routes through the Panama and

Suez Canal. However, the reduction in transportation costs is not necessarily of a similar magnitude because transportation difficulties differ between these routes. Bekkers et al. (2015) study the foreseeable impact on trade of the opening of the NSR. According to their estimations, the commercial use of this route will mean a reduction in shipping distances and a decrease in average transport days of around a third compared to the currently used Southern Sea Route. These trade cost reductions will boost trade flows between Northeast Asia (i.e. Japan, South Korea and China) and Northwest Europe by an average of around 10%. These reductions may also have other implications, such as the restructuring of global supply chains within Europe and between Europe and Asia. However, it seems that the Artic routes are still very limited (Babin et al., 2020).

Determining which of the aforementioned factors dominates is an empirical matter. In this chapter, I focus on examining this question. To do this, I estimate structural gravity equations that consider all known biases in the literature so far (Yotov et al., 2016), which I will outline in next section.

3.3. Methodology and data

The gravity model is one of the most successful econometric tools in economics and is particularly suitable for the study of international trade flows since the well-known pioneering book by Timbergen (1962). In its simplest version, the gravity model relates bilateral trade flows to economic size, the GDP of the countries of origin and destination, and the geographical distance between the partners. Later developments introduce other variables that affect trade barriers, such as whether the countries share a common border, a common language, are they islands, etc. This is the so-called "augmented" gravity model. This econometric methodology allows to carefully examining the determinants of bilateral trade flows.

Over time, the gravity equation has become more sophisticated with the theoretical contributions of various authors.[2] In their influential article, Anderson and van Wincoop (2003) state that gravity estimations should take into account not only bilateral trade barriers, but also those faced by the exporter and importer with respect to third-party partners. These are the terms of multilateral resistance, in the terminology of Anderson and van Wincoop (2003). In practice, in a cross-section setting, the introduction into the gravity equation of dummy

[2] The firsts theoretical developments come from the papers of Anderson (1979), Bergstrand (1985), Deardoff (1998), and Baier and Bergstrand (2001).

variables for the countries that act as exporters and importers allows to control for these multilateral resistance terms. However, multilateral resistance can change over time. Therefore, in a panel data setting, we need to introduce exporter time and importer time dummies into the gravity equation. This is known in the literature as country-year fixed effects (CYFE). In addition, unobserved constant bilateral heterogeneity and endogeneity are controlled for with county-pair-fixed effects -CPFE- (Baier and Bergstrand, 2007; Baldwin and Taglioni, 2007; Gil-Pareja et al., 2008). In another influential article, Santos Silva and Tenreyro (2006) point out that the residuals in the gravity equation are usually heteroscedastic. The latter, together with the existence of zeros in bilateral trade flows, means that traditional estimates based on log-linear specifications of the gravity model are biased. Therefore, these authors propose a Poisson Pseudo Maximun Likelihood (PPML) estimator to solve both problems. Finally, some authors (Yotov, 2012; Bergstrand et al., 2015; Yotov et al., 2016; Baier et al., 2019) have highlighted the need to include both international and domestic trade flows to avoid biased estimations and adequately measure effects of trade policy on the creation and diversion of trade. In fact, in this context, the inclusion of domestic trade flows is very important as it allows identifying the country-specific effects of climate change on trade.

In this research, I estimate a gravity equation with CYFE and CPFE using the PPML estimator and a database that incorporates national and international flows. It is important to note that, based exclusively on international trade flows, the inclusion of CYFE and CPFE only allows identifying those variables that are pair-specific and vary over time (e.g. when two countries establish an RTA). However, as has been pointed out by Beverelli et al. (2023), the introduction of domestic flows into the gravity equations allows us to identify the impact of country-specific variables (such as my variables of interest) on international trade, but only *in relation to* domestic trade. In addition, the introduction of domestic flows is also an alternative to deal with endogeneity problems. These authors provide a battery of reasons that support the control for endogeneity through the methodology used. On the one hand, the inclusion of exporter and importer fixed effects control for country-specific behaviour between trade and climate change. On the other hand, the variable of interest is the result of the interaction of a dummy variable with 'international trade' (labelled *int*, which takes the value one for international flows) and climate change. As these authors state, according to Nizalova and Murtazashvili (2016), consistent estimates are obtained because the intrinsic exogeneity of the international trade dummy implies a non-correlation with my measures of climate change. Finally, the pair-fixed effects strongly control for the omitted variables. Thus, following these authors, my methodology allows avoiding the use of an estimation of instrumental variables (IV).

Finally, following Bergstrand et al. (2015), I use a set of interactive dummies to control globalization trends. In this way, I account for the variation over time of trade costs (fixed and variable) that affect international trade relative to domestic trade.

I estimate the following gravity equations:

$$X_{ijt} = \exp^{(\beta_1 PTA_{ijt} + \beta_2 (GATT/WTO)_{ijt} + \beta_3 temp_{i(j)t} + \sum_{1987}^{2016} \beta_t Glob_{ijt} + \mu_{ij} + \delta_{it} + \gamma_{jt})} u_{ijt}$$

(3.1a)

$$X_{ijt} = \exp^{(\beta_1 PTA_{ijt} + \beta_2 (GATT/WTO)_{ijt} + \beta_4 event_{i(j)t} + \sum_{1987}^{2016} \beta_t Glob_{ijt} + \mu_{ij} + \delta_{it} + \gamma_{jt})} u_{ijt}$$

(3.1b)

$$Glob_{ijt} = int_{ij} * year$$

where X_{ijt} are the exports from country "i" to country "j" at time "t", *PTA* is a dummy for Preferential Trade Agreements, *GATT/WTO* is a dummy for the GATT/WTO system, *Glob* measures the globalization and is composed of a dummy variable for international trade (which takes the value 1 for international flows and zero for national flows, labelled as *int*) interacted with year dummies (except 1986, to avoid multicollinearity), *temp* are the average annual temperatures of the countries (implicitly interacted with *int*) and *event* is the number of *extreme climate* events (implicitly interacted with *int*), μ_{ij} are CPFE and δ_{it} and γ_{jt} are CYFE for the exporter and importer, respectively.

Data for PTAs and the GATT/WTO system are taken from the Dynamic Gravity Dataset (DGD) developed by the United States International Trade Commission – USITC - (see Gurevich and Herman, 2018). This database was designed to be easily combined with the usual sources of bilateral trade data. In my case, I use a panel dataset created by Thomas Zylkin. The advantage of these data is that they incorporate both domestic and international trade flows for manufacturing trade over the period 1986–2006 for 69 countries, which has been extended to 2016.[3] We have selected 67 countries for our analysis because to the lack of enough data for two of the countries included in the aforementioned sample (Argentina and Hong Kong).

As indicated in the previous chapter, I have chosen two measures that reflect climate change: *temperatures* and *extreme climate events*. On the one hand, the average annual *temperatures* of each country have been extracted from the

[3] One potential caveat of this dataset is that it does not include trade in agricultural products, which prevents us from analysing the effects of climate on bilateral trade flows that are likely to be considerable. For instance, Klomp et al. (2018) explore the impact of natural disasters on the degree of agricultural protection. The results obtained are that natural disasters increase agricultural trade controls in high-income countries to favour domestic farmers, while trade barriers in poor countries are reduced in an attempt to diminish food scarcity.

Climate Change Knowledge Portal (World Bank). On the other hand, *extreme climate events* are taken from the International Disasters Database (EM-DAT),[4] Center for Research on the Epidemiology of Disasters. As established in previous chapters, I have considered the following events: Wildfires ($Wildfire_{ijt}$), Floods ($Flood_{ijt}$), Extreme Temperatures (Ext_Temp_{ijt}), Epidemics ($Epidemic_{ijt}$), Insect Infestation ($Insect_{ijt}$), Storms ($Storm_{ijt}$), Droughts ($Drought_{ijt}$) and Landslides ($Landslide_{ijt}$).

3.4. Results

3.4.1 "Partial" equilibrium.

I estimate equations (1a) and (1b) by PPML with CPFE and CYFE (Table 1). I start with regressions that do not consider the impact of globalization (columns 1 and 3). Then, I estimate the same specification that includes the globalization trend as in Bergstrand et al. (2015).

In addition to the PTAs and the GATT/WTO system dummies, in column (1) I present the impact of increasing temperatures of the countries. As shown, PTAs and GATT/WTO membership have a positive and significant impact on

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[4] Felbermayr and Gröschl (2013) use this dataset to develop IV estimates of openness to analyse the effect of trade on income.

bilateral (relative to domestic) trade flows, as expected, with an especially strong effect in the case of the GATT/WTO system. Note that due to the inclusion of country-pair fixed effects in the regressions, I only identify the impact of those countries that joined the agreements during the sample period. Regarding the variable of interest, I obtain a positive and significant coefficient (0.202). The estimated parameter implies that an increase of one degree Celsius leads to a 22% increase in international flows relative to domestic ones. [5] In the case of events (column 3), the parameter is 0.005, which implies an impact on bilateral trade of around 0.5% for each additional event.

In columns 2 and 4, I introduce the measure of globalization. [6] As shown, and in line with expectations, the parameters corresponding to the respective *Glob* variables are positive, highly significant, and increasing over time (with some exceptions, such as the outset of the financial crisis). The process of world trade integration increases international flows relative to internal ones over time. This means that the omission of a measure of globalization in the regressions implies that the estimated parameters of the other variables in the model are capturing this phenomenon, overestimating the impact of the corresponding variables. In fact, this is what we observe in the estimations. The values of the parameters of

[5] [exp (0.202) – 1]*100 = 22%.

[6] As a robustness check, I have included (in different regressions) a measure of the Gross Domestic Product and the Gross Domestic Product per capita of the countries, both interacting with the "international trade dummy". My main findings remain unchanged.

the PTAs and the GATT/WTO system have been drastically reduced, but they are still highly significant. As expected, the same occurs with my *temp* variable, whose impact has been reduced to around 3.8% although it remains statistically and economically significant. In the case of the *events* variable, the sign of the estimated parameter changes, although it continues to be significant at conventional levels, with an impact of around -0.5%. Once we take into account the significant reduction (statistical and economic) of international trade costs relative to domestic ones, an extreme climate event will have a negative impact on international flows (relative to domestic ones).

To deepen my findings, I have performed additional estimates. First, I have examined the country-specific impacts. In Table 2, I present these estimations for temperatures and events in columns (1) and (2), respectively.[7] I have performed a regression for each country by splitting the corresponding variable of interest by the average effect excluding the corresponding country plus the country´s own effect. It is important to note that by excluding a country, this country acts as exporter and as importer, which means that climate change in the partner countries (exporters) also has an effect on the country under study (the importer), also driving the general impact observed.

[7] To save space, I do not report fixed effects and other estimated coefficients.

As can be seen, the positive average coefficient for temperatures shown in column 3 of Table 1 is not too generalised, although the positive cases predominate over the negative ones. I found 26 positive and significant cases (at least at 10% level) and 11 negatives out of 67 cases. There are some countries with very high positive impacts (Malawi or Morocco, for instance) for which international flows are strongly positively affected relative to international ones. More interesting are the countries that drive the general impact, that is, big traders, also with high impacts. Among them, I find the (quite relevant) coefficients of Germany (0.058), the United Kingdom (0.055), the Netherlands (0.081), Mexico (0.378), Switzerland (0.202), Spain (0.157) or India (0.287). Most of them, European countries.

On the other hand, for some countries the estimated parameter is negative (and significant), which means that the increase in temperatures affects more the costs of international trade in relation to internal ones. This is the case of Japan (-0.164), Italy (-0.048), Belgium (-0.097), or Singapore (-0.323). For thirty countries, we cannot find a significant difference in the relative cost of trade according to the type of trade (international or domestic).

If we focus on the events, at first sight it seems that the overall (negative) result is due to a few countries: in only 13 of 67 cases, we find a negative (and significant) coefficient, in eight a positive (and significant) one with no significant effect for the rest of the countries. However, a notable difference emerges for two countries: when either China or Japan are excluded from the sample, the estimated average parameter completely loses its statistical significance. It is important to point out that for the rest of the regressions for each country the coefficient of the global effect of the *event* variable excluding the corresponding country is always negative and significant with a value not very different from that presented in column 4 of Table 2 (see the Appendix). Therefore, the impact of these countries is crucial for the average effect observed, although other relevant exporters also present a negative and significant estimated coefficient, such as Germany, France or Italy.

As for *events*, we can take a step forward that might shed some light on the cases of China and Japan. In our database, we have information about the "type of event". Therefore, we have divided our *events* variable into the eight categories according to the type of event: Wildfires ($Wildfire_{ijt}$), Floods ($Flood_{ijt}$), Extreme Temperatures (Ext_Temp_{ijt}), Epidemics ($Epidemic_{ijt}$), Insect Infestation ($Insect_{ijt}$), Storms ($Storm_{ijt}$), Droughts ($Drought_{ijt}$), and Landslides ($Landslide_{ijt}$). The results of estimating equation 1 for each of these variables are presented in column 1 of Table 3. In addition, we have divided each of these variables into the effect on China and the rest of the sample and the effect on Japan and the rest of the sample (columns 2 and 3).[8]

As can be seen, Extreme Temperatures (with an impact of around 6%), Epidemics (6%), Insect Infestation (23%), Storms (1.1%) and Landslides (2.1%) decrease international flows relative to domestic ones, Wildfires increase them (3.5%) while Floods and Droughts do no show a differential effect between international and domestic flows. Focusing on the case of China, there is an event in which a clear influence of this country with respect to the average of the rest of the countries appears. As can be seen, when referring to Storms, excluding China makes the general average parameter no longer significant and the specific impact of this event for China increases to around 3%. Thus, these types of events (mainly cyclones, tornadoes and convective hail) negatively impact China to a great extent. In the case of Japan, something similar occurs with our Extreme Temperature variable (with a negative impact of around 18%), so the exclusion of this country makes the general average close to non-significant (at the 10% level). As in China, the impact of Storms in Japan is quite strong (around 2.4%)

[8] It is important to note that there is no multicollinearity problem in the general regression that includes the variables for the different types of events. However, when considering the variables corresponding to the case of China, I have detected a very high correlation between *Floods* and *Storms*. Therefore, I have removed the *Floods* variable for China. In any case, by including this variable, the conclusions reached for *Storms* are exactly the same. With respect to Japan, there is no collinearity problem.

and also influences the general average, which is halved. Finally, Landslides also have a relatively negative impact on Japan´s international trade. The rest of the events do not seem to have had any significant impact in this country.

It is now interesting to estimate the specific impact of each type of event for all the countries in the sample. This is reflected in Table 4. It is quite clear that an exhaustive analysis of what are the impacts of each type of event by country does not make any sense. However, an interesting comment is worth making. We have to realise that we are looking at the impact of an event in the countries of origin on international trade. As previously indicated, when carrying out the analysis by country, we estimate the impact of a specific event on the exports of that country (first order impact) and on its imports from the occurrence of this event in its trading partners (second order impact). Therefore, it is quite possible that a specific event does not occur in one country, but it does occur in its partners, thus affecting the international trade of the first country. Consider, for instance, the world´s largest exporter China. What happens in China is likely to affect a large part of its partners. In fact, as we have seen, if we exclude China from the analysis (and Japan) the estimated coefficient of some events loses its statistical significance.

Table 3.1. Trade and Climate change. Period 1986-2016.

	(1)	(2)	(3)	(4)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
PTA_{ijt}	0.320***	0.122**	0.368***	0.122**
	(0.065)	(0.056)	(0.066)	(0.056)
$GATT/WTO_{ijt}$	1.540***	1.024***	1.620***	1.064***
	(0.092)	(0.116)	(0.086)	(0.109)
$temp_{i(j)t}$	0.202***	0.037***		
	(0.013)	(0.010)		
$event_{i(j)t}$			0.005***	-0.005***
			(0.002)	(0.002)
$Glob_{ij1987}$		0.024***		0.029***
		(0.008)		(0.007)
$Glob_{ij1988}$		0.088***		0.121***
		(0.010)		(0.010)
$Glob_{ij1989}$		0.126***		0.162***
		(0.016)		(0.015)
$Glob_{ij1990}$		0.193***		0.254***
		(0.019)		(0.019)
$Glob_{ij1991}$		0.228***		0.267***
		(0.018)		(0.019)
$Glob_{ij1992}$		0.244***		0.285***
		(0.018)		(0.019)
$Glob_{ij1993}$		0.277***		0.306***
		(0.020)		(0.021)
$Glob_{ij1994}$		0.323***		0.370***
		(0.023)		(0.023)
$Glob_{ij1995}$		0.411***		0.447***
		(0.024)		(0.024)
$Glob_{ij1996}$		0.447***		0.454***
		(0.025)		(0.025)
$Glob_{ij1997}$		0.509***		0.560***
		(0.028)		(0.029)
$Glob_{ij1998}$		0.554***		0.617***
		(0.027)		(0.029)
$Glob_{ij1999}$		0.539***		0.594***
		(0.029)		(0.031)
$Glob_{ij2000}$		0.603***		0.668***
		(0.030)		(0.033)
$Glob_{ij2001}$		0.581***		0.634***
		(0.029)		(0.030)
$Glob_{ij2002}$		0.531***		0.601***
		(0.030)		(0.034)
$Glob_{ij2003}$		0.577***		0.629***
		(0.031)		(0.033)
$Glob_{ij2004}$		0.624***		0.670***
		(0.032)		(0.034)
$Glob_{ij2005}$		0.642***		0.691***
		(0.033)		(0.036)

Table 3.1. Trade and Climate change. Period 1986-2016.

	(1)	(2)	(3)	(4)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
$Glob_{ij2006}$		0.671^{***}		0.739^{***}
		(0.033)		(0.036)
$Glob_{ij2007}$		0.794^{***}		0.855^{***}
		(0.039)		(0.040)
$Glob_{ij2008}$		0.822^{***}		0.869^{***}
		(0.039)		(0.040)
$Glob_{ij2009}$		0.736^{***}		0.785^{***}
		(0.042)		(0.042)
$Glob_{ij2010}$		0.819^{***}		0.853^{***}
		(0.044)		(0.043)
$Glob_{ij2011}$		0.824^{***}		0.873^{***}
		(0.045)		(0.043)
$Glob_{ij2012}$		0.818^{***}		0.869^{***}
		(0.047)		(0.045)
$Glob_{ij2013}$		0.847^{***}		0.907^{***}
		(0.048)		(0.048)
$Glob_{ij2014}$		0.804^{***}		0.876^{***}
		(0.048)		(0.046)
$Glob_{ij2015}$		0.786^{***}		0.865^{***}
		(0.054)		(0.050)
$Glob_{ij2016}$		0.745^{***}		0.821^{***}
		(0.056)		(0.052)
Constant	10.946^{***}	11.776^{***}	11.410^{***}	11.835^{***}
	(0.095)	(0.108)	(0.083)	(0.103)
Observations	136,153	136,153	136,153	136,153
Country pair FE	Yes	Yes	Yes	Yes
Importer-year and Exporter year FE	Yes	Yes	Yes	Yes
Domestic trade	Yes	Yes	Yes	Yes
Pseudo R2	0.99	0.99	0.99	0.99

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
Standard errors are clustered by country-pair.

Table 3.2. Trade and Climate change by countries. Period 1986-2016.

Country	(1) Coefficient of temperatures (temp)	(2) Coefficient of events (event)
Australia	-0.030 (0.028)	-0.005 (0.004)
Austria	0.107*** (0.018)	0.005 (0.004)
Belgium	-0.097*** (0.018)	0.005 (0.009)
Bolivia	0.187** (0.075)	0.020** (0.009)
Brazil	0.095*** (0.030)	0.003 (0.002)
Bulgaria	0.348*** (0.050)	0.022*** (0.006)
Cameroon	0.053 (0.195)	0.023* (0.014)
Canada	0.021 (0.016)	0.002 (0.003)
Chile	0.107** (0.043)	0.004 (0.003)
China	0.025 (0.018)	-0.010***(0.003)
Colombia	0.104* (0.058)	0.003 (0.006)
Costa Rica	0.202* (0.121)	-0.002 (0.006)
Cyprus	0.382*** (0.090)	-0.005 (0.007)
Denmark	-0.002 (0.014)	-0.014***(0.003)
Ecuador	0.003 (0.050)	-0.002 (0.005)
Egypt	0.246*** (0.071)	0.004 (0.005)
Finland	-0.042** (0.020)	-0.016**(0.007)
France	0.013 (0.018)	-0.008**(0.003)
Germany	0.058*** (0.019)	-0.007***(0.002)
Greece	-0.063 (0.049)	-0.008*(0.005)
Hungary	0.491*** (0.043)	0.004 (0.011)
Iceland	0.092 (0.081)	0.001 (0.006)
India	0.287*** (0.077)	-0.003 (0.005)
Indonesia	-0.232*** (0.064)	-0.011 (0.006)
Iran	-0.301*** (0.114)	0.016 (0.011)
Ireland	0.034 (0.027)	-0.004 (0.006)
Israel	0.200*** (0.056)	0.003 (0.006)
Italy	-0.048** (0.023)	-0.013***(0.003)
Japan	-0.164*** (0.031)	-0.020***(0.004)
Jordan	-0.027 (0.057)	0.001 (0.008)
Kenya	-0.004 (0.054)	0.013 (0.009)
Korea	-0.016 (0.031)	-0.007*(0.004)
Kuwait	-0.199*** (0.074)	-0.003 (0.007)
Macao	0.277 (0.211)	-0.031 (0.027)

Table 3.2. Trade and Climate change by countries. Period 1986-2016. (cont.)

	(1)	(2)
Country	Coefficient of temperatures (temp)	Coefficient of events (event)
Malawi	0.759^{***} (0.294)	0.043 (0.034)
Malaysia	-0.193^{**} (0.086)	-0.003 (0.007)
Malta	0.024 (0.080)	0.002 (0.008)
Mauritius	-0.170^{**} (0.082)	0.003 (0.005)
Mexico	0.378^{***} (0.094)	0.013^{***} (0.003)
Morocco	0.510^{**} (0.203)	-0.014^{*}(0.008)
Myanmar	0.424 (0.300)	0.027 (0.027)
Nepal	-0.474^{***} (0.143)	-0.004 (0.012)
Netherlands	0.081^{***} (0.020)	-0.002 (0.004)
Niger	-0.117 (0.150)	-0.027^{**}(0.013)
Nigeria	0.030 (0.051)	-0.006 (0.012)
Norway	0.045 (0.031)	-0.013^{**}(0.006)
Panama	0.223^{***} (0.087)	-0.012 (0.007)
Philippines	0.126^{**} (0.060)	0.003 (0.004)
Poland	0.307^{***} (0.026)	0.023^{***} (0.008)
Portugal	0.047 (0.037)	-0.005 (0.005)
Qatar	0.417^{***} (0.156)	0.002 (0.007)
Romania	0.292^{***} (0.050)	0.074^{**} (0.037)
Senegal	0.087 (0.104)	0.030^{**} (0.014)
Singapore	-0.323^{***} (0.110)	-0.021^{**}(0.010)
South Africa	0.049 (0.039)	-0.002 (0.006)
Spain	0.157^{***} (0.022)	-0.003 (0.003)
Sri Lanka	-0.105 (0.074)	-0.010^{*}(0.006)
Sweden	-0.012 (0.012)	-0.010^{***}(0.004)
Switzerland	0.202^{***} (0.037)	-0.009 (0.007)
Tanzania	0.045 (0.072)	0.015 (0.013)
Thailand	0.031 (0.047)	0.002 (0.004)
Trinidad and Tobago	0.101 (0.179)	0.005 (0.007)
Tunisia	0.202^{***} (0.055)	-0.004 (0.008)
Turkey	0.195^{***} (0.034)	-0.002 (0.003)
United Kingdom	0.055^{***} (0.015)	0.002 (0.003)
United States	0.031 (0.023)	-0.002 (0.002)
Uruguay	-0.015 (0.059)	-0.012^{***}(0.005)

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
Standard errors are clustered by country-pair.

Therefore, it is interesting to see what is the effect of the events in China on the imports of the rest of the countries. For that reason, I have estimated for each country how its imports are affected by events in China, on the one hand, and events in the rest of the countries as a whole, on the other. The results show[9] that most countries were affected by what happened in China. This fact does not prevent other specific countries, probably the big partners, from also having an impact. The exceptions are Cyprus, Finland (significant only at 10%), India, Niger (significant only at 10%), Norway, Romania, Switzerland, Trinidad and Tobago and Uruguay. Only India is a relevant partner of China, the rest have only marginal trade relationships. In other words, climate change will have a greater impact when its manifestation occurs mainly in big traders, and that is precisely where this occurs.

[9] Regressions provided upon request.

Table 3.3. Trade and Climate change. The case of China and Japan. Period 1986-2016.

	(1)	(2)	(3)
Dependent variable	Nominal trade flows in current US dollars	Nominal trade flows in current US dollars	Nominal trade flows in current US dollars
$Wildfire_{ijt}$	0.035***		
	(0.008)		
$Wildfire\text{-}no\text{-}China_{ijt}$		0.032***	
		(0.008)	
$Wildfire\text{-}China_{ijt}$		0.046***	
		(0.008)	
$Wildfire\text{-}no\text{-}Japan_{ijt}$			0.034***
			(0.007)
$Wildfire\text{-}Japan_{ijt}$			-0.007
			(0.011)
$Flood_{ijt}$	0.000		
	(0.002)		
$Flood\text{-}no\text{-}China_{ijt}$		0.000	
		(0.002)	
$Flood\text{-}no\text{-}Japan_{ijt}$			0.001
			(0.002)
$Flood\text{-}Japan_{ijt}$			-0.008
			(0.007)
Ext_Temp_{ijt}	-0.062***		
	(0.016)		
$Ext\_Temp\text{-}no\text{-}China_{ijt}$		-0.058***	
		(0.017)	
$Ext\_Temp\ \text{-}China_{ijt}$		-0.062***	
		(0.019)	
$Ext\_Temp\text{-}no\text{-}Japan_{ijt}$			-0.020*
			(0.012)
$Ext\_Temp\ \text{-}Japan_{ijt}$			-0.203***
			(0.032)
$Epidemic_{ijt}$	-0.062***		
	(0.019)		
$Epidemic\text{-}no\text{-}China_{ijt}$		-0.068***	
		(0.019)	
$Epidemic\text{-}China_{ijt}$		-0.040*	
		(0.023)	
$Epidemic\text{-}no\text{-}Japan_{ijt}$			-0.066***
			(0.019)
$Epidemic\text{-}Japan_{ijt}$			0.037
			(0.041)
$Insect_{ijt}$	-0.256***		
	(0.068)		
$Insect\text{-}no\text{-}China_{ijt}$		-0.226***	
		(0.071)	
$Insect\text{-}China_{ijt}$		-0.293***	
		(0.107)	
$Insect\text{-}no\text{-}Japan_{ijt}$			-0.300***
			(0.065)
$Insect\text{-}Japan_{ijt}$			-0.014
			(0.092)

Table 3.3. Trade and Climate change. The case of China and Japan. Period 1986-2016. (cont.)

	(1)	(2)	(3)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
$Storm_{ijt}$	-0.011***		
	(0.003)		
$Storm\text{-}no\text{-}China_{ijt}$		-0.004	
		(0.003)	
$Storm\text{-}China_{ijt}$		-0.027***	
		(0.006)	
$Storm\text{-}no\text{-}Japan_{ijt}$			-0.006**
			(0.003)
$Storm\text{-}Japan_{ijt}$			-0.024***
			(0.008)
$Drought_{ijt}$	0.002		
	(0.015)		
$Drought\text{-}no\text{-}China_{ijt}$		-0.018	
		(0.014)	
$Drought\text{-}China_{ijt}$		0.054*	
		(0.029)	
$Drought\text{-}no\text{-}Japan_{ijt}$			-0.003
			(0.014)
$Drought\text{-}Japan_{ijt}$			0.038
			(0.059)
$Landslide_{ijt}$	-0.021***		
	(0.006)		
$Landslide\text{-}no\text{-}China_{ijt}$		-0.038***	
		(0.009)	
$Landslide\text{-}China_{ijt}$		-0.029***	
		(0.009)	
$Landslide\text{-}no\text{-}Japan_{ijt}$			-0.015***
			(0.005)
$Landslide\text{-}Japan_{ijt}$			-0.050**
			(0.020)
Observations	136.153	136.153	136.153
Country-pair FE	Yes	Yes	Yes
Importer-year and Exporter-year FE	Yes	Yes	Yes
Domestic trade	Yes	Yes	Yes
Pseudo R2	.99	.99	.99

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

The coefficients for PTAs, GATT-OMC and the constant have been omitted for brevity.

Standard errors are clustered by country-pair.

3.4.2. General Equilibrium and Welfare.

Finally, I perform a General Equilibrium analysis that closely follows the implementation of Baier et al. (2019)[10] and which is based on partial (equilibrium) estimations from column 1 of Table 3. The starting point (see, for instance, Costinot & Rodríguez-Clare, 2014) is a theoretical model for international trade flows based on an Armingon-CES model with a single sector being labor (L) the only factor of production of the (standard) type:

$$X_{ij} = \frac{A_i w_i^{-\theta} \tau_{ij}^{-\theta}}{\sum_k A_k w_k^{-\theta} \tau_{kj}^{-\theta}} E_j \qquad (3.2)$$

where i is origin, j destination, X are trade flows (domestic, when i coincides with j, and international, if it is not the case), A is the level of technology, w is the cost of production (wages), τ are iceberg trade costs, θ is the elasticity of substitution across (differentiated) goods, which is also assumed to be the trade elasticity, and E is total expenditure. It is the case that $E_j \equiv \sum_i X_{ij}$. In the model, trade unbalances (D, assumed exogenous) are introduced additively to expenditure[11], $E_j \equiv w_j L_j + D_j$.

[10] To explain the General Equilibrium, I closely follow Baier et al. (2019) and Thomas Zylkin´s web page http://www.tomzylkin.com/uploads/4/1/0/4/41048809/help_file.pdf, where the Stata command (ge_gravity) and the methodology are described.

[11] The existence of trade unbalances implies that the change in real wages does not exactly coincide with the change in welfare. However, the changes in real wages and welfare will be the same if

As stated, the partial effects of the occurrence of an event on trade (assuming that wages as fixed) are the result of estimating the structural gravity equation (column 1 of Table 3). Therefore, the direct trade impact of lowering trade barriers associated with a specific event is $\beta = -\theta \Delta ln\tau_{ijt}$.

When simulating a general equilibrium, it should be the case that a country's labor income is the result of the value of the country's shipments to all destinations $Y_i \equiv w_i L_i \equiv \sum_j X_{ij}$. Then,

$$w_i L_i = \sum_j \frac{A_i w_i^{-\theta} \tau_{ij}^{-\theta}}{\sum_k A_k w_k^{-\theta} \tau_{kj}^{-\theta}} \left(w_j L_j + D_j \right) \quad \forall i \tag{3.3}$$

Furthermore, the price levels in each country can be expressed as $P_j \equiv \left[\sum_k A_k w_k^{-\theta} \tau_{kj}^{-\theta} \right]^{-\frac{1}{\theta}}$.

Therefore, wages in a country are a function of its ability both to sell in markets with strong demand and to buy in technologically advanced markets. The system of equations determined by (3) is solved if we consider variations in the variables. Following the notation of Dekle et al. (2007), consider $\widehat{w}_i = \frac{w_i^{'}}{w_i}$, the

the "multiplicative" alternative is considered, which assumes national expenditure as a fixed multiple of national output. In any case, the differences between both alternatives are usually quite small and qualitatively similar.

change in wages (or any other variable) in country "i" as a result of the occurrence of an event. Because of $\hat{\tau}_{ij}^{-\theta} = e^{\beta xevent_i}$, we have that:

$$Y_i\widehat{w}_i = \widehat{w}_i^{-\theta} \sum_j \frac{\pi_{ij} e^{\beta xevent_i}}{\hat{P}_j^{-\theta}} \left(Y_j\widehat{w}_j + D_j\right) \quad \forall i \tag{3.4}$$

where $\pi_{ij} \equiv \frac{X_{ij}}{E_j}$ are trade shares and $\hat{P}_j \equiv \left[\sum_k \pi_{kj} \widehat{w}_k^{-\theta} e^{\beta xevent_j}\right]^{-\frac{1}{\theta}}$

To find a solution to equation (4) we only need information on trade flows (domestic and international),[12] production and expenditure levels of the countries. Furthermore, it is necessary to assign a value to the trade elasticity θ. Following Baier et al. (2019) we consider that θ=4.[13] Also, since the trade is done in nominal terms, the algorithm performs the normalization $\sum_i Y_i\widehat{w}_i = \sum_i Y_i$. This implies that world output remains constant under the baseline and counterfactual.

Therefore, changes in welfare are measured as follows[14]:

$$\widehat{W}_i = \frac{\hat{E}_i}{\hat{P}_i} \tag{3.5}$$

where $\hat{E}_i = \frac{Y_i\widehat{w}_i}{E_i}$

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[12] Explaining the Stata command on his website, Thomas Zylkin states this clear cautionary note: *"One common issue that researchers new to these methods should be aware of is that GE trade models require a "square" data set with information on internal trade flows in addition to data on international trade flows."*.

[13] They follow the recommendations of Simonovska and Waugh (2014).

[14] I focus on changes in welfare, although Stata´s command output also provides us with trade volumes and changes in nominal wages and prices.

The estimates based on equation (5) for temperatures and events as a whole and for each of our eight events are shown in Table 5, in which I present the change in welfare in percentage terms.[15] In the Appendix, I provide the Stata output for all events and countries. It should be clear that these estimations are based on the average estimated coefficients show in the second and four columns of Table 1 and in the first column of Table 3, which are common for every country. I have considered just the estimated coefficients that are significant. Therefore, no change in welfare is considered for floods and droughts. Table 5 shows the average, maximum and minimum values across countries. I consider the trade balance of the first year of the sample (1986) as the baseline for the counterfactual.

Some interesting conclusions can be drawn from Table 5. Temperatures, by increasing international trade with respect to domestic one, increase welfare on average while the contrary occurs with events. With respect to specific events, some comments are in order. First, *Insect infestation* and *Extreme temperatures* cause the largest reduction in average welfare, especially the first one. Second, *Landslides* and *Storms* also reduce welfare, but to a much lesser extent. In all four cases, the reduction in welfare is generalised. Third, *Floods* and *Droughts* have null impact on welfare. As before stated, it is important to take into account that these events did not present significant estimated parameters.

[15] The output in Stata is the new level of welfare divided by the old level of welfare.

Fourthly, *Wildfires*, with a positive and significant estimated parameter (which implies that the costs of domestic trade increase with respect to international ones) have a positive (and generalised) effect on welfare. Finally, *Epidemics*, although they have a positive average effect on welfare, have a mixed impact on welfare (although in most cases it is positive). In the latter case, two comments can be made. On the one hand, although the estimated average parameter (partial equilibrium) is almost identical to that of *Extreme Temperatures*, the consequences on welfare are very different. On the other hand, and in connection with the previous point, what matters for welfare is the different evolution of nominal wages and prices across countries.

However, we cannot be happy with this average results. As shown, the impact of temperatures and the distinct types of events on international trade is quite different by countries. Therefore, it is relevant to calculate the change in welfare of each country based on its own estimated coefficients. The results are shown in Table 6. As expected, the impact on welfare of our variables of interest is quite distinct in each country. An additional comment is in order. There is no point in calculating a net impact and the reason is clear. The values obtained imply the result on welfare of the impact of the rising temperatures along a specific period of time and the occurrence of all the events (where the respective coefficients are significant) in a given year "at the same time". However, as we have seen, for instance, insect infestations are quite rare events.

Table 3.4. Impact of the type of events on trade by country.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country	**Events**	**Wildfire**	**Flood**	**Extreme**	**Epidemic**	**Insect infestation**	**Storm**	**Drought**	**Landslide**
Whole sample	-0.005*** (0 .002)	0.035*** (0.008)	0.000 (0.002)	−0.062*** (0.016)	−0.062*** (0.019)	−0.256*** (0.068)	−0.011*** (0.003)	0.002 (0.015)	−0.021*** (0.006)
Australia	-0.005 (0.004)	NS	-0.087** (0.004)	NS	NS	NS	NS	NS	−0.020** (0.009)
Austria	0.005 (0.004)	0.081*** (0.011)	NS	NS	−0.108*** (0.040)	−0.286*** (0.091)	NS	NS	−0.051** (0.025)
Belgium	0.005 (0.009)	0.085*** (0.022)	0.019** (0.009)	NS	0.147*** (0.062)	NS	-0.029** (0.014)	NS	NS
Bolivia	0.020** (0.009)	NS	NS	NS	−0.171*** (0.084)	−0.346** (0.139)	0.028* (0.015)	0.123* (0.066)	NS
Brazil	0.003 (0.002)	0.045*** (0.008)	0.012** (0.005)	NS	−0.083** (0.033)	−0.611*** (0.107)	-0.006* (0.003)	NS	NS
Bulgaria	0.022*** (0.006)	NS	0.068*** (0.010)	NS	-0.101* (0.053)	NS	-0.028** (0.013)	NS	−0.061*** (0.021)
Cameroon	0.023* (0.014)	0.112*** (0.023)	NS	-0.090** (0.037)	-0.215** (0.096)	-1.241*** (0.315)	NS	NS	NS
Canada	0.002 (0.003)	0.037*** (0.006)	0.010*** (0.003)	−0.069*** (0.021)	NS	−0.246* (0.142)	−0.009*** (0.003)	-0.038* (0.020)	NS
Chile	0.004 (0.003)	0.049*** (0.015)	NS	NS	-0.166*** (0.048)	-0.347* (0.134)	NS	NS	-0.032*** (0.009)
China	-0.010***(0.003)	0.046*** (0.008)	excluded	−0.062*** (0.019)	−0.040* (0.023)	−0.293*** (0.107)	−0.027*** (0.006)	0.054* (0.029)	−0.029*** (0.009)
Colombia	0.003 (0.006)	NS	NS	-0.073* (0.042)	NS	-0.492*** (0.163)	NS	NS	NS
Costa Rica	-0.002 (0.006)	0.056*** (0.018)	NS	NS	-0.176*** (0.61)	-0.901*** (0.224)	NS	NS	NS
Cyprus	-0.005 (0.007)	0.056** (0.024)	NS	-0.079* (0.042)	-0.165** (0.065)	-0.727*** (0.211)	0.015* (0.008)	-0.119** (0.053)	NS
Denmark	-0.014***(0.003)	NS	-0.012** (0.005)	-0.120*** (0.033)	-0.076** (0.035)	-0.351*** (0.104)	-0.018*** (0.006)	NS	-0.025** (0.010)
Ecuador	-0.002 (0.005)	NS	NS	NS	-0.151*** (0.038)	NS	NS	NS	NS
Egypt	0.004 (0.005)	NS	0.014** (0.005)	NS	-0.225*** (0.043)	-0.684*** (0.173)	NS	NS	NS
Finland	-0.016**(0.007)	0.026** (0.012)	NS	-0.109** (0.044)	NS	NS	-0.035** (0.017)	NS	NS
France	-0.008**(0.003)	0.021* (0.012)	-0.010** (0.004)	-0.040*** (0.013)	-0.092*** (0.028)	-0.346*** (0.123)	-0.009** (0.003)	NS	NS
Germany	-0.007***(0.002)	0.031** (0.012)	NS	NS	-0.086*** (0.021)	-0.378*** (0.103)	-0.010*** (0.003)	NS	-0.027* (0.014)
Greece	−0.008* (0.005)	0.073*** (0.019)	NS	-0.092*** (0.028)	-0.095*** (0.037)	NS	NS	NS	NS
Hungary	0.004 (0.011)	0.086** (0.040)	NS	0.076* (0.039)	-0.109** (0.055)	NS	NS	NS	0.050*** (0.019)
Iceland	0.001 (0.006)	NS	NS	-0.065* (0.034)	-0.139*** (0.052)	NS	-0.016** (0.008)	0.081*** (0.026)	-0.081* (0.047)
India	-0.003 (0.005)	0.049** (0.020)	0.010* (0.005)	0.092* (0.055)	-0.188*** (0.036)	-0.757*** (0.210)	NS	0.057** (0.027)	NS
Indonesia	-0.011 (0.006)	-0.078* (0.046)	-0.016** (0.006)	-0.060* (0.034)	-0.058*** (0.020)	NS	NS	NS	-0.041*** (0.015)
Iran	0.016 (0.011)	NS	NS	NS	-0.181** (0.071)	-0.815** (0.136)	NS	NS	0.050* (0.030)
Ireland	-0.004 (0.006)	NS	NS	NS	0.085* (0.048)	NS	-0.027** (0.010)	NS	NS
Israel	0.003 (0.006)	0.037*** (0.013)	NS	-0.052* (0.031)	-0.216*** (0.054)	-1.088*** (0.187)	NS	NS	NS
Italy	-0.013***(0.003)	0.037*** (0.012)	-0.023*** (0.006)	-0.114*** (0.018)	-0.055** (0.024)	-0.353*** (0.106)	-0.008** (0.003)	NS	-0.016** (0.007)
Japan	-0.020***(0.004)	NS	NS	−0.203*** (0.032)	NS	NS	−0.024*** (0.008)	NS	−0.050** (0.020)
Jordan	0.001 (0.008)	NS	NS	NS	NS	NS	0.012* (0.006)	NS	NS
Kenya	0.013 (0.009)	NS	0.039** (0.017)	NS	-0.160*** (0.044)	-0.659*** (0.222)	NS	NS	NS
Korea	−0.007* (0.004)	NS	NS	NS	NS	-0.173* (0.091)	-0.016** (0.008)	NS	-0.025*** (0.007)
Kuwait	-0.003 (0.007)	-0.062** (0.026)	NS	NS	-0.130*** (0.040)	-0.576** (0.274)	NS	NS	NS
Macao	-0.031 (0.027)	NS	-0.071*** (0.013)	-0.610* (0.322)	0.114* (0.064)	1.184*** (0.203)	-0.061* (0.036)	0.205*** (0.059)	-0.269*** (0.048)
Malawi	0.043 (0.034)	0.535** (0.246)	NS	NS	-0.311*** (0.069)	NS	0.163*** (0.052)	NS	NS

Table 3.4. Impact of the type of events on trade by country. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country	**Events**	**Wildfire**	**Flood**	**Extreme**	**Epidemic**	**Insect infestation**	**Storm**	**Drought**	**Landslide**
Malaysia	-0.003 (0.007)	NS	NS	NS	NS	-0.526*** (0.146)	NS	NS	NS
Malta	0.002 (0.008)	0.081*** (0.018)	NS	NS	-0.219*** (0.063)	-0.907*** (0.233)	NS	NS	NS
Mauritius	0.003 (0.005)	NS	NS	-0.061* (0.031)	-0.127*** (0.034)	NS	NS	NS	-0.055*** (0.011)
Mexico	0.013*** (0.003)	0.075*** (0.013)	0.012* (0.007)	-0.119** (0.057)	-0.204*** (0.036)	-1.026*** (0.166)	0.019*** (0.006)	NS	NS
Morocco	−0.014* (0.008)	NS	NS	NS	-0.272** (0.131)	-0.745** (0.300)	NS	NS	NS
Myanmar	0.027 (0.027)	0.206** (0.085)	NS	NS	NS	-0.493** (0.250)	NS	NS	NS
Nepal	-0.004 (0.012)	0.219** (0.109)	NS	NS	NS	NS	NS	-0.109* (0.066)	NS
Netherlands	-0.002 (0.004)	0.040*** (0.013)	NS	-0.091*** (0.024)	-0.285*** (0.070)	-0.658*** (0.166)	NS	NS	NS
Niger	-0.027**(0.013)	0.095** (0.038)	NS	NS	NS	-0.840*** (0.282)	-0.048** (0.020)	NS	NS
Nigeria	-0.006 (0.012)	NS	NS	NS	-0.233*** (0.038)	-0.801*** (0.168)	NS	NS	NS
Norway	-0.013**(0.006)	NS	-0.020** (0.008)	NS	-0.148** (0.066)	-0.642*** (0.188)	NS	NS	NS
Panama	-0.012 (0.007)	NS	NS	-0.110* (0.056)	NS	-0.836*** (0.144)	-0.023** (0.010)	NS	NS
Philippines	0.003 (0.004)	0.061*** (0.016)	0.015* (0.008)	NS	-0.110*** (0.025)	-0.554*** (0.197)	NS	NS	-0.025*** (0.009)
Poland	0.023*** (0.008)	NS	0.022*** (0.007)	0.175*** (0.030)	-0.215*** (0.052)	-0.819** (0.155)	NS	NS	NS
Portugal	-0.005 (0.005)	0.048** (0.020)	NS	-0.083*** (0.021)	-0.065* (0.035)	-0.432** (0.188)	NS	-0.054* (0.030)	NS
Qatar	0.002 (0.007)	0.048* (0.026)	-0.027** (0.014)	NS	-0.304** (0.153)	-1.286*** (0.046)	NS	NS	-0.073*** (0.024)
Romania	0.074** (0.037)	NS	0.168*** (0.043)	0.310*** (0.066)	0.308*** (0.110)	-1.035*** (0.313)	NS	NS	NS
Senegal	0.030** (0.014)	NS	NS	NS	NS	NS	NS	0.312* (0.179)	-0.059** (0.028)
Singapore	-0.021**(0.010)	NS	NS	-0.209* (0.114)	NS	NS	-0.045** (0.020)	NS	NS
South Africa	-0.002 (0.006)	NS	NS	-0.054** (0.026)	-0.127*** (0.033)	-0.514* (0.282)	NS	NS	NS
Spain	-0.003 (0.003)	NS	0.010* (0.006)	-0.044** (0.017)	-0.089*** (0.030)	-0.593*** (0.112)	NS	-0.037* (0.021)	NS
Sri Lanka	−0.010* (0.006)	NS	NS	NS	-0.111** (0.047)	NS	NS	NS	NS
Sweden	-0.010***(0.004)	NS	NS	-0.101*** (0.029)	NS	NS	-0.013** (0.005)	NS	-0.023** (0.010)
Switzerland	-0.009 (0.007)	0.044* (0.023)	-0.029** (0.012)	NS	-0.124*** (0.031)	NS	NS	0.088** (0.043)	-0.124*** (0.036)
Tanzania	0.015 (0.013)	0.082*** (0.030)	NS	NS	-0.147*** (0.055)	NS	0.043*** (0.013)	NS	-0.039* (0.023)
Thailand	0.002 (0.004)	NS	0.011* (0.005)	NS	-0.084*** (0.029)	-0.417*** (0.160)	NS	NS	-0.030* (0.016)
Trinidad and	0.005 (0.007)	0.048* (0.029)	0.023* (0.014)	NS	NS	NS	NS	-0.095** (0.047)	NS
Tunisia	-0.004 (0.008)	NS	NS	NS	-0.234*** (0.046)	NS	NS	NS	NS
Turkey	-0.002 (0.003)	NS	NS	NS	-0.109*** (0.041)	-0.665*** (0.197)	NS	NS	-0.024** (0.012)
United Kingdom	0.002 (0.003)	0.025*** (0.008)	NS	-0.030* (0.016)	NS	-0.197** (0.092)	NS	NS	NS
United States	-0.002 (0.002)	0.029*** (0.009)	NS	-0.091*** (0.023)	NS	-0.177** (0.086)	-0.008** (0.003)	NS	-0.014* (0.008)
Uruguay	-0.012***(0.005)	0.047** (0.023)	NS	-0.086** (0.038)	NS	-0.506*** (0.102)	NS	NS	NS

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
Standard errors are clustered by country-pair.

Table 3.5. General Equilibrium. Welfare effect (% change).

Event	Average Impact	Highest Impact	Lowest Impact
Temperature$_{ijt}$	0.14%	0.16%	0.15%
Events$_{ijt}$	-0.03%	-0.09%	-0.01%
Wildfire$_{ijt}$	0.23%	0.67%	0.02%
Floodi$_{jt}$	0.00%	0.00%	0.00%
Ext_Temp$_{ijt}$	-0.40%	-1.15%	-0.04%
Epidemic$_{ijt}$	0.56%	6.93%	-0.08%
Insecti$_{jt}$	-1.56%	-4,36%	-0.17%
Storm$_{ijt}$	-0.07%	-0.22%	-0.01%
Drought$_{ijt}$	0.00%	0.00%	0.00%
Landslide$_{ijt}$	-0.14%	-0.39%	-0.01%

Note: The numbers are the average of the sample of countries.

Table 3.6. Specific welfare effects of rising temperatures and types of events by countries.

Country	Temperature	Wildfire	Flood	Extreme temperatures	Epidemic	Insect infestation	Storm	Drought	Landslide
Australia			-0.05%						-0.09%
Austria	0.81%	0.61%			-0.75%	-1.85%			-0.36%
Belgium	-0.39%	0.37%	0.08%		0.65%		-0.12%		
Bolivia	1.75%				-1.46%	-2.84%	0.25%	1.13%	
Brazil	0.08%	0.04%	0.01%		-0.07%	-0.42%	-0.01%		
Bulgaria	0.26%		0.05%		-0.07%		-0.02%		-0.04%
Cameroon		1.00%		-0.77%	-1.79%	-8.68%			
Canada		0.28%	0.07%	-0.49%		-1.61%	-0.07%	-0.28%	
Chile	0.61%	0.28%			-0.83%	-1.61%			-0.17%
China		0.06%		-0.09%	-0.06%	-0.41%	-0.05%	0.08%	-0.03%
Colombia				-0.24%		-1.48%			
Costa Rica		0.29%			-0.86%				
Cyprus	3.98%	0.55%		-0.77%	-1.58%	-6.34%	0.15%	-1.15%	
Denmark			-0.15%	-1.40%	-0.91%	-3.74%	-0.22%		-0.31%
Ecuador					-0.98%				
Egypt	1.31%		0.07%		-1.12%	-3.19%			
Finland	-0.25%	0.16%		-0.63%			-0.21%		
France		0.11%	-0.05%	-0.21%	-0.48%	-1.59%	-0.05%		
Germany	0.28%	0.15%			-0.39%	-1.55%	-0.05%		-0.13%
Greece		0.53%		-0.64%	-0.66%				
Hungary	1.63%	0.24%		0.21%	-0.28%				0.14%
Iceland				-0.47%	-0.97%		-0.12%	0.60%	-0.57%
India	0.63%	0.10%	0.02%	0.19%	-0.35%	-1.21%		0.12%	
Indonesia	-1.14%	-0.41%	-0.09%	-0.32%	-0.31%				-0.22%
Iran	-2.51%				-1.54%	-6.25%			0.44%
Ireland					1.24%		-0.39%		
Israel	1.00%	0.19%		-0.25%	-0.98%	-3.48%			
Italy	-0.30%	0.24%	-0.15%	-0.70%	-0.34%	-1.95%	-0.05%		-0.11%
Japan	-0.31%			-0.38%			-0.05%		-0.10%
Jordan							0.07%		
Kenya			0.16%		-0.66%	-2.51%			
Korea						-0.82%	-0.09%		-0.13%
Kuwait	-0.21%	-0.77%			-1.57%	-5.84%			
Malta		0.90%			-2.20%	-7.44%			
Mauritius	-1.69%			-0.64%	-1.29%				-0.59%
Macao			-2.40%			-7.92%		0.06%	-8.23%

Table 3.6. Specific welfare effects of rising temperatures and types of events by countries. (cont.)

Country	Temperature	Wildfire	Flood	Extreme temperatures	Epidemic	Insect infestation	Storm	Drought	Landslide
Mexico	3.39%	0.59%	0.09%	-0.85%	-1.40%	-5.01%	0.15%		
Myanmar		3.05%				-1.15%			
Morocco	3.49%				-1.44%	-3.46%			
Myanmar		0.00%				0.00%			
Nepal	-3.43%	1.89%						-0.86%	
Netherlands	1.12%	0.55%		-1.17%	-3.36%	-6.63%			
Niger		1.84%				-11.42%	-0.90%		
Nigeria					-1.11%	-3.59%			
Norway			-0.16%		-1.16%	-4.17%			
Panama	1.73%			-0.79%		-5.12%	-0.17%		
Philippines	0.77%	0.36%	0.09%		-0.60%	-2.47%			-0.14%
Poland	0.29%		0.02%	0.16%	-0.16%	-0.48%			
Portugal		0.39%		-0.63%	-0.50%	-2.80%		-0.42%	
Qatar	3.58%	0.38%	-0.21%		-2.18%	-7.58%			-0.56%
Romania	0.33%		0.19%	0.35%	0.35%	-0.10%			
Senegal								1.24%	-0.21%
Singapore	-5.34%			-3.63%			-0.85%		
South Africa				-0.23%	-0.53%	-1.83%			
Spain	0.66%		0.04%	-0.17%	-0.34%	-1.83%		-0.14%	
Sri Lanka					-0.14%				
Sweden				-1.02%			-0.14%		-0.25%
Switzerland	1.20%	0.25%	-0.16%		-0.64%			0.50%	-0.65%
Tanzania		0.81%			-1.39%		0.42%		-0.38%
Thailand			0.04%		-0.26%	-1.10%			-0.10%
Trinidad and Tobago		0.42%	0.20%					-0.78%	
Tunisia	1.09%				-0.65%				
Turkey	0.75%				-0.38%	-1.92%			-0.09%
United Kingdom	0.31%	0.14%		-0.16%		-1.01%			
United States		0.07%		-0.19%		-0.36%	-0.02%		-0.03%
Uruguay		0.07%		-0.19%		-0.36%			

3.5. Conclusions.

In Chapter 3, I have analysed the impact of climate change on international flows through a solid econometric methodology. I have estimated a theory-consistent gravity equation using annual data from a sample of 67 countries over the period 1986-2016. My main variables of interest are *temperatures* and *extreme climate events* (*wildfire, floods, extreme temperatures, epidemics, insect infestation, storms, droughts, and landslides*).

The results suggest that the increase in temperatures raises the trade costs of domestic flows relative to international ones, while the opposite occurs with events. However, the analysis reveals a remarkable degree of heterogeneity across countries (and across events). In particular, I find that the estimated impact of the events is mainly due to the influence of China and Japan on the estimations. In the first case, what matters are the storms; while in the second, extreme temperatures are the relevant phenomenon. In general, extreme climate events have a negative impact on welfare, although there are exceptions.

3.6 References

Abman, R, Lundberg, Clark and Ruta, M. (2021). The Effectiveness of Environmental Provisions in Regional Trade Agreements. Policy Research Working Paper 9601. World Bank, Washington, DC.

Anderson, J.E. (1979). A theoretical foundation to the gravity equation. American Economic Review, 69, pp. 106–116.

Anderson, J.E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93 (1), pp. 170-192.

Antweiler, W., B. Copeland, and Taylor, S. (2001). Is Free Trade Good for the Environment? *American Economic Review*, 91 (4), pp. 877–908.

Babin, J., Lasserre, F. and Pic, P. (2020). *Arctic Shipping and Polar Seaways* in Encyclopedia of Water: Science, Technology, and Society, Ch. 140, pp.1539-1550, Wiley.

Baghdadi, L., Martinez-Zarzoso, I. and Zitouna, H. (2013). "Are RTA agreements with environmental provisions reducing emissions?", *Journal of International Economics*, 90 (2): 378-390.

Baier, S.C. and Bergstrand, J.H. (2001). The growth and world trade: tariff, transport cost, and income similarity. Journal of International Economics 53 1–27.

Baier, S. L. & Bergstrand, J. H. (2007). “Do free trade agreements actually increase members´ international trade?”, *Journal of International Economics,* 71, 72-95.

Baier, S. L., Yotov, Y. V. & Zylkin, T. (2019). “On the widely differing effects of free trade agreements: Lessons from twenty years of trade integration”, *Journal of International Economics*, 116, 206-226.

Baldwin. R., & Taglioni, D. (2007). “Trade effects of the euro: a comparison of estimators”, *Journal of Economic Integration*, 22 (4), 780-818.

Bekkers, E., Francois, J. F. and Rojas-Romagosa, H. (2015). “Melting ice caps and the economic impact of opening the Northern Sea Route”, *The Economic Journal,* 128 (May), pp. 1095-1127.

Bellmann, C. and Bulatnikova, A. (2022). “Incorporating environmental provisions in regional trade agreements”, OECD Trade and Environment Working Papers 2022/01.

Bergstrand, J.H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. Review of Economics and Statistics, 67, pp. 474–481.

Bergstrand, J. H., Larch, M., & Yotov, Y. V. (2015). "Economic integration agreements, border effects, and distance elasticities in the gravity equation", *European Economic Review*, 78, 307-327.

Beverelli, C., Keck, A., Larch, M. and Yotov, Y. V. (2023). Institutions, trade, and development: identifying the impact of country-specific characteristics on international trade, Oxford Economic Papers, gpad014, https://doi.org/10.1093/oep/gpad014

Costinot, A., and Rodríguez-Clare, A. (2014). "Trade Theory with Numbers: Quantifying the Consequences of Globalization", Handbook of International Economics (Ch. 4), Vol. IV, (Eds. Gita Gopinath, Elhanan Helpman and Kenneth S. Rogoff eds.), Elsevier Ltd., Oxford, pp. 197-261.

Clive, G. and Shunta, Y. (2018). "Assessing Implementation of Environmental Provisions in Regional Trade Agreements", OECD Trade and Environment Working Papers 2018/01.

Copeland, B. and S. Taylor. (2003). Trade and Environment: Theory and Evidence, Princeton University Press, Princeton.

Deardoff, A.V. (1998). Determinants of bilateral trade: does gravity work in a neoclassic world? In The Regionalization of the World Economy, edited by J. Frankel. Chicago: University of Chicago Press.

Dekle, R., Eaton, J. and Kortum, S. (2007). “Unbalanced Trade”, *American Economic Review*, 97 (2), pp. 351–355.

Deryugina, T. and Hsiang, M. (2014). “Does the environment still matter? Daily temperature and income in the United States”, NBER Working Paper 20750.

Felbermayr, G. and Gröschl, J. (2013). “Natural disasters and the effect of trade on income: A new panel IV approach”, *European Economic Review*, 58, pp. 18-30.

Gassebner, M, Keck, A. and The, R. (2010). “Shaken, not stirred: The impact of disasters on international trade”, *Review of International Economics*, 18 (2), pp. 351-368.

Gil-Pareja S, Llorca-Vivero R., & Martínez-Serrano J. A. (2008). “Assessing the enlargement and deepening of the European Union”. *The World Economy*, 31 (9), pp. 1253-1272.

Gosling S.N., Zaherpour J., Ibarreta D. (2018). “PESETA III: Climate change impacts on labor productivity”, JRC Technical Reports, European Union, in https://adaptecca.es/sites/default/files/documentos/2018_jrc_pesetaiii_impact_labor_productivity.pdf.

Grossman, G., and Krueger, A. B. (1992). Environmental Impacts of a North American Free Trade Agreement, CEPR Discussion Papers 644, London.

Hancock P. A., Ross J. M. and Szalma, J. L. (2007). “A Meta-Analysis of Performance Response Under Thermal Stressors. Human Factors”: *The Journal of the Human Factors and Ergonomics Society*, 49, pp. 851-877.

Klomp, J. and Hoogezand, B. (2018). “Natural disasters and agricultural protection: a panel data analysis”, *World Development*, 104, pp. 404-417.

Martínez-Zarzoso, I. (2018). Assessing the effectiveness of environmental provisions in regional trade agreements: An empirical analysis, OECD Trade and Environment Working Papers 2018/02.

Nizalova, O. Y. and Murtazashvili, I. (2016). “Exogenous Treatment and Endogenous Factors: Vanishing of Omitted Variable Bias on the Interaction Term,” *Journal of Econometric Methods*, 5 (1), pp. 71-77.

Santos Silva, J. M. C., & Tenreyro, S. (2006). “The log of gravity”, *The Review of Economics and Statistics*. 88 (4), pp. 641-658.

Simonovska, I. and Waugh, M. E., (2014). “The elasticity of trade: estimates and evidence”, *Journal of International Economics*, 92 (1), pp. 34–50.

Tinbergen, J. (1962). Shaping the World Economy. Twentieth Century Fund, New York.

Yamaguchi, S. (2020a). “Greening Regional Trade Agreements – Subsidies Related to Energy and Environmental Goods”, OECD Trade and Environment Working Papers 2020/01.

Yamaguchi, S. (2020b). “Greening Regional Trade Agreements on Investment”, OECD Trade and Environment Working Papers 2020/03.

Yotov Y. V. (2012). “A simple solution to the distance puzzle in international trade. Economic Letters, 117 (3), pp. 794-798.

3.7 APPENDIX

Appendix I

Output exit by countries from Stata for specific impacts of events.

I present the Stata order for the first country as an example. I have discarded all the irrelevant information (the coefficients of the globalization terms and the constant, for instance) showing the countries in alphabetical order (which does not necessarily coincide with the iso_3 nomenclature).

ppmlhdfe trade agree_pta member_gatt_wto_joint event_no_AUS events_o_AUS

_IyeaXint_1987- _IyeaXint_2016, a(exp#year imp#year exp#imp) cluster(exp#imp)

```
Iteration 1:   deviance = 2.6989e+08  eps = .          iters = 10   tol = 1.0e-04  min(eta) =  -5.75  P
Iteration 2:   deviance = 7.8958e+07  eps = 2.42e+00  iters = 9    tol = 1.0e-04  min(eta) =  -7.14
Iteration 3:   deviance = 3.3137e+07  eps = 1.38e+00  iters = 9    tol = 1.0e-04  min(eta) =  -8.74
Iteration 4:   deviance = 1.8983e+07  eps = 7.46e-01  iters = 9    tol = 1.0e-04  min(eta) = -10.68
Iteration 5:   deviance = 1.4727e+07  eps = 2.89e-01  iters = 9    tol = 1.0e-04  min(eta) = -12.73
Iteration 6:   deviance = 1.3542e+07  eps = 8.75e-02  iters = 8    tol = 1.0e-04  min(eta) = -13.97
Iteration 7:   deviance = 1.3233e+07  eps = 2.34e-02  iters = 8    tol = 1.0e-04  min(eta) = -15.02
Iteration 8:   deviance = 1.3155e+07  eps = 5.94e-03  iters = 6    tol = 1.0e-04  min(eta) = -16.37
Iteration 9:   deviance = 1.3135e+07  eps = 1.50e-03  iters = 5    tol = 1.0e-04  min(eta) = -17.45
Iteration 10:  deviance = 1.3130e+07  eps = 3.78e-04  iters = 4    tol = 1.0e-04  min(eta) = -18.44
Iteration 11:  deviance = 1.3129e+07  eps = 9.35e-05  iters = 2    tol = 1.0e-04  min(eta) = -19.43
Iteration 12:  deviance = 1.3129e+07  eps = 2.20e-05  iters = 4    tol = 1.0e-05  min(eta) = -20.38
Iteration 13:  deviance = 1.3129e+07  eps = 4.73e-06  iters = 2    tol = 1.0e-05  min(eta) = -21.25   S
Iteration 14:  deviance = 1.3129e+07  eps = 9.18e-07  iters = 4    tol = 1.0e-06  min(eta) = -22.11   S
Iteration 15:  deviance = 1.3129e+07  eps = 1.63e-07  iters = 5    tol = 1.0e-07  min(eta) = -23.02   S
Iteration 16:  deviance = 1.3129e+07  eps = 2.55e-08  iters = 4    tol = 1.0e-07  min(eta) = -23.79   S
Iteration 17:  deviance = 1.3129e+07  eps = 3.26e-09  iters = 5    tol = 1.0e-08  min(eta) = -24.29   S
Iteration 18:  deviance = 1.3129e+07  eps = 3.93e-10  iters = 5    tol = 1.0e-09  min(eta) = -24.46   S O
------------------------------------------------------------------------------------------------------------

(legend: p: exact partial-out   s: exact solver   h: step-halving   o: epsilon below tolerance)
Converged in 18 iterations and 108 HDFE sub-iterations (tol = 1.0e-08)
HDFE PPML regression                            No. of obs      =    136,153
Absorbing 3 HDFE groups                         Residual df     =      4,485
Statistics robust to heteroskedasticity         Wald chi2(34)   =    2927.75
Deviance             =  13128646.69             Prob > chi2     =     0.0000
Log pseudolikelihood =  -6897964.49             Pseudo R2       =     0.9978
Number of clusters (exp#imp)=      4,486
                              (Std. Err. adjusted for 4,486 clusters in exp#imp)
-------------------------------------------------------------------------------------
```

trade | Coef. Std. Err. z P>|z| [95% Conf. Interval]

agree_pta | .1217941 .0555695 2.19 0.028 .0128798 .2307083

member_gatt_wto_joint | 1.063973 .1086319 9.79 0.000 .8510579 1.276887

event_no_AUS | -.004514 .0019346 -2.33 0.020 -.0083057 -.0007223

events_o_AUS | -.0050434 .003566 -1.41 0.157 -.0120327 .0019458

agree_pta | .1218048 .0555551 2.19 0.028 .0129188 .2306907

member_gatt_wto_joint | 1.06433 .1086179 9.80 0.000 .8514426 1.277217

event_no_AUT | -.0045946 .0019133 -2.40 0.016 -.0083446 -.0008446

events_o_AUT | .0045522 .0036458 1.25 0.212 -.0025934 .0116977

agree_pta | .122038 .0555698 2.20 0.028 .0131233 .2309528

member_gatt_wto_joint | 1.065809 .1087634 9.80 0.000 .852637 1.278982

event_no_BEL | -.004784 .0019112 -2.50 0.012 -.0085299 -.0010382

events_o_BEL | .0048569 .0091353 0.53 0.595 -.013048 .0227618

agree_pta | .1218018 .0555534 2.19 0.028 .0129192 .2306844

member_gatt_wto_joint | 1.064024 .1086562 9.79 0.000 .8510617 1.276986

event_no_BOL | -.0045434 .0019093 -2.38 0.017 -.0082856 -.0008011

events_o_BOL | .0199781 .0087615 2.28 0.023 .0028058 .0371504

agree_pta | .1219826 .0555577 2.20 0.028 .0130915 .2308737

member_gatt_wto_joint | 1.064638 .108553 9.81 0.000 .8518779 1.277398

event_no_BRA | -.0046829 .0019249 -2.43 0.015 -.0084557 -.0009102

events_o_BRA | .0027624 .0017855 1.55 0.122 -.0007371 .0062618

agree_pta | .1215715 .0555636 2.19 0.029 .0126689 .2304741

member_gatt_wto_joint | 1.06268 .1086789 9.78 0.000 .8496732 1.275687

event_no_BGR | -.0045496 .0019091 -2.38 0.017 -.0082913 -.0008079

events_o_BGR | .0224367 .0056741 3.95 0.000 .0113156 .0335578

agree_pta | .1217881 .0555535 2.19 0.028 .0129054 .2306709

member_gatt_wto_joint | 1.063962 .1086531 9.79 0.000 .8510057 1.276918

event_no_CMR | -.0045391 .0019092 -2.38 0.017 -.008281 -.0007971

events_o_CMR | .0227839 .0136684 1.67 0.096 -.0040058 .0495735

agree_pta | .1201065 .0556869 2.16 0.031 .0109622 .2292508

member_gatt_wto_joint | 1.068181 .1088107 9.82 0.000 .8549164 1.281446

event_no_CAN | -.0051574 .0019269 -2.68 0.007 -.008934 -.0013808

events_o_CAN | .0023042 .0026732 0.86 0.389 -.0029352 .0075435

agree_pta | .1218891 .0555596 2.19 0.028 .0129942 .2307839

member_gatt_wto_joint | 1.064138 .1086285 9.80 0.000 .8512303 1.277046

event_no_CHL | -.0045887 .0019152 -2.40 0.017 -.0083425 -.000835

events_o_CHL | .0038667 .0029526 1.31 0.190 -.0019204 .0096537

agree_pta | .1209289 .0554311 2.18 0.029 .0122859 .2295719

member_gatt_wto_joint | 1.115174 .1133621 9.84 0.000 .8929882 1.337359

event_no_CHN | -.0011862 .0018778 -0.63 0.528 -.0048665 .0024942

events_o_CHN | -.009512 .0030515 -3.12 0.002 -.0154929 -.003531

agree_pta | .121706 .0555535 2.19 0.028 .0128232 .2305889

member_gatt_wto_joint | 1.064122 .1086425 9.79 0.000 .8511863 1.277057

event_no_COL | -.0045649 .0019131 -2.39 0.017 -.0083144 -.0008153

events_o_COL | .0025741 .0059052 0.44 0.663 -.0089998 .0141481

agree_pta | .1217884 .0555533 2.19 0.028 .012906 .2306709

member_gatt_wto_joint | 1.06398 .1086618 9.79 0.000 .8510071 1.276953

event_no_CRI | -.0045309 .0019108 -2.37 0.018 -.008276 -.0007858

events_o_CRI | -.0024843 .0056394 -0.44 0.660 -.0135373 .0085687

agree_pta | .1217727 .0555533 2.19 0.028 .0128902 .2306552

member_gatt_wto_joint | 1.063792 .1086575 9.79 0.000 .8508269 1.276756

event_no_CYP | -.0045055 .0019098 -2.36 0.018 -.0082487 -.0007623

events_o_CYP | -.0046441 .0074054 -0.63 0.531 -.0191585 .0098703

agree_pta | .1217475 .0555536 2.19 0.028 .0128645 .2306305

member_gatt_wto_joint | 1.064015 .1086778 9.79 0.000 .8510109 1.27702

event_no_DNK | -.0044896 .001914 -2.35 0.019 -.0082409 -.0007383

events_o_DNK | -.0137887 .0034191 -4.03 0.000 -.02049 -.0070874

agree_pta | .12179 .0555534 2.19 0.028 .0129074 .2306727

member_gatt_wto_joint | 1.064028 .1086528 9.79 0.000 .8510721 1.276983

event_no_ECU | -.0045332 .0019114 -2.37 0.018 -.0082794 -.000787

events_o_ECU | -.0020867 .0052197 -0.40 0.689 -.0123172 .0081438

agree_pta | .1218262 .055554 2.19 0.028 .0129425 .23071

member_gatt_wto_joint | 1.063908 .1086456 9.79 0.000 .8509666 1.276849

event_no_EGY | -.0045553 .0019119 -2.38 0.017 -.0083025 -.0008081

events_o_EGY | .0037639 .0051236 0.73 0.463 -.0062782 .0138061

agree_pta | .121737 .0555532 2.19 0.028 .0128548 .2306193

member_gatt_wto_joint | 1.06408 .1086835 9.79 0.000 .8510644 1.277096

event_no_FIN | -.0044953 .0019127 -2.35 0.019 -.0082441 -.0007466

events_o_FIN | -.0156314 .0065609 -2.38 0.017 -.0284904 -.0027723

agree_pta | .1216635 .0555452 2.19 0.028 .0127969 .2305302

member_gatt_wto_joint | 1.063214 .1086044 9.79 0.000 .8503536 1.276075

event_no_FRA | -.0043304 .0019691 -2.20 0.028 -.0081897 -.0004711

events_o_FRA | -.0076555 .0031384 -2.44 0.015 -.0138068 -.0015043

agree_pta | .1216025 .0555639 2.19 0.029 .0126993 .2305057

member_gatt_wto_joint | 1.063489 .1087225 9.78 0.000 .8503964 1.276581

event_no_DEU | -.0043428 .001978 -2.20 0.028 -.0082195 -.000466

events_o_DEU | -.0065635 .0024007 -2.73 0.006 -.0112687 -.0018583

agree_pta | .1217815 .0555528 2.19 0.028 .0129 .230663

member_gatt_wto_joint | 1.064005 .1086637 9.79 0.000 .8510286 1.276982

event_no_GRC | -.0045172 .0019123 -2.36 0.018 -.0082652 -.0007692

events_o_GRC | -.0078794 .0045598 -1.73 0.084 -.0168164 .0010576

agree_pta | .1217065 .0555512 2.19 0.028 .0128282 .2305847

member_gatt_wto_joint | 1.063769 .1086319 9.79 0.000 .8508548 1.276684

event_no_HUN | -.0045347 .0019121 -2.37 0.018 -.0082823 -.0007871

events_o_HUN | .0037095 .0113298 0.33 0.743 -.0184965 .0259154

agree_pta | .1217806 .0555532 2.19 0.028 .0128983 .2306629

member_gatt_wto_joint | 1.064006 .1086564 9.79 0.000 .8510431 1.276968

event_no_ISL | -.0045298 .0019095 -2.37 0.018 -.0082722 -.0007873

events_o_ISL | .0012486 .005993 0.21 0.835 -.0104975 .0129947

agree_pta | .1218432 .0555611 2.19 0.028 .0129454 .2307409

member_gatt_wto_joint | 1.064755 .1085821 9.81 0.000 .8519382 1.277572

event_no_IND | -.0046341 .0019357 -2.39 0.017 -.0084279 -.0008403

events_o_IND | -.0027209 .0053581 -0.51 0.612 -.0132225 .0077806

agree_pta | .1221635 .0556 2.20 0.028 .0131894 .2311376

member_gatt_wto_joint | 1.063201 .1086663 9.78 0.000 .8502194 1.276183

event_no_IDN | -.0044048 .0019241 -2.29 0.022 -.008176 -.0006336

events_o_IDN | -.0114068 .0059212 -1.93 0.054 -.0230122 .0001986

agree_pta | .1218451 .055553 2.19 0.028 .0129632 .230727

member_gatt_wto_joint | 1.068139 .1082143 9.87 0.000 .8560427 1.280235

event_no_IRN | -.0046467 .0019039 -2.44 0.015 -.0083783 -.0009152

events_o_IRN | .0156037 .01137 1.37 0.170 -.0066811 .0378886

agree_pta | .1217857 .0555532 2.19 0.028 .0129035 .2306679

member_gatt_wto_joint | 1.063999 .1086452 9.79 0.000 .8510586 1.27694

event_no_IRL | -.0045283 .0019137 -2.37 0.018 -.008279 -.0007776

events_o_IRL | -.0044069 .0064595 -0.68 0.495 -.0170673 .0082535

agree_pta | .12185 .0555545 2.19 0.028 .0129653 .2307348

member_gatt_wto_joint | 1.064122 .1086253 9.80 0.000 .8512199 1.277023

event_no_ISR | -.0045823 .0019144 -2.39 0.017 -.0083345 -.0008302

events_o_ISR | .0032381 .0060886 0.53 0.595 -.0086953 .0151715

agree_pta | .1214913 .0555385 2.19 0.029 .0126378 .2303449

member_gatt_wto_joint | 1.063076 .1086839 9.78 0.000 .8500594 1.276093

event_no_ITA | -.004291 .0019462 -2.20 0.027 -.0081055 -.0004766

events_o_ITA | -.0125321 .0032627 -3.84 0.000 -.0189268 -.0061375

member_gatt_wto_joint | 1.061722 .0991795 10.71 0.000 .8673338 1.25611

event_no_JPN | -.0016482 .001486 -1.11 0.267 -.0045607 .0012643

events_o_JPN | -.0196403 .0042622 -4.61 0.000 -.0279942 -.0112865

agree_pta | .1218086 .0555548 2.19 0.028 .0129232 .2306939

member_gatt_wto_joint | 1.064233 .1086507 9.79 0.000 .8512812 1.277184

event_no_JOR | -.0045368 .0019102 -2.38 0.018 -.0082806 -.0007929

events_o_JOR | .0013387 .0080582 0.17 0.868 -.0144551 .0171326

agree_pta | .1217954 .0555537 2.19 0.028 .0129121 .2306787

member_gatt_wto_joint | 1.064067 .1086506 9.79 0.000 .8511153 1.277018

event_no_KEN | -.0045514 .0019095 -2.38 0.017 -.0082939 -.0008088

events_o_KEN | .0130594 .0094602 1.38 0.167 -.0054823 .031601

agree_pta | .122391 .0558446 2.19 0.028 .0129375 .2318444

member_gatt_wto_joint | 1.064135 .108719 9.79 0.000 .8510499 1.27722

event_no_KOR | -.0044424 .0019421 -2.29 0.022 -.0082488 -.0006361

events_o_KOR | -.0068503 .0037144 -1.84 0.065 -.0141304 .0004298

agree_pta | .1217867 .0555531 2.19 0.028 .0129046 .2306687

member_gatt_wto_joint | 1.064004 .108655 9.79 0.000 .8510443 1.276964

event_no_KWT | -.0045309 .0019105 -2.37 0.018 -.0082755 -.0007862

events_o_KWT | -.0028448 .0074843 -0.38 0.704 -.0175137 .011824

agree_pta | .1218503 .0555521 2.19 0.028 .0129702 .2307304

member_gatt_wto_joint | 1.064079 .1086705 9.79 0.000 .8510886 1.277069

event_no_MAC | -.0045121 .0019101 -2.36 0.018 -.0082559 -.0007683

events_o_MAC | -.0308663 .0269199 -1.15 0.252 -.0836283 .0218957

agree_pta | .121779 .0555535 2.19 0.028 .0128962 .2306618

member_gatt_wto_joint | 1.064047 .1086544 9.79 0.000 .851088 1.277005

event_no_MWI | -.0045351 .0019091 -2.38 0.018 -.0082769 -.0007932

events_o_MWI | .0426869 .0341934 1.25 0.212 -.0243309 .1097047

agree_pta | .1217054 .055548 2.19 0.028 .0128334 .2305775

member_gatt_wto_joint | 1.064081 .1086327 9.80 0.000 .8511644 1.276997

event_no_MYS | -.0045636 .0019257 -2.37 0.018 -.008338 -.0007892

events_o_MYS | -.0028636 .0071744 -0.40 0.690 -.0169251 .0111979

agree_pta | .1217943 .0555537 2.19 0.028 .0129111 .2306776

member_gatt_wto_joint | 1.063996 .1086557 9.79 0.000 .8510348 1.276957

event_no_MLT | -.0045322 .0019098 -2.37 0.018 -.0082752 -.0007891

events_o_MLT | .0021461 .0080621 0.27 0.790 -.0136554 .0179475

agree_pta | .1217947 .0555539 2.19 0.028 .012911 .2306785

member_gatt_wto_joint | 1.063997 .1086555 9.79 0.000 .8510359 1.276958

event_no_MUS | -.0045311 .0019094 -2.37 0.018 -.0082736 -.0007887

events_o_MUS | .0032084 .0050545 0.63 0.526 -.0066981 .013115

agree_pta | .1209502 .055277 2.19 0.029 .0126093 .2292912

member_gatt_wto_joint | 1.071088 .1072371 9.99 0.000 .860907 1.281269

event_no_MEX | -.0057915 .0019433 -2.98 0.003 -.0096004 -.0019826

events_o_MEX | .0126546 .0027737 4.56 0.000 .0072182 .0180911

agree_pta | .1215778 .0555582 2.19 0.029 .0126856 .2304699

member_gatt_wto_joint | 1.06394 .1086513 9.79 0.000 .8509878 1.276893

event_no_MMR | -.0045741 .0019089 -2.40 0.017 -.0083156 -.0008327

events_o_MMR | .0267922 .0270245 0.99 0.321 -.0261749 .0797593

agree_pta | .1217852 .0555532 2.19 0.028 .0129029 .2306674

member_gatt_wto_joint | 1.063997 .1086542 9.79 0.000 .8510388 1.276955

event_no_NPL | -.0045276 .0019094 -2.37 0.018 -.0082699 -.0007854

events_o_NPL | -.0044556 .0115819 -0.38 0.700 -.0271557 .0182445

agree_pta | .1218716 .0555537 2.19 0.028 .0129884 .2307547

member_gatt_wto_joint | 1.063936 .1084761 9.81 0.000 .8513272 1.276546

event_no_NLD | -.0046117 .0019492 -2.37 0.018 -.0084322 -.0007913

events_o_NLD | -.002411 .0041152 -0.59 0.558 -.0104768 .0056547

agree_pta | .1217795 .0555531 2.19 0.028 .0128974 .2306616

member_gatt_wto_joint | 1.063996 .1086583 9.79 0.000 .8510299 1.276962

event_no_NER | -.004525 .0019094 -2.37 0.018 -.0082673 -.0007826

events_o_NER | -.0273883 .0129046 -2.12 0.034 -.0526808 -.0020958

agree_pta | .1217863 .0555531 2.19 0.028 .0129042 .2306683

member_gatt_wto_joint | 1.063982 .1086546 9.79 0.000 .8510224 1.276941

event_no_NGA | -.0045184 .0019137 -2.36 0.018 -.0082691 -.0007677

events_o_NGA | -.0063877 .0115164 -0.55 0.579 -.0289593 .0161839

agree_pta | .1217322 .0555527 2.19 0.028 .012851 .2306134

member_gatt_wto_joint | 1.064011 .1086707 9.79 0.000 .8510202 1.277001

event_no_NOR | -.0044959 .0019134 -2.35 0.019 -.0082462 -.0007457

events_o_NOR | -.0130166 .0059306 -2.19 0.028 -.0246404 -.0013929

agree_pta | .1210897 .0556093 2.18 0.029 .0120976 .2300819

member_gatt_wto_joint | 1.066042 .1085571 9.82 0.000 .8532741 1.27881

event_no_PHL | -.0048014 .0019535 -2.46 0.014 -.0086302 -.0009726

events_o_PHL | .0033871 .0041123 0.82 0.410 -.004673 .0114471

agree_pta | .1216976 .0555551 2.19 0.028 .0128117 .2305836

member_gatt_wto_joint | 1.063539 .1086407 9.79 0.000 .8506069 1.276471

event_no_PAN | -.0044782 .0019134 -2.34 0.019 -.0082284 -.000728

events_o_PAN | -.0115889 .007138 -1.62 0.104 -.0255792 .0024014

agree_pta | .1212446 .055528 2.18 0.029 .0124117 .2300774

member_gatt_wto_joint | 1.064646 .1084882 9.81 0.000 .8520131 1.277279

event_no_POL | -.004734 .00191 -2.48 0.013 -.0084776 -.0009904

events_o_POL | .0232471 .0083343 2.79 0.005 .0069123 .039582

agree_pta | .121785 .055553 2.19 0.028 .0129032 .2306668

member_gatt_wto_joint | 1.063995 .1086524 9.79 0.000 .8510406 1.27695

event_no_PRT | -.0045274 .0019112 -2.37 0.018 -.0082732 -.0007816

events_o_PRT | -.0045936 .004852 -0.95 0.344 -.0141034 .0049162

agree_pta | .1217963 .055553 2.19 0.028 .0129144 .2306781

member_gatt_wto_joint | 1.064055 .1086545 9.79 0.000 .8510958 1.277014

event_no_QAT | -.0045373 .0019101 -2.38 0.018 -.008281 -.0007936

events_o_QAT | .0018506 .0072541 0.26 0.799 -.0123672 .0160685

agree_pta | .1211586 .0555752 2.18 0.029 .0122331 .230084

member_gatt_wto_joint | 1.063756 .1086092 9.79 0.000 .8508859 1.276626

event_no_ROM | -.0045443 .0019092 -2.38 0.017 -.0082863 -.0008024

events_o_ROM | .0735471 .0368465 2.00 0.046 .0013293 .1457649

agree_pta | .1217902 .0555539 2.19 0.028 .0129066 .2306739

member_gatt_wto_joint | 1.064034 .1086544 9.79 0.000 .8510753 1.276993

event_no_SEN | -.0045424 .0019091 -2.38 0.017 -.0082843 -.0008006

events_o_SEN | .0304971 .014485 2.11 0.035 .0021071 .0588872

agree_pta | .1220133 .0555136 2.20 0.028 .0132087 .2308179

member_gatt_wto_joint | 1.061703 .10834 9.80 0.000 .8493605 1.274046

event_no_SGP | -.0040337 .0019575 -2.06 0.039 -.0078703 -.000197

events_o_SGP | -.0206607 .0096698 -2.14 0.033 -.0396131 -.0017084

agree_pta | .1217834 .0555546 2.19 0.028 .0128985 .2306684

member_gatt_wto_joint | 1.064024 .1086425 9.79 0.000 .8510885 1.276959

event_no_ZAF | -.0045495 .0019168 -2.37 0.018 -.0083063 -.0007927

events_o_ZAF | -.0020019 .0055328 -0.36 0.717 -.0128461 .0088422

agree_pta | .1218069 .055555 2.19 0.028 .0129212 .2306926

member_gatt_wto_joint | 1.063988 .1086395 9.79 0.000 .8510584 1.276917

event_no_ESP | -.0045604 .0019227 -2.37 0.018 -.0083289 -.0007919

events_o_ESP | -.0026585 .0031732 -0.84 0.402 -.0088779 .0035609

agree_pta | .121777 .0555533 2.19 0.028 .0128944 .2306595

member_gatt_wto_joint | 1.063978 .1086576 9.79 0.000 .8510129 1.276943

event_no_LKA | -.0045191 .0019104 -2.37 0.018 -.0082635 -.0007748

events_o_LKA | -.0103817 .0058563 -1.77 0.076 -.0218598 .0010963

agree_pta | .1217687 .0555529 2.19 0.028 .012887 .2306505

member_gatt_wto_joint | 1.063885 .108654 9.79 0.000 .850927 1.276843

event_no_SWE | -.004496 .0019151 -2.35 0.019 -.0082496 -.0007424

events_o_SWE | -.0096178 .0036175 -2.66 0.008 -.016708 -.0025277

agree_pta | .1218827 .0555722 2.19 0.028 .0129631 .2308022

member_gatt_wto_joint | 1.063704 .1086521 9.79 0.000 .8507494 1.276658

event_no_CHE | -.0044843 .0019192 -2.34 0.019 -.0082457 -.0007228

events_o_CHE | -.0086561 .006784 -1.28 0.202 -.0219525 .0046403

agree_pta | .1217892 .0555531 2.19 0.028 .0129072 .2306712

member_gatt_wto_joint | 1.064014 .1086532 9.79 0.000 .8510576 1.27697

event_no_TZA | -.0045447 .0019094 -2.38 0.017 -.0082869 -.0008024

events_o_TZA | .0149138 .0130893 1.14 0.255 -.0107407 .0405683

agree_pta | .1212496 .0555682 2.18 0.029 .012338 .2301613

member_gatt_wto_joint | 1.064326 .10856 9.80 0.000 .8515525 1.2771

event_no_THA | -.0046695 .0019218 -2.43 0.015 -.0084362 -.0009029

events_o_THA | .0023611 .0035495 0.67 0.506 -.0045959 .009318

agree_pta | .1217992 .0555534 2.19 0.028 .0129165 .2306819

member_gatt_wto_joint | 1.06406 .1086557 9.79 0.000 .8510988 1.277021

event_no_TTO | -.0045361 .0019097 -2.38 0.018 -.0082791 -.0007931

events_o_TTO | .0053741 .0073877 0.73 0.467 -.0091055 .0198538

agree_pta | .1217853 .0555532 2.19 0.028 .012903 .2306677

member_gatt_wto_joint | 1.063996 .1086588 9.79 0.000 .8510286 1.276963

event_no_TUN | -.0045278 .0019101 -2.37 0.018 -.0082716 -.0007841

events_o_TUN | -.0042628 .008071 -0.53 0.597 -.0200818 .0115561

agree_pta | .1217858 .0555538 2.19 0.028 .0129023 .2306693

member_gatt_wto_joint | 1.064099 .1086283 9.80 0.000 .8511919 1.277007

event_no_TUR | -.0045615 .0019178 -2.38 0.017 -.0083202 -.0008027

events_o_TUR | -.0017075 .0034004 -0.50 0.616 -.0083722 .0049572

agree_pta | .1222487 .0555682 2.20 0.028 .0133369 .2311604

member_gatt_wto_joint | 1.065121 .1081172 9.85 0.000 .8532152 1.277027

event_no_GBR | -.0049724 .0019535 -2.55 0.011 -.0088012 -.0011436

events_o_GBR | .0020552 .003039 0.68 0.499 -.0039012 .0080116

agree_pta | .1233068 .0554863 2.22 0.026 .0145556 .2320579

member_gatt_wto_joint | 1.079592 .1070613 10.08 0.000 .8697558 1.289428

event_no_USA | -.0079823 .0030468 -2.62 0.009 -.0139539 -.0020107

events_o_USA | -.0019133 .0023389 -0.82 0.413 -.0064975 .0026709

agree_pta | .1217775 .0555533 2.19 0.028 .0128952 .2306599

member_gatt_wto_joint | 1.063999 .1086596 9.79 0.000 .8510297 1.276968

event_no_URY | -.0045214 .0019102 -2.37 0.018 -.0082652 -.0007775

events_o_URY | -.0121031 .0045621 -2.65 0.008 -.0210446 -.0031616

APPENDIX II

Impact by countries of types of events on welfare (common coefficients)

Table A2. Impact of Climate Events on Welfare (common coefficients).

Country	Wildfire	Flood	Extreme temperatures	Epidemic	Insect infestation	Storm	Drought	Landslide
Australia	1.0016	1.00	0.9972	1.0024	0.9890	0.9995	1.00	0.9990
Austria	1.0023	1.00	0.9956	1.0008	0.9833	0.9992	1.00	0.9985
Belgium	1.0015	1.00	0.9975	1.0005	0.9984	0.9995	1.00	0.9991
Bolivia	1.0031	1.00	0.9945	1.0229	0.9788	0.9990	1.00	0.9982
Brazil	1.0003	1.00	0.9995	1.0081	0.9980	0.9999	1.00	0.9998
Bulgaria	1.0002	1.00	0.9996	1.0005	0.9983	0.9999	1.00	0.9999
Cameroon	1.0030	1.00	0.9947	1.0036	0.9790	0.9990	1.00	0.9982
Canada	1.0026	1.00	0.9956	1.0006	0.9833	0.9992	1.00	0.9985
Chile	1.0019	1.00	0.9967	1.0043	0.9877	0.9994	1.00	0.9989
China	1.0005	1.00	0.9991	1.0006	0.9965	0.9998	1.00	0.9997
Colombia	1.0012	1.00	0.9980	1.0017	0.9919	0.9996	1.00	0.9993
Costa Rica	1.0018	1.00	0.9968	1.0028	0.9878	0.9994	1.00	0.9990
Cyprus	1.0034	1.00	0.9940	1.0041	0.9760	0.9989	1.00	0.9980
Denmark	1.0043	1.00	0.9926	1.0015	0.9718	0.9986	1.00	0.9975
Ecuador	1.0024	1.00	0.9959	1.0043	0.9839	0.9992	1.00	0.9985
Egypt	1.0018	1.00	0.9968	1.0031	0.9873	0.9994	1.00	0.9989
Finland	1.0021	1.00	0.9964	1.0003	0.9861	0.9993	1.00	0.9988
France	1.0019	1.00	0.9968	1.0009	0.9878	0.9994	1.00	0.9989
Germany	1.0017	1.00	0.9971	1.0001	0.9891	0.9995	1.00	0.9990
Greece	1.0025	1.00	0.9957	1.0017	0.9833	0.9992	1.00	0.9985
Hungary	1.0010	1.00	0.9984	1.0015	0.9938	0.9997	1.00	0.9994
Iceland	1.0025	1.00	0.9956	1.0041	0.9828	0.9992	1.00	0.9985
India	1.0007	1.00	0.9988	1.0172	0.9953	0.9998	1.00	0.9996
Indonesia	1.0019	1.00	0.9967	1.0622	0.9876	0.9994	1.00	0.9989
Iran	1.0031	1.00	0.9946	1.0047	0.9786	0.9990	1.00	0.9982
Ireland	1.0050	1.00	0.9915	1.0002	0.9677	0.9984	1.00	0.9971
Israel	1.0018	1.00	0.9970	1.0008	0.9886	0.9994	1.00	0.9990
Italy	1.0023	1.00	0.9961	1.0006	0.9853	0.9993	1.00	0.9987
Japan	1.0007	1.00	0.9988	1.0000	0.9953	0.9998	1.00	0.9996
Jordan	1.0020	1.00	0.9964	1.0033	0.9858	0.9993	1.00	0.9988
Kenya	1.0014	1.00	0.9975	1.0038	0.9897	0.9995	1.00	0.9991
Korea	1.0018	1.00	0.9969	1.0006	0.9884	0.9994	1.00	0.9989
Kuwait	1.0045	1.00	0.9923	1.0068	0.9707	0.9986	1.00	0.9974
Macao	1.0119	1.00	0.9794	0.9794	0.9208	0.9961	1.00	0.9938
Malawi	1.0026	1.00	0.9955	1.0044	0.9825	0.9992	1.00	0.9985
Malaysia	1.0039	1.00	0.9932	1.0050	0.9742	0.9987	1.00	0.9977

Table A2. Impact of Climate Events on Welfare (common coefficients). (cont.)

Country	Wildfire	Flood	Extreme temperatures	Epidemic	Insect infestation	Storm	Drought	Landslide
Malta	1.0038	1.00	0.9934	1.0022	0.9746	0.9988	1.00	0.9978
Mauritius	1.0038	1.00	0.9935	1.0066	0.9754	0.9988	1.00	0.9978
Mexico	1.0027	1.00	0.9955	1.0010	0.9829	0.9991	1.00	0.9985
Morocco	1.0020	1.00	0.9965	1.0042	0.9864	0.9993	1.00	0.9988
Myanmar	1.0017	1.00	0.9971	0.9971	0.9885	0.9994	1.00	0.9990
Nepal	1.0029	1.00	0.9950	1.0693	0.9805	0.9991	1.00	0.9983
Netherlands	1.0047	1.00	0.9920	1.0022	0.9695	0.9985	1.00	0.9973
Niger	1.0066	1.00	0.9887	0.9992	0.9567	0.9979	1.00	0.9962
Nigeria	1.0017	1.00	0.9970	1.0067	0.9878	0.9994	1.00	0.9990
Norway	1.0028	1.00	0.9952	1.0020	0.9814	0.9991	1.00	0.9984
Panama	1.0026	1.00	0.9955	1.0044	0.9822	0.9992	1.00	0.9985
Philippines	1.0020	1.00	0.9966	1.0016	0.9870	0.9993	1.00	0.9988
Poland	1.0003	1.00	0.9995	1.0006	0.9981	0.9999	1.00	0.9998
Portugal	1.0028	1.00	0.9953	1.0011	0.9821	0.9991	1.00	0.9984
Qatar	1.0027	1.00	0.9953	1.0063	0.9815	0.9991	1.00	0.9984
Romania	1.0004	1.00	0.9993	0.9999	0.9974	0.9999	1.00	0.9998
Senegal	1.0013	1.00	0.9978	1.0046	0.9912	0.9996	1.00	0.9992
Singapore	1.0067	1.00	0.9885	1.0200	0.9564	0.9978	1.00	0.9961
South Africa	1.0016	1.00	0.9973	0.9999	0.9899	0.9995	1.00	0.9991
Spain	1.0014	1.00	0.9977	1.0007	0.9909	0.9995	1.00	0.9992
Sri Lanka	1.0031	1.00	0.9947	1.0133	0.9795	0.9990	1.00	0.9982
Sweden	1.0037	1.00	0.9936	1.0003	0.9758	0.9988	1.00	0.9978
Switzerland	1.0019	1.00	0.9967	1.0008	0.9875	1.0007	1.00	0.9989
Tanzania	1.0034	1.00	0.9941	1.0113	0.9763	0.9989	1.00	0.9980
Thailand	1.0011	1.00	0.9981	1.0014	0.9928	0.9996	1.00	0.9994
Trinidad and Tobago	1.0030	1.00	0.9949	1.0022	0.9804	0.9990	1.00	0.9983
Tunisia	1.0018	1.00	0.9969	1.0023	0.9879	0.9994	1.00	0.9986
Turkey	1.0013	1.00	0.9978	1.0010	0.9916	0.9996	1.00	0.9993
United Kingdom	1.0019	1.00	0.9967	1.0018	0.9873	0.9994	1.00	0.9989
United States	1.0008	1.00	0.9987	1.0013	0.9950	0.9998	1.00	0.9996
Uruguay	1.0021	1.00	0.9964	1.0139	0.9860	0.9993	1.00	0.9988

CHAPTER 4

IN SEARCH OF FACTORS EXPLAINING THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE.

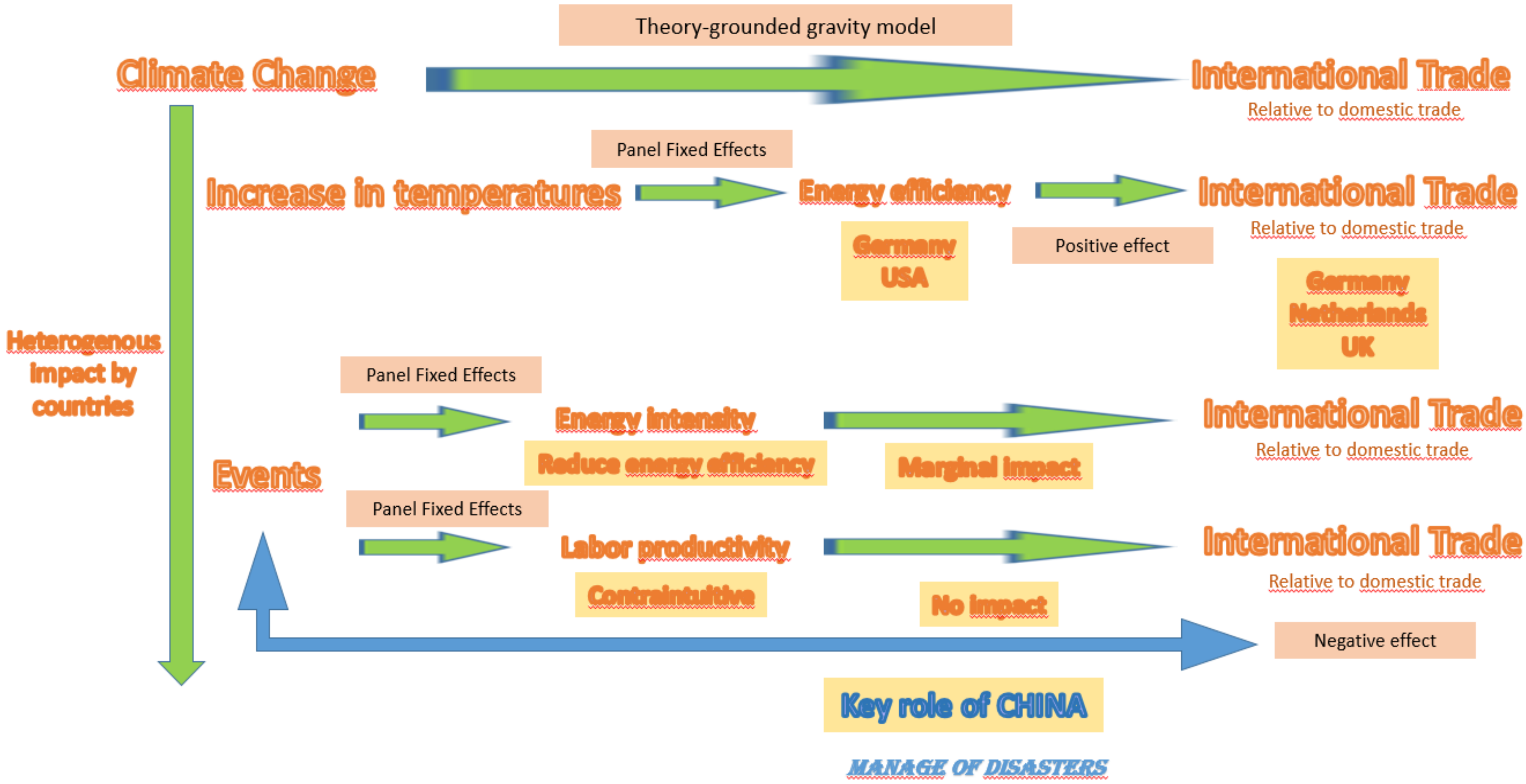
CHAPTER 4

IN SEARCH OF FACTORS EXPLAINING THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE.

Abstract

As we have seen, climate change, through rising temperatures and extreme weather events, impacts international trade. The literature suggests that this relationship is driven by the damage to infrastructure and reduced productivity caused by these global phenomena. Furthermore, recent research indicates that the effect on energy consumption could explain the real effects of disasters in the case of the United States. In this chapter, I analyze whether the secular increase in global temperatures and the occurrence of extreme climate events (wildfires, floods, extreme temperatures, epidemics, insect infections, storms, droughts and landslides) affect countries' energy consumption and labor productivity, which can subsequently affect international trade. By estimating a theory-based gravity model, my results suggest that energy efficiency is the channel through which rising temperatures could affect international trade. In this sense, countries such as Germany, the Netherlands, the United Kingdom and the United States have a notable influence on the average result. Furthermore, the impact of events on international trade does not seem to be channelled through either energy efficiency or labor productivity. A deeper analysis clearly suggests the key role played by China in this regard. The huge investment in infrastructure made by the Chinese government since 1998 to manage these types of disasters seems to be the reasonable explanation. In this sense, if I divide the gravity equation estimation between the periods before and after this year, the estimated coefficients for storms and landslides (with the same causes as floods) for the China´s case strongly drive the general result.

GRAPHICAL ABSTRACT



CHAPTER 4

IN SEARCH OF FACTORS EXPLAINING THE IMPACT OF CLIMATE CHANGE ON INTERNATIONAL TRADE.

4.1. Introduction

As we have seen, climate change, through rising temperatures and extreme weather events, has an impact on international trade. The results in Chapter 3 suggest that rising temperatures increase, on average, international trade relative to domestic trade, while the opposite is true for extreme weather events. When disaggregated by countries and types of events, a clear heterogeneity emerges in both dimensions.

An open question remains: Why did I find this impact? The literature proposes three possible explanations for the impact of climate change on international trade: lower productivity due to the effect of heat (Hancock et al., 2007, or Gosling et al. - 2018) that affects workers and probably the maintenance of machines and technology; damage to infrastructure caused by meteorological disasters (Dellink et al. -2017) and a possible positive effect derived from the opening of new maritime routes (Bekkers et al. - 2015). Recently, Canova and Pappa (2022), analysing in depth the case of the US, conclude that the real effects (on output, income and unemployment) of natural disasters are only "those impacting on energy" and this is independent of the type of disasters.[1] In particular, the authors state that energy consumption is the key variable that shows a significant decrease for the industrial sector, but also affects the residential and transportation sectors.

The energy system is vulnerable to a wide variety of climate change impacts in terms of production and supply. On the one hand, the increase in temperatures affects because the generation capacity of thermoelectric plants is reduced and the efficiency of the transmission network decreases. However, residential demand seems much more affected by temperatures than manufacturing or service demand. According to the study carried out by Chukwuemeka and Nnaemeka (2022), which aims to investigate the effects of temperature variations on energy demand with a focus on electricity, the demand for cooling processes increases once the temperature exceeds a specific threshold; instead, users can demand electricity for heating, and their demand grows once the temperature falls below a specified threshold. In this study, the results suggest that residential electricity demand in the G7 countries responds to cold days rather than hot days.

According to the study by Yao (2022), using temperature and night light data (night light has a strong linear relationship with electricity consumption)

[1] I thank Favio Canova for kindly sending me the paper.

there is a U-shaped relationship between electricity consumption and temperature with a global turning point of minimum electricity consumption around 14.6°C (it is higher in urban and more industrial areas). A warming planet could reduce the need for heating in cold seasons and increase the demand for cooling in hot seasons, heterogeneously affecting countries in different geographic locations (van Ruijven, De Cian and Wing, 2019). Therefore, when characterizing the relationship between temperature and electricity consumption (derived from primary energy generation), the literature usually assumes a U-shaped curve, with the minimum point being the equilibrium temperature between heating and cooling needs (see also Gupta, 2012, or Li, Yang and Long, 2018).

On the other hand, extreme weather events have a wide variety of energy impacts.[2] First, water scarcity (droughts) can cause power supply disruptions by reducing hydroelectric power production and threatening oil and gas extraction and refining, as well as thermoelectric plants that rely on surface water for cooling. Wildfires and extreme winds can damage ground power lines and transmission towers, causing interruptions in the transmission of electricity. Floods and landslides can affect underground power lines and damage roads, railways, pipelines and storage facilities and, near the coast, storms can destroy oil storage

2 See Zamuda et al. (2018).

tanks as well as roads and railways. Additionally, extreme cold events, including ice and snow, can damage power lines and affect fuel supplies.

In this chapter, I capitalize on the results provided by the literature that looks for a connection between climate change and both energy consumption and labor productivity across countries and, from there, I look for the relationship between climate change and international trade. To do this, I use data on primary energy intensity (primary energy consumption over GDP) and labor productivity from 67 countries over the period 1986-2016.[3] To preview my results, I find that climate change affects both energy consumption and labor productivity. However, only the energy channel seems to be relevant to explain the effect of temperatures on international trade. Regarding the events, the reaction of the Chinese government to manage the disastrous consequences of events seems to explain the sample impact obtained.

[3] I tried to use the same sample size as in chapter 3, except that I have to restrict the analysis of labor productivity to start in 1990.

4.2. Methodology and Data

To perform my analysis, I construct two types of equation. One of these are the "energy" equations. The other are the equations of "labor productivity". Using panel data fixed effects I estimate the following equations: [4]

- Energy equations.

$$lnECI_{it} = \beta_0 + \beta_1 lnGDPpc_{it} + \beta_2 temp_{it} + f_i + u_{it} \quad (4.1)$$

$$lnECI_{it} = \beta_0 + \beta_1 lnGDPpc_{it} + \beta_2 events_{it} + f_i + u_{it} \quad (4.2)$$

- Labor productivity equations.

$$lnLproduct_{it} = \beta_0 + \beta_1 \ln(\frac{K}{L})_{it} + \beta_2 HCI_{it} + \beta_3 internet\_share_{it} + \beta_4 temp_{it} + f_i + u_{it} \quad (4.3)$$

$$lnLproduct_{it} = \beta_0 + \beta_1 \ln(\frac{K}{L})_{it} + \beta_2 HCI_{it} + \beta_2 internet\_share_{it} + \beta_3 events_{it} + f_i + u_{it} \quad (4.4)$$

where $lnECI_{it}$ is the (logarithm) of the intensity of primary energy consumption (primary energy consumption over GDP) of country "i" in year "t", $lnGDPpc_{it}$ is the (logarithm) of Gross Domestic Product per capita, $lnLproduct_{it}$ is the (logarithm) of labor productivity, $\log(\frac{K}{L})_{it}$ is the capital-labor ratio, HCI_{it} is an index of human capital while $internet\_share_{it}$ is the ratio of Internet users to

[4] The corresponding Hausman test rejects the null that the error term is uncorrelated with the regressors. Therefore, fixed effects is the preferred model.

population, $temp_{it}$ and $events_{it}$ are measures of climate change, f_i are country fixed effects, and u_{it} is the usual error term. Furthermore, the $events_{it}$ variable is decomposed into the eight types considered: $Wildfire_{ijt}$, $Flood_{ijt}$, Ext_Temp_{ijt}, $Epidemic_{ijt}$, $Insect_{ijt}$, $Storm_{ijt}$, $Drought_{ijt}$ *and* $Landslide_{ijt}$. Therefore, the control variables for my analysis, in addition to my variables of interest, are GDP per capita in equations (3) and (4), and the capital-labor ratio, human capital and the number of Internet users over the population in equations (5) and (6).

Regarding equations (1) and (2), it is important to note that the inclusion of GDP (or, alternatively, population) in an "energy" equation is common in this type of study (Trotter, 2016, and Trotter et al. 2016). It is quite clear that the increase in the production of goods and services implies the increase in energy consumption. In our case, I have controlled for it by including it on the left side of the equation (energy consumption over GDP). In addition, we include GDP per capita as an explanatory variable. Presumably, the economic structure and technological level of countries also influence energy consumption.[5] In principle, as countries get richer, with a greater participation of the service sector (and usually less of the idustrial sector) and with more advanced energy saving technologies, consume less energy, *ceteris paribus*.[6]

[5] For instance, Liu and Noor (2020) discuss the need for energy efficiency management in ASEAN countries.

[6] Zhou et al. (2021) find, in an analysis of 21 developed countries between 1996 and 2015 that a 1% increase in GDP per capita leads to a reduction of 0.62–0.78% in energy intensity.

In relation to equations (3) and (4), the explanatory variables used are in line with the Solow´s traditional theory of growth (Solow, 1956), in which increases in labor productivity are the result of capital accumulation and technical change; as well as modern theories of endogenous growth where *investment* in human capital, innovation, and knowledge are significant factors to economic *growth* (Arrow, 1962; Uzawa, 1965; Lucas, 1988; or Romer, 1990). Therefore, I include the capital-labor ratio as a proxy for capitalization of the economy, and proxies for human capital and digital capital. These last two variables are probably the most relevant to explain the level and evolution of labor productivity across countries in the period analyzed (Adarov and Stehrer, 2020; Lucas Jr, 2015; Manuelli and Seshadri, 2014) and account for technical change and knowledge. As pointed out by Bye and Fæhn (2022), human capital is a key determinant to knowledge accumulation and structural change by its role on innovative capacity (participation in R&D) and absorptive capacity of new knowledge from abroad.[7]

Regarding the data sources, the intensity of primary energy consumption is from Ritchie et al. (2022), in the database of "Our world in data". From this data source page, I have also obtained the real GDP, population, and internet users for countries. Labor productivity (in real terms) is taken from the World

[7] An alternative specification (used as robustness check) is in the Appendix IV.

Development Indicators (World Bank), whereas physical capital, number of employees and the human capital index are taken from the Penn World Table (PWT 10.01).

Average annual temperature is obtained from the Climate Change Knowledge Portal (World Bank) and extreme weather events are taken from the International Disaster Database (EM-DAT). My sample covers the known 67 countries for the period 1986-2016 in the case of equations (1) and (2) and for the period 1990-2016 for the equations (3) and (4).

4.3. The connection between climate change and the intensity of primary energy consumption.

The results of the estimations of equations (1) and (2) are found in Table 1.[8] The proposed equations explain the variation in energy intensity well, obtaining a within-R^2 of around 0.45. As expected, primary energy intensity decreases with GDP per capita, showing evidence of higher energy efficiency, as countries get richer. The estimated coefficient suggests that a 1% increase in GDP per capita is associated with a reduction of about 0.5% in (primary) energy

[8] In this kind of equations there is some risk of endogeneity relating the variable GDPpc. Instrumental variables (IV) estimations considering human capital as an instrument of GDPpc (coefficient of correlation 0.74) does not change estimations in a significant way. In fact, the estimated parameter for the *temperature* variable somewhat increases and that of *events* remains almost the same.

intensity.[9] As shown, climate change affects energy intensity. On average, one additional degree Celsius reduces the intensity of energy consumption by around 3.2%, while one additional weather event increases it by 0.6%. That is, an increase in temperatures favors energy efficiency on average, while an extreme weather event reduces it. [10]

In Table 3, I present the disaggregated estimations by country and type of event. In Column 1, I show the estimated impact of rising temperatures by country. As shown, there is heterogeneity, and in around half of the countries, I observe a significant impact one way or another.[11] As explained, the literature on this subject finds a U-shaped relationship between electricity (which is generated, from primary sources) and temperature, estimating a turning point of around 15 degrees Celsius. This means that those countries before the turning point should reduce their energy consumption over time when temperatures rise, and the opposite would be true for countries after the turning point. If I look at the average annual temperatures across countries, I find that the predictable result is

[9] This impact is slightly lower than the range obtained in Zhou et al. (2020).

[10] It make sense to consider if lags in temperatures have any impact on energy efficiency if agents anticipate some mitigation actions. My estimations show that the first lag is significant (coefficient of -0.024 and standard deviation of 0.009), the second lag just at 10% level (coefficient of -0.015 and standard deviation of 0.009) and the rest of lags are non-significant. In Appendix I, I present these estimations as well as country specific impacts considering one lag.

[11] The increase in energy efficiency occurs mainly in the coldest countries. With respect to other economic variable (GDPpc) the result along my research is quite coherent with that found by Pretis et al. (2018) who state, "warming can increase prosperity in cold places but decrease prosperity in already warm areas".

obtained in about 66% of the cases (with a significant estimated impact) for countries before the turning point (this is the case for Bulgaria, Denmark, Germany, Hungary, Norway, Poland, Romania, Sweden, Switzerland, and the US, but not for Bolivia, Jordan, Nigeria, Qatar, and South Africa). Similarly, I obtain the expected result for about 80% of the cases (with a significant estimated impact) for countries after the turning point (this is the case for India, Indonesia, Iran, Malaysia, Malta, Mauritius, Morocco, Myanmar, Senegal, Sri Lanka, Thailand, and Trinidad and Tobago, but not for China, Iceland, Korea, and Nepal).

Results change when I focus on extreme climate events. In the second column of Table 3, I present the overall impact across countries. As can be seen, I found a significant impact (at least at the 5% level) in only 13 countries, and in eight of them, it is positive, in line with the general average. More importantly, when I disaggregate China from the rest of the sample, the corresponding estimated average parameter for the remaining countries completely loses its statistical significance, so the overall result is essentially due to the case of China. [12] Disaggregating by type of event, I see that floods, droughts, and landslides drive

[12] This is not the case for any of the other regressions with each individual country (in the Appendix).

the overall impact. As can be seen, climate events do not have a widespread impact across countries, with the exception of China, India, Nepal, and Thailand.

Table 4.1. Primary energy intensity and climate change. Period 1986-2016. Fixed effects estimation.

	(1)	(2)
Dependent variable	**Log of primary energy consumption intensity**	**Log of primary energy consumption intensity**
lnGDPpc	-0.479***	-0.534***
	(0.015)	(0.013)
$Temp_{it}$	-0.032***	
	(0.009)	
$Events_{it}$		0.006***
		(0.002)
constant	5.375***	5.317***
	(0.153)	(0.125)
Observations	2028	2046
Within-R2	0.429	0.447

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

4.4. The connection between climate change and labor productivity.

The impact of climate change on labor productivity (equations 3 and 4) appears in Table 2. As shown, the proposed equations are adequate and explain more than 65% of the variation in labor productivity within countries. My three control variables (capitalization, human capital and the proportion of internet users over population) have the expected (positive) sign and are highly significant. In this case, the increase in temperatures does not have a general impact on labor productivity, while the impact of events is positive and significant, contrary (a priori) to what was expected.[13]

The disaggregation by country and type of event appears in Table 4. Regarding temperatures, and focusing on the estimated significant parameters at conventional levels, I observe that for some countries the increase in temperatures also increases labor productivity (the cases of China, Indonesia, Malta, Mauritius, Myanmar, Poland and Tanzania) while in others (Bolivia, Brazil, Bulgaria, Iran, Italy, Jordan, Kenya, Kuwait, Macao, Mexico, Qatar, Singapore and Spain) higher temperatures have a negative impact on labor productivity. In general terms (although with relevant exceptions) in warmer countries, productivity growth decreases with temperatures, as should be expected.

Focusing on events, only a few countries have a significant average impact (at least at 5% level) on labor productivity: China, Jordan, Myanmar, Nigeria, Poland, Romania and Turkey. If I disaggregate China from the rest, the average impact drastically decreases, showing again the key role of this country in the results obtained when referring to events.[14] By type of events, floods, extreme

[13] An additional event increases productivity around 0.9% on average.

[14] The impact in the case of China is around 3.44% while the average impact for the rest of the countries is around 0.36%. Something similar does not happen with any of the other countries that leave the average impact unaltered.

temperatures, storms and landslides (positively) impact labor productivity. What is more interesting is that all events (except epidemics) have a significant effect in China. Floods, storms, landslides wildfires and extreme temperatures have a positive effect, while insect infestations and droughts have a negative effect. The rest of the countries do not present any generalized impact. It is important to note that the found negative effect of insect infestation and droughts on labour productivity is perfectly reasonable because these two types of events could directly affect human health. In any case, the positive outcome of the rest of the events is not intuitive and needs further explanation.

Table 4.2. Labor productivity and climate change. Period 1990-2016. Fixed effects estimation.

	(1)	(2)
Dependent variable	**Log of labor productivity**	**Log of labor productivity**
$Ln(K/L)_{it}$	0.308^{***}	0.317^{***}
	(0.011)	(0.011)
HCI_{it}	0.255^{***}	0.227^{***}
	(0.029)	(0.029)
$Internet\_share_{it}$	0.044^{**}	0.055^{***}
	(0.018)	(0.018)
$Temp_{it}$	0.001	
	(0.006)	
$Events_{it}$		0.009^{***}
		(0.001)
constant	6.270^{***}	6.243^{***}
	(0.146)	(0.106)
Observations	1687	1702
Within-R2	0.673	0.673

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Table 4.3. Impact of rising temperatures and extreme events on the intensity of primary energy consumption.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Temperature	Events	Wildfire	Flood	Extreme temperatures	Epidemic	Insect infestation	Storm	Drought	Landslide
Whole sample	- 0.032***	0.006*** (0 .002)	NS	0.011***(0.003)	NS	NS	NS	NS	0.028*** (0.014)	0.028*** (0 .009)
Australia	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Austria	NS	NS		NS	NS			NS		NS
Belgium	NS	NS		NS				NS		
Bolivia	-0.280*** (0.107)	0.065*** (0.023)	NS	0.108*** (0.042)	NS	NS		NS	NS	NS
Brazil	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bulgaria	-0.226*** (0.049)	NS	NS	NS	NS			NS	NS	
Cameroon	-0.253* (0.135))	NS		NS		NS			NS	NS
Canada	NS	NS	NS	NS	NS	NS		NS	NS	
Chile	NS	NS	NS	NS	NS	NS		NS		-0.417**(0.196)
China	0.386*** (0.088)	0.025*** (0.005)	NS	0.040*** (0.010)	NS	NS	-0.508** (0.212)	NS	NS	0.073***(0.021)
Colombia	NS	NS	NS	NS		NS	NS	NS	NS	NS
Costa Rica	NS	NS	NS	0.081* (0.042)				NS	NS	NS
Cyprus	NS	NS	NS		NS	NS		NS	NS	
Denmark	-0.093** (0.039)	NS						NS	NS	
Ecuador	NS	NS	NS	NS		NS			NS	NS
Egypt	NS	NS		NS	NS	NS		NS		
Finland	NS	NS		NS				NS		
France	NS	NS	NS	NS	NS	NS		NS	NS	NS
Germany	-0.099**(0.045)	NS		NS	NS	NS		NS		NS
Greece	NS	NS	NS	NS	NS				NS	
Hungary	-0.204**(0.044)	NS		NS	NS			NS	NS	
Iceland	0.232*** (0.054)	-0.156** (0.079)		NS						NS
India	0.223** (0.107)	0.037*** (0.010)	NS	0.026** (0.013)	NS	NS		0.135** (0.070)	NS	0.068** (0.032)
Indonesia	0.665*** (0.225)	NS	NS	0.016* (0.009)		NS	NS	NS	NS	NS
Iran	0.171*** (0.054)	NS	NS	-0.044* (0.022)		NS		NS	NS	NS
Ireland	NS	NS		NS		NS		NS		
Israel	NS	NS	NS	NS	NS	NS		NS	NS	
Italy	NS	NS	NS	NS	NS	NS		NS	NS	NS
Japan	NS	NS	NS	NS	NS	NS		NS		NS
Jordan	-0.110** (0.045)	NS		NS	NS			NS	NS	
Kenya	NS	NS		NS		NS		NS	NS	NS
Korea	0.197*** (0.067)	NS	NS	NS	NS	NS		NS	NS	NS
Kuwait	NS	NS		NS		NS				
Macao										

Table 4.3. Impact of rising temperature and extreme events on the intensity of primary energy consumption.

Country	(1) Temperature	(2) Events	(3) Wildfire	(4) Flood	(5) Extreme	(6) Epidemic	(7) Insect	(8) Storm	(9) Drought	(10) Landslide
Malawi	NS	NS		NS		NS			NS	
Malaysia	0.447***(0.140)	0.054*** (0.020)	NS	0.084***		NS		NS	NS	NS
Malaysia	0.447***(0.140)	0.054*** (0.020)	NS	0.084***		NS		NS	NS	NS
Malta	0.532*** (0.076)									
Mauritius	0.540*** (0.083)	NS		NS		NS		NS		
Mexico	NS	NS	NS	NS	NS	NS		NS	NS	NS
Morocco	0.179** (0.074)	NS		NS	NS		NS	NS	NS	
Myanmar	0.299** (0.135)	0.079*** (0.020)		0.091* (0.047)		NS		NS		NS
Nepal	0.596*** (0.007)	0.088*** (0.022)	0.194* (0.117)	0.289***	NS	NS		-0.476*** (0.074)	NS	0.098** (0.049)
Netherlands	NS	NS		NS	NS	NS		NS		
Niger	NS	NS		NS		NS	NS	NS	NS	
Nigeria	-0.630*** (0.096)	-0.020* (0.011)		-0.104***	NS	NS	NS	NS		0.270***
Norway	-0.085** (0.043)	0.105* (0.062)		NS				NS		
Panama	NS	NS	NS	NS		NS		NS	NS	
Philippines	NS	NS	NS	NS		NS	NS	NS	NS	NS
Poland	-0.185*** (0.042)	-0.138*** (0.029)	NS	NS	-0.204*** (0.054)			NS		
Portugal	NS	NS	NS	NS	NS			NS	NS	
Qatar	-0.764*** (0.056)									
Romania	-0.156** (0.076)	-0.059*** (0.015)		-0.064** (0.026)	-0.114* (0.065)	NS		NS	NS	NS
Senegal	0.258*** (0.009)	NS		NS		NS	NS	NS	NS	
Singapore	NS	NS				NS				
South Africa	-0.180** (0.081)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Spain	NS	NS	NS	NS	NS	NS		NS	NS	NS
Sri Lanka	0.419*** (0.142)	0.050** (0.024)		NS		NS		NS	NS	NS
Sweden	-0.093** (0.039)	NS			NS	NS		NS		
Switzerland	-0.162*** (0.058)	0.144** (0.064)		NS	NS	NS		NS		NS
Tanzania	NS	NS	NS	NS		NS	NS	NS	NS	NS
Thailand	0.173** (0.098)	0.058*** (0.014)	NS	0.049** (0.021)	0.345** (0.140)	0.245*** (0.094)		NS	0.174** (0.073)	NS
Trinidad and	0.463*** (0.113)	NS		NS				NS	0.402** (0.188)	NS
Tunisia	NS	NS		NS					NS	
Turkey	NS	NS	NS	NS	NS	NS		NS		NS
United	NS	NS		NS	NS	NS		NS		
United States	-0.132*** (0 .072)	NS	NS	NS	NS	NS		NS	NS	NS
Uruguay	NS	NS		NS	NS			NS	NS	

Note: NS: non-significant, *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Table 4.4. Impact of rising temperatures and extreme events on labor productivity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	**Temperature**	**Events**	**Wildfire**	**Flood**	**Extreme**	**Epidemic**	**Insect**	**Storm**	**Drought**	**Landslide**
Whole sample	0.001 (0.006)	0.009*** (0 .001)	NS	0.010***(0.002)	0.025***(0.007)	NS	NS	0.009***	NS	0.017***
Australia	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Austria	NS	NS		NS	NS			NS		NS
Belgium	NS	NS		NS	NS			NS		
Bolivia	-0.128** (0.077)	NS	NS	NS	NS	NS		NS	NS	NS
Brazil	-0.316*** (0.079)	NS	NS	-0.021* (0.012)	NS	NS	NS	NS	NS	NS
Bulgaria	-0.055** (0.033)	NS	NS	NS	NS			NS	NS	
Cameroon	NS	NS		NS		NS			NS	NS
Canada	NS	NS	NS	NS	NS	NS		NS		
Chile	NS	NS	NS	NS	NS	-0.196* (0.114)		NS		
China	0.558*** (0.058)	0.034*** (0.003)	0.140** (0.068)	0.052*** (0.006)	0.085***	NS	-0.483*** (0.121)	0.034***	-0.091*** (0.027)	0.094***(0.012)
Colombia	NS	NS	NS	NS		NS	NS	NS	NS	NS
Costa Rica	NS	NS	NS	NS				NS	NS	NS
Cyprus	NS	NS	NS		NS	NS		NS	NS	
Denmark	NS	NS						NS	NS	
Ecuador	NS	NS	NS	NS		NS			NS	NS
Egypt	NS	NS		NS	NS	NS		NS		
Finland	NS	NS		NS						
France	NS	NS	NS	NS	NS	NS		NS	NS	NS
Germany	NS	NS		NS	NS	NS		NS		NS
Greece	-0.070* (0.040)	0.024* (0.014)	NS	NS	NS					
Hungary	NS	0.036* (0.022)		NS	NS			NS	NS	
Iceland	NS	NS								NS
India	NS	NS	0.146* (0.085)	0.012** (0.006)		NS	NS	NS	NS	NS
Indonesia	0.336** (0.159)	0.011* (0.006)	NS	0.015* (0.088)	NS	NS		NS	NS	NS
Iran	-0.098** (0.037)	0.021* (0.012)	NS	NS		NS		NS	NS	NS
Ireland	NS	NS		NS		NS		NS		
Israel	NS	NS	NS	NS		NS		NS	NS	
Italy	-0.139** (0.048))	NS	NS	-0.031* (0.018)	NS	NS		NS	NS	NS
Japan	NS	NS	NS	NS	NS	NS		NS		NS
Jordan	-0.155*** (0.034)	0.066** (0.029)		0.169* (0.089)	0.182* (0.093)			NS	NS	
Kenya	-0.210** (0.086)	NS		NS		NS			NS	NS
Korea	NS	NS	NS	NS	NS	NS		NS	NS	NS
Kuwait	-0.091** (0.038)	NS		NS		NS				
Macao	-0.163**(0.060)	NS				NS		NS		

Table 4.4. Impact of rising temperatures and extreme events on labor productivity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	**Temperature**	**Events**	**Wildfire**	**Flood**	**Extreme**	**Epidemic**	**Insect**	**Storm**	**Drought**	**Landslide**
Malawi	NS	NS		NS		-0.048* (0.027)			NS	
Malaysia	NS	NS	NS	NS		NS		NS	NS	NS
Malta	0.098** (0.049)									
Mauritius	0.203*** (0.057)	NS		NS		NS		NS)		
Mexico	-0.224*** (0.078)	NS	NS	NS	NS	NS		NS	NS	NS
Morocco	0.085* (0.048)	NS		NS	NS		NS	NS	NS	
Myanmar	0.558** (0.088)	0.117*** (0.021)		0.105** (0.053)		NS		0.247***		0.426***
Nepal	0.096* (0.050)	NS	NS	NS	NS	NS		NS	NS	NS
Netherlands	NS	NS		NS	NS	NS		NS		
Niger	NS	NS		NS		NS	NS	NS	NS	
Nigeria	NS	-0.018*** (0.007)		-0.063** (0.022)	NS	NS	NS	0.148** (0.066)		NS
Norway	NS	NS		NS				NS		
Panama	NS	NS	NS	NS		NS		NS	NS	
Philippines	NS	NS	NS	NS		NS	NS	NS	NS	NS
Poland	0.100*** (0.031)	0.075*** (0.018)	-0.220* (0.113)	0.070* (0.039)	0.077** (0.034)			0.063* (0.033)		
Portugal	NS	NS	NS	NS	NS			NS	NS	
Qatar	-0.308*** (0.096)									
Romania	NS	0.020** (0.010)		0.045** (0.016)	NS	NS		NS	-0.242** (0.112)	-0.285** (0.139)
Senegal	NS	NS		NS		NS	NS	NS	NS	
Singapore	-0.268***(0.091)	NS				NS				
South Africa	NS	NS	NS	NS	NS	NS		NS	NS	NS
Spain	-0.324*** (0.053)	NS	0.136*** (0.042)	-0.094*** (0.030)	NS	0.240*** (0.071)		NS	NS	0.379***
Sri Lanka	NS	NS		NS		NS		NS	NS	NS
Sweden	0.054* (0.032)	NS			NS	NS		NS		
Switzerland	NS	NS			NS					
Tanzania	0.279** (0.113)	NS	NS	NS		NS	NS	NS	NS	NS
Thailand	NS	NS	NS	NS	NS	NS		NS	NS	NS
Trinidad and	NS	NS		NS				NS	NS	NS
Tunisia	NS	NS		NS						
Turkey	NS	0.024** (0.011)	NS	NS	NS	NS		NS		NS
United	NS	NS		NS	NS	NS		NS		
United States	NS	NS	NS	NS	NS	NS		NS	NS	NS
Uruguay	NS	NS		NS	NS			NS	NS	

Note: NS: non-significant, *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

4.5. Connecting the results with the impact of climate change on international trade.

4.5.1 A first view: Descriptive analysis

How can the previous results be reconciled with what was found regarding international trade in the previous chapter? On the one hand, in general terms, in this work, higher temperatures increase international trade with respect to domestic trade. These results suggest greater energy efficiency (and no impact on labor productivity) of countries as temperatures rise, which is consistent with a bias towards international trade because foreign sales require a more efficient economic system. Looking at the impacts by country, in the previous chapter, there are twenty-five countries for which rising temperatures increase international trade compared to domestic trade.[15] Focusing on my analysis and considering these countries, I find the following. In eight of them (32%), higher temperatures have some kind of efficiency improvement (reduction in energy intensity, increase in labor productivity, or both), in two of them (8%), there is some kind of efficiency reduction, in another two there are mixed results, and in the rest of the countries I do not obtain a significant relationship between the increase in temperatures and the dependent variables.

[15] Austria, Bolivia, Brazil, Bulgaria, Chile, Cyprus, Egypt, Germany, Hungary, India, Israel, Malawi, Mexico, Morocco, Netherlands, Panama, Philippines, Poland, Qatar, Romania, Spain, Switzerland, Tunisia, Turkey and United Kingdom.

In addition, there are eleven countries for which the increase in temperatures decreases international trade compared to domestic trade.[16] Making the parallelism with the previous analysis, of them, in no case the higher temperatures have any type of efficiency improvement, in five (45%) there is some type of efficiency reduction, in two there are mixed results and, in the rest, I do not obtain a significant relationship between the increase in temperatures and the dependent variables. Therefore, it seems that, in any case, for higher temperatures to have a bias to international trade, they have to imply (or almost) an improvement in efficiency.

Turning now to events, on average disasters reduce international trade relative to domestic trade. In my case, I get mixed results. On the one hand, energy efficiency is reduced by the impact of these phenomena, but contrary to expectations, labor productivity increases. A characteristic of both analysis is that, if I ignore China, the average impact is null or it is drastically reduced. Something similar occurs when talking about events and international trade.[17] By type of event, biological events (epidemics and insect infestation), extreme temperatures, storms and landslides negatively affect international flows in relation to internal ones. However, China's influence on this outcome is crucial,

[16] Belgium, Finland, Indonesia, Iran, Italy, Japan, Kuwait, Malaysia, Mauritius Nepal, Singapore. See, also, Table 7.

[17] The Stata output is in the Appendix.

especially when it comes to storms (or floods or landslides).[18] Next, I have carried out regressions decomposing the events for China, on the one hand, and the rest of the countries, on the other (Table 5). As can be seen, the influence of China on the average results obtained is crucial, especially when it comes to storms, floods and landslides. This result is consistent with the one obtained regarding the impact of climate change on international trade (with respect to domestic trade).

The aforementioned results seem contradictory. Consider the floods in China. On the one hand, these events reduce energy efficiency, probably because they affect critical infrastructure. On the other hand, labor productivity also increases. How is this possible? In the following pages, I will try to answer this question.

[18] The correlations between these phenomena for China are high. Therefore, the conclusions we can draw from the three events are the same. I do not observe essential changes if we exclude each of them from my regressions.

Table 4.5. Energy intensity, labor productivity, and types of events.

	(1)	(2)
Dependent variable	**Log of primary energy consumption intensity**	**Log of labor productivity**
Wildfire-no-China$_{ijt}$	0.006	0.009
	(0.011)	(0.007)
Wildfire-China$_{ijt}$	0.028	0.149**
	(0.103)	(0.068)
Flood-no-China$_{ijt}$	0.006*	0.005**
	(0.003)	(0.002)
Flood-China$_{ijt}$	0.041***	0.054***
	(0.010)	(0.006)
Ext_Temp-no-China$_{ijt}$	-0.019	0.022***
	(0.012)	(0.007)
Ext_Temp -China$_{ijt}$	0.053	0.085***
	(0.050)	(0.029)
Epidemic-no-China$_{ijt}$	-0.004	-0.007
	(0.007)	(0.004)
Epidemic-China$_{ijt}$	-0.076	-0.056
	(0.059)	(0.037)
Insect-no-China$_{ijt}$	-0.003	-0.012
	(0.037)	(0.030)
Insect-China$_{ijt}$	-0.509**	-0.486***
	(0.511)	(0.121)
Storm-no-China$_{ijt}$	-0.004	0.001
	(0.004)	(0.003)
Storm-China$_{ijt}$	0.018	0.034***
	(0.011)	(0.007)
Drought-no-China$_{ijt}$	0.035**	0.003
	(0.016)	(0.010)
Drought-China$_{ijt}$	-0.059	-0.092***
	(0.044)	(0.027)
Landslide-no-China$_{ijt}$	0.026**	0.005
	(0.010)	(0.006)
Landslide-China$_{ijt}$	0.073***	0.095***
	(0.021)	(0.012)
Observations	2046	1702

Note: *significant at 10% level, **significant at 5% level, ***significant at 1% level

Standard errors are clustered by country.
Control variables in both equations have been excluded for simplicity.

4.5.2. A step forward: inclusion of energy intensity and labor productivity in the estimation of trade flows.

It is now interesting to see whether energy intensity and labor productivity have an impact on international trade, as well as the connection between these variables and climate change in that relationship. To see this, I am going to estimate the structural gravity model described in Equations (1) and (2), with the inclusion, on the one hand, of the energy intensity variable and, on the other, of labor productivity. In Table 6, I present the results obtained. In Columns 1 and 2 of both tables, I present the results without including the aforementioned factors, while in Columns 3 to 6, I present the results including energy intensity (Columns 3 and 4) and labor productivity (Columns 5 and 6). As can be seen, energy intensity presents a negative and highly significant coefficient, which implies that international trade increases with respect to domestic trade at a higher level of energy efficiency (with an elasticity of around 0.75). More importantly, by introducing this variable into the gravity equation, my *temp* variable completely loses its statistical significance, which means that, on average, the impact of temperatures on international trade comes from this channel. Removing the “temp” variable from the gravity equation, the estimated coefficient is -0.765 (not shown). Thus, if we focus on the estimation in Column 1 of Table 1, I see that an additional degree of temperature will imply an increase of 2.44% [(-0.032) * (-0.765)] of international trade flows with respect to intranational trade ones. Regarding events, I observe a slight decrease in the impact, which is now only significant at the 10% level (although very close to 5%). Likewise, part of the effect of these phenomena on international trade comes from this channel but to a much lesser extent than temperatures. Making a parallel with the previous case, an additional event would decrease international trade in relation to domestic trade by around 0.46% [0.006*(-0.765)].

Next, I introduce labor productivity into the gravity equation. As shown, the respective coefficient is not significant at conventional levels, leaving the impacts of my *temp* and *event* variables unchanged. This implies that this factor has no effect on "relative" bilateral trade flows. That is, although events influence labor productivity, there should be no relevant effect between those tasks devoted to domestic trade in relation to those devoted to international trade.

At this point, it is interesting to note whether the respective coefficients by country of the variables that measure climate change are altered when introducing the energy intensity variable. The results are presented in Table 7. In general, the interpretation of the change in the coefficients is as follows. If the coefficient was positive and is reduced once we include the energy intensity variable, this implies that the impact of temperatures comes (totally or partially) from this channel, and this is because temperatures imply an increase in energy efficiency (see Table 3). The same happens if the coefficient is negative and becomes more negative. The opposite situation should imply that temperatures decrease energy efficiency. As can be seen, the changes in the coefficients are quite generalized. However, we are going to focus on the three most relevant cases in this analysis: Germany, the Netherlands, and the United Kingdom (UK). The differential impact on these countries (especially Germany) drives the overall result. The case of Germany seems clear. In this country, an increase in average temperature considerably improves energy efficiency (Column 1 of Table 3), and from here (it seems wholly), international trade increases with respect to domestic trade.

The other cases are different. The change in the respective positive coefficients of the Netherlands (partly reduced) and the UK (fully) is not due to an improvement in their energy efficiency (again, Column 1 of Table 3) resulting from the increase in temperatures. Therefore, the only sensible alternative is for this change to be driven mainly by variations in the energy efficiency of the partners. Unfortunately, this methodology does not allow us to distinguish the impact of our variables of interest when countries act as exporters or importers.

However, I can estimate the impact of the energy intensity of trading partners when a specific country acts as an exporter, on the one hand, and as an importer, on the other. If I look at Table 3, I realize that there are two very important partners of both countries with improvements in energy efficiency because of the increase in temperatures: Germany and the US. Therefore, I have regressed the bilateral trade flows of the Netherlands and the UK (each separately) when they act as exporters and importers, and I have disaggregated the energy intensity of Germany and the US from that of the other partners. The results are shown in Table 8. As can be seen, both German and US energy intensity impact Dutch trade, albeit in different directions: An improvement in US energy efficiency increases exports for the Netherlands, while an improvement in energy efficiency in Germany reduces imports for the Netherlands. Considering the estimated coefficients, an increase of one degree Celsius in the US and Germany will imply an increase of 9.43% [(-0.132) * (-0.715)] of the exports of the Netherlands and a decrease of 6.30% [(-0.099) * (0.636)] of imports to the Netherlands, respectively. In any case, the estimations in Table 7 tell us that the balance has to be positive. For its part, UK trade is affected by an increase in US energy efficiency: An increase of, on average, one degree Celsius in the US will imply a 10.89% increase in UK exports, with no impact on imports.

Focusing on the events (Columns 3 and 4 in Table 3), I can see that there are no significant changes in the estimated parameters (albeit with some exceptions) with slight reductions across the board (as expected) in relevant countries, such as (of course) China, Germany, Japan, France, or Italy. As shown in Table 9, China remains the crucial country in determining the sample estimated coefficient. In any case, the impact of events on international trade (which, as has been said, is mainly driven by the case of China) can be explained only to a very limited extent by the energy intensity channel.

When referring to the impact of labor productivity, I observe (Table 7) that this variable does not play an explanatory role in the impact on relative trade flows (international versus domestic). When conducting the analysis by country (not shown), there is no relevant change in the respective estimated coefficients.[19]

As we have seen, energy efficiency nor labour productivity are the channels (or vey partially) through which disasters impact trade. Additionally, we have seen that in the sample's impact, China is the key and specially relating the phenomena of Storms – Floods - Landslides. The answer probably lies in the Chinese government's reaction to the occurrence of this type of disaster, especially after the Yangtze River floods in 1998 (Wei et al. 2022, or Jia, et al. 2022). The large investments in infrastructure to manage the risk of floods have generated quite relevant economic development in the area (which accounts for close to 30% of China's GDP). This fact has probably implied a high impact on labour productivity, but in tasks more oriented to domestic goods and services

[19] Regressions will be provided upon request.

(infrastructure construction, urbanization of areas, etc.), which explain why this type of event positively affects domestic sales with respect to international ones.

Therefore, my view is that the explanation is based on the management of these events since 1998 through very large investments in infrastructure (domestic trade) by the Chinese government. But, how it should be viewed? Therefore, my view is that the explanation is based on the management of these events since 1998 through very large investments in infrastructure (domestic trade) by the Chinese government. But, how it should be viewed? In my opinion, the way forward is to see whether there has been any change in the impact of weather events on international trade before and after this year. For this reason, I have divided the entire sample into the periods 1986–1998 and 1999–2016. The results are shown in Table 9. As can be seen, in the case of China, the coefficient for the first period of the sample is far from significant, while the coefficient for the second period is highly significant. In the case of the rest of the countries in the sample, the coefficient is not significant in both periods.

Obviously, the total impact is the result of a weighted average of the partial impacts. For this reason, I have disaggregated by type of event.[20] Focusing on storms and landslides, we can see that in the first period, neither coefficient is

[20] Floods have been removed from the estimation because the respective variable has a very high correlation with storms and multicollinearity problems would arise.

significant at the conventional level (storms at 10%), but both coefficients are negative and highly significant in the second period. Furthermore, they are responsible for the sign and significance of the entire impact, as is quite clear when I group the events into two types: storms and landslides, and the rest (Column 3). Therefore, these results suggest that something different happened in the Chinese economy compared to these types of events after 1998, as stated.

Table 4.6. Trade and Climate change. Inclusion of energy intensity and labor productivity.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
PTA_{ijt}	0.122^{**}	0.122^{**}	0.142^{**}	0.143^{**}	0.051	0.051
	(0.056)	(0.056)	(0.056)	(0.056)	(0.053)	(0.053)
$GATT/WTO_{ijt}$	1.024^{***}	1.064^{***}	1.260^{***}	1.293^{***}	0.913^{***}	0.942^{***}
	(0.116)	(0.109)	(0.116)	(0.111)	(0.125)	(0.124)
$temp_{i(j)t}$	0.037^{***}		0.015		0.037^{***}	
	(0.010)		(0.009)		(0.010)	
$event_{i(j)t}$		-0.005^{***}		-0.004^{*}		-0.005^{**}
		(0.002)		(0.002)		(0.002)
$lnEnergy\_Intensity_{i(j)t}$			-0.728^{***}	-0.732^{***}		
			(0.151)	(0.149)		
$lnLabor\_Productivity_{i(j)t}$					-0.087	-0.074
					(0.130)	(0.129)
$Glob_{ij1987}$	0.024^{***}	0.029^{***}	0.019^{**}	0.022^{***}	-	-
	(0.008)	(0.007)	(0.008)	(0.007)	-	-
$Glob_{ij1988}$	0.088^{***}	0.121^{***}	0.080^{***}	0.097^{***}	-	-
	(0.010)	(0.010)	(0.011)	(0.010)	-	-
$Glob_{ij1989}$	0.126^{***}	0.162^{***}	0.103^{***}	0.119^{***}	-	-
	(0.016)	(0.015)	(0.017)	(0.016)	-	-
$Glob_{ij1990}$	0.193^{***}	0.254^{***}	0.169^{***}	0.202^{***}	-	-
	(0.019)	(0.019)	(0.020)	(0.019)	-	-
$Glob_{ij1991}$	0.228^{***}	0.267^{***}	0.188^{***}	0.212^{***}	-	-
	(0.018)	(0.019)	(0.019)	(0.019)	-	-
$Glob_{ij1992}$	0.244^{***}	0.285^{***}	0.200^{***}	0.222^{***}	0.011	0.015^{*}
	(0.018)	(0.019)	(0.020)	(0.021)	(0.009)	(0.009)
$Glob_{ij1993}$	0.277^{***}	0.306^{***}	0.217^{***}	0.236^{***}	0.038^{**}	0.029^{*}
	(0.020)	(0.021)	(0.023)	(0.024)	(0.018)	(0.017)
$Glob_{ij1994}$	0.323^{***}	0.370^{***}	0.268^{***}	0.290^{***}	0.087^{***}	0.098^{***}
	(0.023)	(0.023)	(0.026)	(0.027)	(0.019)	(0.019)

Table 4.6. Trade and Climate change. Inclusion of energy intensity and labor productivity. (cont.)

$Glob_{ij1995}$	0.411***	0.447***	0.345***	0.362***	0.179***	0.177***
	(0.024)	(0.024)	(0.030)	(0.032)	(0.026)	(0.026)
$Glob_{ij1996}$	0.447***	0.454***	0.361***	0.367***	0.215***	0.185***
	(0.025)	(0.025)	(0.032)	(0.032)	(0.029)	(0.028)
$Glob_{ij1997}$	0.509***	0.560***	0.425***	0.454***	0.290***	0.303***
	(0.028)	(0.029)	(0.035)	(0.036)	(0.033)	(0.033)
$Glob_{ij1998}$	0.554***	0.617***	0.463***	0.497***	0.337***	0.361***
	(0.027)	(0.029)	(0.035)	(0.038)	(0.034)	(0.035)
$Glob_{ij1999}$	0.539***	0.594***	0.430***	0.458***	0.324***	0.339***
	(0.029)	(0.031)	(0.040)	(0.032)	(0.038)	(0.039)
$Glob_{ij2000}$	0.603***	0.668***	0.473***	0.508***	0.388***	0.413***
	(0.030)	(0.033)	(0.043)	(0.047)	(0.042)	(0.043)
$Glob_{ij2001}$	0.581***	0.634***	0.424***	0.452***	0.369***	0.383***
	(0.029)	(0.030)	(0.046)	(0.030)	(0.038)	(0.038)
$Glob_{ij2002}$	0.531***	0.601***	0.366***	0.405***	0.319***	0.352***
	(0.030)	(0.034)	(0.048)	(0.053)	(0.039)	(0.041)
$Glob_{ij2003}$	0.577***	0.629***	0.406***	0.432***	0.368***	0.379***
	(0.031)	(0.033)	(0.051)	(0.053)	(0.043)	(0.043)
$Glob_{ij2004}$	0.624***	0.670***	0.443***	0.465***	0.418***	0.424***
	(0.032)	(0.034)	(0.053)	(0.055)	(0.045)	(0.045)
$Glob_{ij2005}$	0.642***	0.691***	0.446***	0.470***	0.438***	0.446***
	(0.033)	(0.036)	(0.056)	(0.059)	(0.047)	(0.047)
$Glob_{ij2006}$	0.671***	0.739***	0.460***	0.495***	0.469***	0.498***
	(0.033)	(0.036)	(0.059)	(0.062)	(0.049)	(0.049)
$Glob_{ij2007}$	0.794***	0.855***	0.561***	0.590***	0.596***	0.616***
	(0.039)	(0.040)	(0.064)	(0.066)	(0.059)	(0.058)
$Glob_{ij2008}$	0.822***	0.869***	0.574***	0.596***	0.625***	0.631***
	(0.039)	(0.040)	(0.066)	(0.067)	(0.059)	(0.058)
$Glob_{ij2009}$	0.736***	0.785***	0.477***	0.500***	0.538***	0.547***
	(0.042)	(0.042)	(0.068)	(0.069)	(0.059)	(0.057)
$Glob_{ij2010}$	0.819***	0.853***	0.551***	0.566***	0.624***	0.617***
	(0.044)	(0.043)	(0.069)	(0.070)	(0.065)	(0.064)
$Glob_{ij2011}$	0.824***	0.873***	0.542***	0.563***	0.633***	0.640***
	(0.045)	(0.043)	(0.075)	(0.075)	(0.068)	(0.066)
$Glob_{ij2012}$	0.818***	0.869***	0.524***	0.549***	0.629***	0.639***
	(0.047)	(0.045)	(0.077)	(0.077)	(0.069)	(0.068)
$Glob_{ij2013}$	0.847***	0.907***	0.543***	0.576***	0.660***	0.679***
	(0.048)	(0.048)	(0.079)	(0.079)	(0.071)	(0.070)
$Glob_{ij2014}$	0.804***	0.876***	0.487***	0.521***	0.619***	0.648***
	(0.048)	(0.046)	(0.082)	(0.082)	(0.076)	(0.073)
$Glob_{ij2015}$	0.786***	0.865***	0.460***	0.499***	0.606***	0.643***
	(0.054)	(0.050)	(0.086)	(0.085)	(0.082)	(0.079)
$Glob_{ij2016}$	0.745***	0.821***	0.418***	0.455***	0.567***	0.601***
	(0.056)	(0.052)	(0.088)	(0.084)	(0.085)	(0.082)
Constant	11.776***	11.835***	11.733***	11.742***	12.212***	12.261***
	(0.108)	(0.103)	(0.104)	(0.100)	(0.298)	(0.286)
Observations	136,153	136,153	134,163	134,163	112,616	112,616
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer-year and Exporter year FE	Yes	Yes	Yes	Yes	Yes	Yes
Intra-national trade	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.99	0.99	0.99	0.99	0.99	0.99

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
Standard errors are clustered by country-pair.

Table 4.7. Trade and climate change. Inclusion of Energy intensity.

	Including Energy intensity			Including Energy intensity
	(1)	(2)	(3)	(4)
Country	**Coefficient of temperatures (temp)**	**Coefficient of temperatures (temp)**	**Coefficient of events (event)**	**Coefficient of events (event)**
Australia	-0.030 (0.028)	-0.053** (0.027)	-0.005 (0.004)	-0.004 (0.004)
Austria	0.107*** (0.018)	0.081*** (0.017)	0.005 (0.004)	0.006 (0.004)
Belgium	-0.097*** (0.018)	-0.118*** (0.018)	0.005 (0.009)	0.006 (0.009)
Bolivia	0.187** (0.075)	0.194** (0.084)	0.020** (0.009)	0.022** (0.010)
Brazil	0.095*** (0.030)	0.117*** (0.032)	0.003 (0.002)	0.005*** (0.002)
Bulgaria	0.348*** (0.050)	0.247*** (0.047)	0.022*** (0.006)	0.017*** (0.005)
Cameroon	0.053 (0.195)	0.031 (0.194)	0.023* (0.014)	0.024* (0.014)
Canada	0.021 (0.016)	0.003 (0.015)	0.002 (0.003)	0.003 (0.003)
Chile	0.107** (0.043)	0.120*** (0.044)	0.004 (0.003)	0.006* (0.004)
China	0.025 (0.018)	0.012 (0.018)	-0.010***(0.003)	-0.009***(0.003)
Colombia	0.104* (0.058)	0.101* (0.061)	0.003 (0.006)	0.003 (0.006)
Costa Rica	0.202* (0.121)	0.195 (0.125)	-0.002 (0.006)	-0.002 (0.006)
Cyprus	0.382*** (0.090)	0.360*** (0.089)	-0.005 (0.007)	-0.004 (0.007)
Denmark	-0.002 (0.014)	-0.039* (0.015)	-0.014***(0.003)	-0.014***(0.004)
Ecuador	0.003 (0.050)	0.006 (0.049)	-0.002 (0.005)	-0.000 (0.006)
Egypt	0.246*** (0.071)	0.221*** (0.072)	0.004 (0.005)	0.004 (0.005)
Finland	-0.042** (0.020)	-0.067*** (0.019)	-0.016**(0.007)	-0.015**(0.007)
France	0.013 (0.018)	-0.005 (0.017)	-0.008**(0.003)	-0.006**(0.003)
Germany	0.058*** (0.019)	0.020 (0.017)	-0.007***(0.002)	-0.006***(0.002)
Greece	-0.063 (0.049)	-0.073 (0.048)	-0.00004	-0.007 (0.005)
Hungary	0.491*** (0.043)	0.413*** (0.039)	0.004 (0.011)	0.001 (0.010)
Iceland	0.092 (0.081)	0.147* (0.086)	0.001 (0.006)	0.002 (0.006)
India	0.287*** (0.077)	0.292*** (0.076)	-0.003 (0.005)	-0.001 (0.005)
Indonesia	-0.232*** (0.064)	-0.218*** (0.061)	-0.011 (0.006)	-0.006 (0.005)
Iran	-0.301*** (0.114)	-0.283*** (0.108)	0.016 (0.011)	0.021 (0.013)
Ireland	0.034 (0.027)	-0.029 (0.030)	-0.004 (0.006)	-0.004 (0.007)
Israel	0.200*** (0.056)	0.207*** (0.057)	0.003 (0.006)	0.005 (0.006)
Italy	-0.048** (0.023)	-0.059** (0.022)	-0.013***(0.003)	-0.011***(0.003)
Japan	-0.164*** (0.031)	-0.149*** (0.030)	-0.020***(0.004)	-0.017***(0.004)
Jordan	-0.027 (0.057)	-0.077 (0.055)	0.001 (0.008)	0.005 (0.009)
Kenya	-0.004 (0.054)	-0.021 (0.054)	0.013 (0.009)	0.014 (0.010)
Korea	-0.016 (0.031)	-0.002 (0.029)	-0.000028	-0.004 (0.003)
Kuwait	-0.199*** (0.074)	-0.254*** (0.079)	-0.003 (0.007)	-0.003 (0.008)
Macao	0.277 (0.211)	0.590** (0.239)	-0.031 (0.027)	-0.026 (0.027)
Malawi	0.759*** (0.294)	0.779*** (0.301)	0.043 (0.034)	0.045 (0.034)
Malaysia	-0.193** (0.086)	-0.169** (0.079)	-0.003 (0.007)	-0.001 (0.007)
Malta	0.024 (0.080)	0.078 (0.100)	0.002 (0.008)	0.004 (0.008)

Table 4.7. Trade and climate change. Inclusion of Energy intensity (cont.).

	Including Energy intensity			Including Energy intensity
	(1)	(2)	(3)	(4)
Country	Coefficient of temperatures (temp)	Coefficient of temperatures (temp)	Coefficient of events (event)	Coefficient of events (event)
Mauritius	-0.170** (0.082)	-0.062 (0.077)	0.003 (0.005)	0.008 (0.005)
Mexico	0.378*** (0.094)	0.372*** (0.098)	0.013*** (0.003)	0.013*** (0.003)
Morocco	0.510** (0.203)	0.551*** (0.208)	-0.000112	-0.013 (0.009)
Myanmar	0.424 (0.300)	0.422 (0.304)	0.027 (0.027)	0.030 (0.029)
Netherlands	0.081*** (0.020)	0.051*** (0.019)	-0.002 (0.004)	-0.002 (0.004)
Niger	-0.117 (0.150)	-0.053 (0.146)	-0.027**(0.013)	-0.022**0.012)
Nigeria	0.030 (0.051)	-0.034 (0.049)	-0.006 (0.012)	-0.003 (0.012)
Norway	0.045 (0.031)	0.002 (0.029)	-0.013**(0.006)	-0.000072
Panama	0.223*** (0.087)	0.187** (0.009)	-0.012 (0.007)	-0.010 (0.008)
Philippines	0.126** (0.060)	0.111* (0.063)	0.003 (0.004)	0.002 (0.004)
Poland	0.307*** (0.026)	0.237*** (0.026)	0.023*** (0.008)	0.017*** (0.006)
Portugal	0.047 (0.037)	0.073* (0.041)	-0.005 (0.005)	-0.000 (0.005)
Qatar	0.417*** (0.156)	0.231* (0.122)	0.002 (0.007)	0.002 (0.007)
Romania	0.292*** (0.050)	0.226*** (0.047)	0.074** (0.037)	0.052** (0.031)
Senegal	0.087 (0.104)	0.117 (0.104)	0.030** (0.014)	0.033** (0.014)
Singapore	-0.323*** (0.110)	-0.326*** (0.106)	-0.021**(0.010)	-0.020**(0.009)
South Africa	0.049 (0.039)	-0.004 (0.039)	-0.002 (0.006)	-0.001 (0.005)
Spain	0.157*** (0.022)	0.149*** (0.023)	-0.003 (0.003)	-0.001 (0.003)
Sri Lanka	-0.105 (0.074)	-0.078 (0.069)	-0.00006	-0.007 (0.006)
Sweden	-0.012 (0.012)	-0.048*** (0.013)	-0.010***(0.004)	-0.009**(0.004)
Switzerland	0.202*** (0.037)	0.149*** (0.036)	-0.009 (0.007)	-0.007 (0.007)
Tanzania	0.045 (0.072)	0.019 (0.072)	0.015 (0.013)	0.016 (0.013)
Thailand	0.031 (0.047)	0.118** (0.049)	0.002 (0.004)	0.009** (0.004)
Trinidad and Tobago	0.101 (0.179)	0.157 (0.170)	0.005 (0.007)	0.007 (0.007)
Tunisia	0.202*** (0.055)	0.194*** (0.057)	-0.004 (0.008)	-0.002 (0.008)
Turkey	0.195*** (0.034)	0.209*** (0.037)	-0.002 (0.003)	-0.001 (0.003)
United Kingdom	0.055*** (0.015)	0.017 (0.015)	0.002 (0.003)	0.003 (0.003)
United States	0.031 (0.023)	0.012 (0.023)	-0.002 (0.002)	-0.001 (0.002)
Uruguay	-0.015 (0.059)	0.021 (0.054)	-0.012***(0.005)	-0.009**(0.00)

*significant at 10% level, ** significant at 5% level, ***significant at 1% level.
The estimations for dummies capturing PTAs, GATT/WTO and Globalization are not shown for the sake of brevity.
Standard errors are clustered by country-pair.

Table 4.8. Impact of energy efficiency of partners on exports and imports of the Netherlands and the UK.

	(1)	(2)	(3)	(4)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
	Netherlands as exporter	*Netherlands as importer*	*UK as exporter*	*UK as importer*
PTA_{ijt}	0.554***	0.466*	0.367***	0.235
	(0.145)	(0.275)	(0.200)	(0.164)
$GATT/WTO_{ijt}$	1.243***	1.879***	1.468***	2.280***
	(0.182)	(0.118)	(0.197)	(0.178)
$temp_{i(j)t}$	0.003	0.019	0.010	0.008
	(0.016)	(0.016)	(0.023)	(0.031)
$lnEnergy\_Intensity_{i(j)t}$ - GER	-0.111	0.636***	0.130	-0.429
	(0.189)	(0.294)	(0.221)	(0.410)
$lnEnergy\_Intensity_{i(j)t}$ - USA	-0.715***	0.164	-0.825***	0.031
	(0.268)	(0.422)	(0.319)	(0.591)
$lnEnergy\_Intensity_{i(j)t}$ - Rest	-0.314	0.560	-0.398	-0.843
	(0.237)	(0.359)	(0.251)	(0.597)
Constant	6.658***	5.552***	6.602***	6.414***
	(0.269)	(0.266)	(0.259)	(0.440)
Observations	1,994	1,994	1,994	1,994
Country pair FE	Yes	Yes	Yes	Yes
Exporter-year	No	Yes	No	No
Importer-year	Yes	No	Yes	Yes
Intra-national trade	Yes	Yes	Yes	Yes
Pseudo R2	0.99	0.99	0.99	0.99

Note: The coefficients of the dummy variables for Globalization are dropped for the sake of brevity. This is equivalent to including the exporter-year and the importer-year in the import and export equations, respectively.

Table 4.9. Trade and Climate change. Period 1986-2016. The events and the case of China.

	(1)	(2)	(3)	(4)
Dependent variable	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**	**Nominal trade flows in current US dollars**
Event__CHN	-0.009*** (0.003)			
Event__CHN__1986-1998$_{i(j)t}$		-0.021 (0.015)		
Wildfire-China$_{ijt}$			0.221*** (0.053)	
Ext__Temp -China$_{ijt}$			-	
Epidemic-China$_{ijt}$			-0.363*** (0.131)	-0.036 (0.050)
Insect-China$_{ijt}$			-0.900** (0.445)	
Drought-China$_{ijt}$			-0.121*** (0.038)	
Storm-China$_{ijt}$			-0.046* (0.025)	-0.033* (0.019)
Landslide-China$_{ijt}$			-0.020 (0.050)	
Event__CHN__1999-2016$_{i(j)t}$		-0.009*** (0.003)		
Wildfire-China$_{ijt}$			0.002 (0.012)	
Ext__Temp -China$_{ijt}$			-0.054*** (0.021)	
Epidemic-China$_{ijt}$			-0.022 (0.021)	-0.011 (0.010)
Insect-China$_{ijt}$			-0.529** (0.113)	
Drought-China$_{ijt}$			0.041* (0.023)	
Storm-China$_{ijt}$			-0.025*** (0.006)	-0.021*** (0.006)
Landslide-China$_{ijt}$			-0.024*** (0.009)	
Event__no__CHN	-0.000 (0.001)			
Event__no__CHN__1986-1998$_{i(j)t}$		0.002 (0.003)	0.002 (0.003)	0.002 (0.003)
Event__no__CHN__1999-2016$_{i(j)t}$		-0.002 (0.003)	-0.002 (0.003)	-0.002 (0.002)
lnEnergy__Intensuty$_{i(j)t}$	-0.732*** (0.149)	-0.742*** (0.151)	-0.727*** (0.148)	-0.727*** (0.148)
Observations	134,163	134,163	134,163	134,163
Country pair FE	Yes	Yes	Yes	Yes
Importer-year and Exporter year FE	Yes	Yes	Yes	Yes
Intra-national trade	Yes	Yes	Yes	Yes
Pseudo R2	0.99	0.99	0.99	0.99

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
Dummies estimations capturing PTAs, GATT/WTO and Globalization are not shown for the sake of brevity.

4.6. Conclusions.

In this paper, I have investigated the causes of the relationship between climate change and international trade obtained from previous research. To do this, I estimate the impact of temperatures and disasters related to climate change both on the intensity of energy consumption and on labor productivity. Regarding the first variable, I tried to measure the effect on energy infrastructure (energy efficiency). In the case of the second variable, I measure labor efficiency. I have made estimations on a sample of 67 countries during the period 1986 – 2016.

On the one hand, my results suggest that energy intensity is the channel through which rising temperatures affect international trade (increasing it relative to domestic trade), with Germany (jointly, although indirectly, with the US) being the main actor in this process. On the other hand, neither energy intensity nor labor productivity seems to play a relevant role in the impact of events on international trade. In this sense, I identify the key role of China in the average result obtained, especially with regard to the storm–flood–landslide phenomena. The counterintuitive result obtained on the impact of these events on labor productivity (also determined by China) gave me a clue: something happened in the Chinese economy related to these events. After the corresponding analysis, I conclude that the enormous investment in infrastructure by the Chinese government starting in 1998 to manage floods seems to be the most reasonable explanation.

4.7. REFERENCES

Adarov, A. and Stehrer, R. (2020): “New Productivity Drivers: Revisiting the Role of Digital Capital, FDI and Integration at Aggregate and Sectoral Levels”, Working Paper 178, The Vienna Institute for International Economic Studies.

Aghion, P., Howitt, P., & Murtin, F. (2011). “The relationship between health and growth: When Lucas meets Nelson-Phelps”, Review of Economics and Institutions, 2(1), 1– 24.

Anderson, J.E. and van Wincoop, E. (2003): “Gravity with gravitas: A solution to the border puzzle”, American Economic Review, 93 (1), pp. 170-192.

Arrow, K. J. (1962).The Economic Implications of Learning by Doing. The Review of Economic Studies, 29 (3), 155-173. https://doi.org/10.2307/2295952.

Baier, S. L., Yotov, Y. V. & Zylkin, T. (2019). On the widely differing effects of free trade agreements: Lessons from twenty years of trade integration. *Journal of International Economics*, 116, 206-226.

Baldwin. R., & Taglioni, D. (2007). Trade effects of the euro: a comparison of estimators. *Journal of Economic Integration*, 22 (4), 780-818.

Bekkers, E., Francois, J. F. and Rojas-Romagosa, H. (2015): “Melting ice caps and the economic impact of opening the Northern Sea Route”, The Economic Journal, 128 (May), pp. 1095-1127.

Bergstrand, J. H., Larch, M., & Yotov, Y. V. (2015). Economic integration agreements, border effects, and distance elasticities in *the gravity equation. European Economic Review*, 78, 307-327.

Bloom, D. E., Canning, D., & Sevilla, J. (2004). The effect of health on economic growth: A production function approach. World Development, 32(1), 1– 13

Canova, F. and Pappa, E. (2022): "Costly disasters, energy consumption, and the role of fiscal policy", CEPR Press Discussion Paper No. 17655.

Chukwuemeka, C. E. and Nnaemeka V. E. (2022): "Temperature and Residential Electricity Demand for Heating and Cooling in G7 Economies: A Method of Moments Panel Quantile Regression Approach". Climate, 10 (10), 1-25.

Dellink, R.; Hwang, H.; Lanzi, E. and Chateau, J. (2017): "International trade consequences of climate change", OECD Trade and Environment Working Papers 2017/01.

EPA - United States Environmental Protection Agency - (2022): "Climate Change Impacts on Energy" available at https://www.epa.gov/climateimpacts/climate-change-impacts-energy.

Gosling S.N., Zaherpour J., Ibarreta D. (2018): "PESETA III: Climate change impacts on labor productivity", JRC Technical Reports, European Union, in https://adaptecca.es/sites/default/files/documentos/2018_jrc_pesetaiii_impact_labor_productivity.pdf.

Gil-Pareja S, Llorca-Vivero R., & Martínez-Serrano J. A. (2008). Assessing the enlargement and deepening of the European Union. *The World Economy*, 31 (9), 1253-1272.

Gupta, E. (2012): "Global warming and electricity demand in the rapidly growing city of Delhi: A semi-parametric variable coefficient approach," *Energy Economics*, Vol. 34 (5) pp. 1407–1421.

Hancock PA, Ross JM, Szalma JL (2007): "A Meta-Analysis of Performance Response Under Thermal Stressors. Human Factors", *The Journal of the Human Factors and Ergonomics Society* 49, pp. 851-877.

Jia, H.; Chen, F.; Pan, D.; Du, E.; Wang, L.; Wang, N.; Yang, A. (2022): "Flood Risk Management in the Yangtze River Basin—Comparison of 1998 and 2020", International Journal of Disaster Risk Reduction 68, 102724.

Li, J., Yang, L. and Long, H. (2018): "Climatic impacts on energy consumption: Intensive and extensive margins", *Energy Economics*, 71, 332-343.

Liu, Y. and R. Noor. 2020. Energy Efficiency in ASEAN: Trends and Financing Schemes.

ADBI Working Paper 1196. Tokyo: Asian Development Bank Institute. Available:

https://www.adb.org/publications/energy-efficiency-asean-trends-financing-schemes

Lucas, R. (1988). On the Mechanics of Economic Development. Journal of Monetary Economics, 22 (1), 3–42.

Lucas, Robert E Jr. 2015. "Human Capital and Growth." American Economic Review, 105 (5): 85-88.

Manuelli, R. E., and Seshadri, A. (2014): "Human Capital and the Wealth of Nations." American Economic Review, 104 (9): 2736-62.

Pretis F., Schwarz M., Tang K., Haustein K. & Myles R. (2018). Uncertain impacts on economic growth when stabilizing global temperatures at 1.5°C or 2°C warming. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering A. http://doi.org/10.1098/rsta.2016.0460

Ritchie, H., Roser, M and Rosado, P. (2022): "Energy". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/energy' [Online Resource]

Romer, P. M. (1990) Endogenous Technological Change. Journal of Political Economy, 98 (5) S71-S102.

Santos Silva, J. M. C., & Tenreyro, S. (2006). The log of gravity, *The Review of Economics and Statistics*. 88 (4), 641-658.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, 70 (1), 65-94. http://www.jstor.org/stable/1884513.

Trotter, I. M., (2016a): "Essays on energy and climate change", PhD Thesis, Universidade Federal de Viçosa, available at http://iantrotter.com/files/Thesis_Ian_Trotter.pdf.

Trotter, I. M., Bolkesjø, T. F., Féres, J. G., and Hollanda, L, (2016) "Climate Change and Electricity Demand in Brazil: A Stochastic Approach", *Energy*, 102,. 596–604.

Uzawa, H. (1965). Optimum Technical Change in An Aggregative Model of Economic Growth. International Economic Review. 6 (1), 18–31.

van Ruijven, B. J., De Cian, E. and Wing, I. (2019): "Amplification of future energy demand growth due to climate change", *Nature Communications*, 10 (1), 1-12.

Wei, D., Jidong, W., Rumei T., Xiaojuan, C. and Yingjun, X. (2022): "A Review of Flood Risk in China during 1950–2019: Urbanization, Socioeconomic Impact Trends and Flood Risk Management", *Water*, 14(20), 3246.

Yao, J. (2021): “Electricity Consumption and Temperature: Evidence from Satellite Data”, IMF WP/21/22.

Yotov Y. V. (2012). A simple solution to the distance puzzle in international trade. Economic Letters, 117 (3), 794-798.

Yotov, Y. V., Piermartini, R., Monteiro, J. A., & Larch, M. (2016). An advanced guide to trade policy analysis: The structural gravity model. United Nations and World Trade Organization. http://vi.unctad.org/tpa/index.html.

Zamuda, C., D.E. Bilello, G. Conzelmann, E. Mecray, A. Satsangi, V. Tidwell, and B.J. Walker, 2018: Energy Supply, Delivery, and Demand. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 174–201.

Zhou, J.; Ma, Z.; Wei, T.; Li, C. (2021): “Threshold Effect of Economic Growth on Energy Intensity— Evidence from 21 Developed Countries”, Energies, 14, 4199. https://doi.org/10.3390/en14144199.

4.8. APPENDIX

Appendix I. Impact of lagged temperatures on energy intensity.

Table 4.1a. Primary energy intensity and climate change for the period 1986–2016: Fixed-effects estimation. Lagged temperatures.

	(1)	(2)	(3)	(4)
Dependent variable	**Log of primary energy consumption intensity**	**Log of primary energy consumption intensity**	**Log of primary energy consumption intensity**	**Log of primary energy consumption intensity**
lnGDPpc	-0.479***	-0.501***	-0.524***	-0.541***
	(0.015)	(0.024)	(0.015)	(0.015)
$Temp_{it}$	-0.032***			
	(0.009)			
$Temp_{it-1}$		-0.024***		
		(0.009)		
$Temp_{it-2}$			-0.015*	
			(0.009)	
$Temp_{it-3}$				-0.011
				(0.009)
Constant	5.375***	5.449***	5.514***	5.607***
	(0.153)	(0.156)	(0.157)	(0.160)
Observations	2028	1963	1898	1833
Within-R2	0.429	0.444	0.462	0.476

Note: *significant at 10% level, **significant at 5% level, ***significant at 1% level

Table 4.1b. Primary energy intensity and climate change for the period 1986–2016 by countries. Fixed-effects estimation. Current and first lag estimations.

	(1)	(2)
Country	**Current impact**	**One lag**
Whole sample	- 0.032*** (0.009)	- 0.024*** (0.009)
Australia	NS	NS
Austria	NS	NS
Belgium	NS	NS
Bolivia	-0.280*** (0.107)	-0.230*** (0.105)
Brazil	NS	NS
Bulgaria	-0.226*** (0.049)	-0.209*** (0.049)
Cameroon	-0.253* (0.135))	-0.239* (0.140)
Canada	NS	NS
Chile	NS	NS
China	0.386*** (0.088)	0.393*** (0.088)
Colombia	NS	NS
Costa Rica	NS	NS
Cyprus	NS	NS
Denmark	-0.093** (0.039)	-0.070* (0.039)
Ecuador	NS	NS
Egypt	NS	NS
Finland	NS	NS
France	NS	NS
Germany	-0.099**(0.045)	-0.083*(0.045)
Greece	NS	NS
Hungary	-0.204**(0.044)	-0.189**(0.044)
Iceland	0.232*** (0.054)	0.228*** (0.055)
India	0.223** (0.107)	0.209* (0.109)
Indonesia	0.665*** (0.225)	0.758** (0.242)
Iran	0.171*** (0.054)	0.179*** (0.054)
Ireland	NS	NS
Israel	NS	NS
Italy	NS	NS
Japan	NS	NS
Jordan	-0.110** (0.045)	-0.101** (0.049)
Kenya	NS	NS
Korea	0.197*** (0.067)	0.188*** (0.069)
Kuwait	NS	NS
Macao		
Malawi	NS	NS
Malaysia	0.447***(0.140)	0.523***(0.158)
Malta	0.532*** (0.076)	0.556*** (0.078)
Mauritius	0.540*** (0.083)	0.553*** (0.082)
Mexico	NS	NS
Morocco	0.179** (0.074)	0.152** (0.075)
Myanmar	0.299** (0.135)	0.255* (0.136)
Nepal	0.596*** (0.007)	0.523*** (0.007)
Netherlands	NS	NS
Niger	NS	NS
Nigeria	-0.630*** (0.096)	-0.539*** (0.098)
Norway	-0.085** (0.043)	-0.083** (0.042)
Panama	NS	NS
Philippines	NS	NS
Poland	-0.185*** (0.042)	-0.168*** (0.042)
Portugal	NS	NS
Qatar	-0.764*** (0.056)	-0.754*** (0.057)
Romania	-0.156** (0.076)	-0.148** (0.074)

	(1)	(2)
Country	**Current impact**	**One lag**
Senegal	0.258*** (0.009)	0.231** (0.009)
Singapore	NS	NS
South Africa	-0.180** (0.081)	-0.162* (0.087)
Spain	NS	NS
Sri Lanka	0.419*** (0.142)	0.398*** (0.154)
Sweden	-0.093** (0.039)	-0.074* (0.039)
Switzerland	-0.162*** (0.058)	-0.147*** (0.057)
Tanzania	NS	NS
Thailand	0.173** (0.098)	NS
Trinidad and Tobago	0.463*** (0.113)	0.469*** (0.114)
Tunisia	NS	NS
Turkey	NS	NS
United Kingdom	NS	NS
United States	-0.132*** (0 .072)	NS
Uruguay	NS	NS

Appendix II

OUTPUT EXIT BY COUNTRIES FROM STATA FOR THE EFFECT OF EVENTS ON ENERGY INTENSITY.

I present the Stata order for the first country as an example.

xtreg ln_energy_per_gdp lngdppc event_no_AUS event_o_AUS , fe i(exp)

```
Fixed-effects (within) regression          Number of obs     =     2,046
Group variable: exp                        Number of groups  =        66
R-squared:                                 Obs per group:
    Within  = 0.4472                                    min =        31
    Between = 0.4340                                    avg =      31.0
    Overall = 0.2549                                    max =        31
                                           F(3,1977)        =    533.01
corr(u_i, Xb) = -0.8761                    Prob > F         =    0.0000

------------------------------------------------------------------------------

ln_energy_pe~p | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]

------------------------------------------------------------------------------

       lngdppc |  -.5331205   .0134009   -39.78   0.000    -.5594019   -.5068391

event_no_AUS_o |    .005842   .0019404     3.01   0.003     .0020365    .0096475

 event_o_AUS_o |   .0021012   .0141396     0.15   0.882    -.0256288    .0298312

         _cons |   5.317503   .1252505    42.45   0.000     5.071866     5.56314

------------------------------------------------------------------------------

       lngdppc |  -.5330792   .0134005   -39.78   0.000    -.5593597   -.5067987

event_no_AUT_o |   .0057774   .0019279     3.00   0.003     .0019965    .0095584

 event_o_AUT_o |   .0050904   .0264292     0.19   0.847    -.0467417    .0569225

         _cons |   5.317009   .1252409    42.45   0.000     5.071391    5.562627

------------------------------------------------------------------------------

       lngdppc |   -.533099   .0133998   -39.78   0.000    -.5593782   -.5068199

event_no_BEL_o |   .0058323   .0019294     3.02   0.003     .0020484    .0096162

 event_o_BEL_o |  -.0026481   .0229188    -0.12   0.908    -.0475958    .0422995

         _cons |   5.317205   .1252341    42.46   0.000       5.0716    5.562809

------------------------------------------------------------------------------
```

---

lngdppc | -.5338016 .01338 -39.90 0.000 -.560042 -.5075611

event__no__BOL__o | .0053836 .0019255 2.80 0.005 .0016074 .0091598

event__o__BOL__o | .0651989 .0228822 2.85 0.004 .0203232 .1100746

__cons | 5.322873 .1250428 42.57 0.000 5.077643 5.568102

---

lngdppc | -.5330782 .0133999 -39.78 0.000 -.5593577 -.5067987

event__no__BRA__o | .0057211 .0019384 2.95 0.003 .0019195 .0095226

event__o__BRA__o | .0089348 .0147719 0.60 0.545 -.0200354 .0379051

__cons | 5.316898 .1252361 42.45 0.000 5.07129 5.562507

---

lngdppc | -.5330203 .0133892 -39.81 0.000 -.5592788 -.5067618

event__no__BGR__o | .0061452 .0019325 3.18 0.001 .0023552 .0099351

event__o__BGR__o | -.0251412 .0173345 -1.45 0.147 -.059137 .0088545

__cons | 5.316085 .1251361 42.48 0.000 5.070672 5.561497

---

lngdppc | -.5331089 .0134003 -39.78 0.000 -.5593892 -.5068287

event__no__CMR__o | .0058043 .001926 3.01 0.003 .0020271 .0095815

event__o__CMR__o | -.0036727 .0338583 -0.11 0.914 -.0700744 .0627289

__cons | 5.317426 .1252446 42.46 0.000 5.071801 5.563052

---

lngdppc | -.5330946 .0134001 -39.78 0.000 -.5593744 -.5068148

event__no__CAN__o | .0058105 .0019285 3.01 0.003 .0020283 .0095927

event__o__CAN__o | -.000381 .0247634 -0.02 0.988 -.0489462 .0481842

__cons | 5.317321 .1252424 42.46 0.000 5.071701 5.562942

---

lngdppc | -.5330547 .0134006 -39.78 0.000 -.5593355 -.5067739

event__no__CHL__o | .0057436 .0019309 2.97 0.003 .0019569 .0095304

event__o__CHL__o | .009377 .020955 0.45 0.655 -.0317191 .0504731

__cons | 5.316742 .1252438 42.45 0.000 5.071118 5.562366

----

lngdppc | -.5379045 .0133655 -40.25 0.000 -.5641165 -.5116925

event_no_CHN_o | .0018296 .0020886 0.88 0.381 -.0022664 .0059256

event_o_CHN_o | .0252415 .0045646 5.53 0.000 .0162896 .0341933

_cons | 5.36598 .1249801 42.93 0.000 5.120874 5.611087

----

lngdppc | -.5331825 .0133979 -39.80 0.000 -.5594581 -.506907

event_no_COL_o | .0059325 .0019308 3.07 0.002 .0021459 .009719

event_o_COL_o | -.0124821 .0205692 -0.61 0.544 -.0528218 .0278575

_cons | 5.318582 .1252247 42.47 0.000 5.072996 5.564168

----

lngdppc | -.5331485 .0133969 -39.80 0.000 -.559422 -.506875

event_no_CRI_o | .0056634 .0019256 2.94 0.003 .0018869 .0094399

event_o_CRI_o | .037866 .0320581 1.18 0.238 -.0250052 .1007371

_cons | 5.317298 .1252055 42.47 0.000 5.071749 5.562847

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lngdppc | -.5330849 .0133981 -39.79 0.000 -.5593607 -.506809

event_no_CYP_o | .0057211 .0019239 2.97 0.003 .0019481 .0094942

event_o_CYP_o | .0462934 .0524019 0.88 0.377 -.0564753 .1490622

_cons | 5.317026 .125218 42.46 0.000 5.071452 5.562599

----

lngdppc | -.5331366 .0133993 -39.79 0.000 -.559415 -.5068583

event_no_DNK_o | .0058194 .0019244 3.02 0.003 .0020454 .0095935

event_o_DNK_o | -.0218974 .0474686 -0.46 0.645 -.1149912 .0711964

_cons | 5.317572 .1252303 42.46 0.000 5.071975 5.563169

----

lngdppc | -.533076 .0134001 -39.78 0.000 -.5593558 -.5067963

event_no_ECU_o | .0057552 .0019305 2.98 0.003 .0019692 .0095412

event_o_ECU_o | .0080761 .0211338 0.38 0.702 -.0333708 .0495231

_cons | 5.316964 .1252367 42.46 0.000 5.071354 5.562573

----

lngdppc | -.5330537 .0133996 -39.78 0.000 -.5593324 -.5067749

event_no_EGY_o | .0058209 .0019259 3.02 0.003 .0020439 .0095978

event_o_EGY_o | -.0085586 .0329087 -0.26 0.795 -.0730979 .0559807

_cons | 5.316808 .1252316 42.46 0.000 5.071208 5.562408

----

lngdppc | -.5330807 .0134019 -39.78 0.000 -.5593641 -.5067973

event_no_FRA_o | .0057786 .0019399 2.98 0.003 .0019741 .009583

event_o_FRA_o | .0055111 .0144435 0.38 0.703 -.0228151 .0338373

_cons | 5.317023 .1252562 42.45 0.000 5.071375 5.562671

----

lngdppc | -.5331388 .0133978 -39.79 0.000 -.5594141 -.5068635

event_no_DEU_o | .0059384 .0019322 3.07 0.002 .0021492 .0097277

event_o_DEU_o | -.0103892 .018945 -0.55 0.583 -.0475434 .026765

_cons | 5.317694 .1252164 42.47 0.000 5.072124 5.563264

----

lngdppc | -.5331379 .0134001 -39.79 0.000 -.5594177 -.506858

event_no_GRC_o | .0057055 .0019289 2.96 0.003 .0019227 .0094884

event_o_GRC_o | .0161218 .0231209 0.70 0.486 -.029222 .0614657

_cons | 5.317516 .1252362 42.46 0.000 5.071907 5.563125

----

lngdppc | -.5324191 .013394 -39.75 0.000 -.5586869 -.5061513

event_no_HUN_o | .0059457 .0019237 3.09 0.002 .002173 .0097184

event_o_HUN_o | -.0563482 .0344199 -1.64 0.102 -.1238513 .0111549

_cons | 5.311186 .1251747 42.43 0.000 5.065698 5.556674

----

lngdppc | -.5337868 .0133902 -39.86 0.000 -.5600473 -.5075264

event_no_ISL_o | .0058853 .0019217 3.06 0.002 .0021166 .009654

event_o_ISL_o | -.1561336 .0787006 -1.98 0.047 -.3104785 -.0017888

_cons | 5.323673 .1251453 42.54 0.000 5.078243 5.569104

----

lngdppc | -.5330434 .0133999 -39.78 0.000 -.5593227 -.506764

event_no_IND_o | .005547 .002009 2.76 0.006 .0016071 .009487

event_o_IND_o | .0081831 .0064722 1.26 0.206 -.0045099 .0208762

_cons | 5.316726 .1252339 42.45 0.000 5.071122 5.56233

----

lngdppc | -.5351505 .0133782 -40.00 0.000 -.5613873 -.5089137

event_no_IDN_o | .0045835 .0019514 2.35 0.019 .0007566 .0084104

event_o_IDN_o | .0370958 .0096886 3.83 0.000 .0180949 .0560966

_cons | 5.335383 .1250184 42.68 0.000 5.090201 5.580564

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lngdppc | -.5352327 .0134355 -39.84 0.000 -.5615819 -.5088836

event_no_IRN_o | .0061923 .0019337 3.20 0.001 .0024 .0099845

event_o_IRN_o | -.0301566 .0189388 -1.59 0.111 -.0672986 .0069854

_cons | 5.337572 .1255869 42.50 0.000 5.091275 5.583868

----

lngdppc | -.5327046 .0134088 -39.73 0.000 -.5590015 -.5064077

event_no_IRL_o | .005699 .0019256 2.96 0.003 .0019225 .0094755

event_o_IRL_o | .0329982 .0386646 0.85 0.394 -.0428294 .1088258

_cons | 5.313409 .1253238 42.40 0.000 5.067628 5.55919

----

lngdppc | -.5331177 .0133997 -39.79 0.000 -.5593967 -.5068388

event_no_ISR_o | .0057392 .0019243 2.98 0.003 .0019653 .009513

event_o_ISR_o | .0273782 .0465872 0.59 0.557 -.063987 .1187434

_cons | 5.317316 .1252322 42.46 0.000 5.071715 5.562917

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lngdppc | -.5330716 .0133985 -39.79 0.000 -.5593484 -.5067949

event_no_ITA_o | .0058924 .0019306 3.05 0.002 .0021062 .0096786

event_o_ITA_o | -.0082304 .0206564 -0.40 0.690 -.0487409 .0322801

_cons | 5.317145 .1252225 42.46 0.000 5.071563 5.562727

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lngdppc | -.5333066 .0133953 -39.81 0.000 -.559577 -.5070362

event_no_JPN_o | .0061745 .0019458 3.17 0.002 .0023585 .0099904

event_o_JPN_o | -.0101313 .0121619 -0.83 0.405 -.0339827 .0137201

_cons | 5.319306 .1251937 42.49 0.000 5.07378 5.564831

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lngdppc | -.5325168 .0134129 -39.70 0.000 -.5588217 -.5062118

event_no_JOR_o | .0056938 .0019248 2.96 0.003 .001919 .0094686

event_o_JOR_o | .0471393 .0475031 0.99 0.321 -.0460221 .1403006

_cons | 5.311714 .1253588 42.37 0.000 5.065865 5.557563

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lngdppc | -.5328844 .0133915 -39.79 0.000 -.5591474 -.5066214

event_no_KEN_o | .0061835 .0019379 3.19 0.001 .0023831 .009984

event_o_KEN_o | -.0173861 .0142726 -1.22 0.223 -.045377 .0106047

_cons | 5.315143 .1251572 42.47 0.000 5.06969 5.560597

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lngdppc | -.5383592 .0133859 -40.22 0.000 -.5646111 -.5121073

event_no_KOR_o | .0061833 .0019156 3.23 0.001 .0024265 .00994

event_o_KOR_o | -.2511705 .0576823 -4.35 0.000 -.364295 -.138046

_cons | 5.366163 .1251001 42.89 0.000 5.120821 5.611505

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lngdppc | -.5330676 .0134 -39.78 0.000 -.5593472 -.5067881

event_no_KWT_o | .0057677 .0019231 3.00 0.003 .0019961 .0095393

event_o_KWT_o | .0358563 .134849 0.27 0.790 -.2286047 .3003173

_cons | 5.316886 .1252361 42.45 0.000 5.071277 5.562495

---

lngdppc | -.5330766 .0133967 -39.79 0.000 -.5593498 -.5068035

event_no_MAC_o | .0057739 .0019225 3.00 0.003 .0020036 .0095441

event_o_MAC_o | 0 (omitted)

_cons | 5.316983 .1252053 42.47 0.000 5.071435 5.562531

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lngdppc | -.5330474 .0134001 -39.78 0.000 -.5593273 -.5067675

event_no_MWI_o | .0057244 .0019299 2.97 0.003 .0019395 .0095093

event_o_MWI_o | .0124448 .0222317 0.56 0.576 -.0311553 .0560449

_cons | 5.316659 .1252387 42.45 0.000 5.071045 5.562273

----

lngdppc | -.5339644 .0133866 -39.89 0.000 -.5602177 -.5077111

event_no_MYS_o | .0053811 .0019275 2.79 0.005 .0016011 .0091612

event_o_MYS_o | .0537426 .0204254 2.63 0.009 .0136851 .0938002

_cons | 5.324838 .1251054 42.56 0.000 5.079486 5.570191

----

lngdppc | -.5330766 .0133967 -39.79 0.000 -.5593498 -.5068035

event_no_MLT_o | .0057739 .0019225 3.00 0.003 .0020036 .0095441

event_o_MLT_o | 0 (omitted)

_cons | 5.316983 .1252053 42.47 0.000 5.071435 5.562531

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lngdppc | -.5332001 .0133994 -39.79 0.000 -.5594785 -.5069218

event_no_MUS_o | .005819 .0019237 3.02 0.003 .0020463 .0095917

event_o_MUS_o | -.0396802 .0622637 -0.64 0.524 -.1617896 .0824293

_cons | 5.318244 .125232 42.47 0.000 5.072643 5.563844

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lngdppc | -.5330935 .0133995 -39.78 0.000 -.5593722 -.5068149

event_no_MEX_o | .0058973 .0019433 3.03 0.002 .0020862 .0097083

event_o_MEX_o | .0001484 .0129459 0.01 0.991 -.0252406 .0255373

_cons | 5.317298 .1252329 42.46 0.000 5.071695 5.5629

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lngdppc | -.5339289 .0133962 -39.86 0.000 -.5602009 -.5076568

event_no_MAR_o | .0059069 .0019226 3.07 0.002 .0021363 .0096774

event_o_MAR_o | -.1057404 .0598671 -1.77 0.078 -.2231497 .0116689

_cons | 5.324852 .1251983 42.53 0.000 5.079317 5.570386

----

lngdppc | -.5393873 .0134578 -40.08 0.000 -.5657802 -.5129944

event_no_MMR_o | .0052353 .0019215 2.72 0.006 .001467 .0090037

event_o_MMR_o | .0790713 .0196054 4.03 0.000 .0406218 .1175207

_cons | 5.376156 .1257825 42.74 0.000 5.129475 5.622836

----

lngdppc | -.5340639 .013357 -39.98 0.000 -.5602592 -.5078686

event_no_NPL_o | .0052087 .0019225 2.71 0.007 .0014384 .0089791

event_o_NPL_o | .0877364 .0223267 3.93 0.000 .04395 .1315228

_cons | 5.323972 .1248236 42.65 0.000 5.079172 5.568771

----

lngdppc | -.533074 .0134018 -39.78 0.000 -.5593572 -.5067909

event_no_NLD_o | .0057721 .0019282 2.99 0.003 .0019907 .0095536

event_o_NLD_o | .0060926 .0263593 0.23 0.817 -.0456022 .0577874

_cons | 5.316958 .1252535 42.45 0.000 5.071315 5.562601

----

lngdppc | -.5335243 .0133816 -39.87 0.000 -.5597679 -.5072807

event_no_NGA_o | .0065807 .0019489 3.38 0.001 .0027585 .0104028

event_o_NGA_o | -.0204549 .0110212 -1.86 0.064 -.0420693 .0011595

_cons | 5.320475 .1250607 42.54 0.000 5.075211 5.56574

----

lngdppc | -.5323321 .0133997 -39.73 0.000 -.5586111 -.5060531

event_no_NOR_o | .0056635 .001923 2.95 0.003 .0018922 .0094347

event_o_NOR_o | .1048215 .0622577 1.68 0.092 -.0172762 .2269191

_cons | 5.309799 .1252381 42.40 0.000 5.064187 5.555412

----

lngdppc | -.5335378 .0133894 -39.85 0.000 -.5597966 -.507279

event_no_PHL_o | .0071699 .0020508 3.50 0.000 .003148 .0111918

event_o_PHL_o | -.0039971 .0053771 -0.74 0.457 -.0145426 .0065484

_cons | 5.319713 .1251251 42.52 0.000 5.074322 5.565104

----

lngdppc | -.5324382 .0134045 -39.72 0.000 -.5587266 -.5061498

event_no_PAN_o | .0058974 .0019247 3.06 0.002 .0021227 .0096721

event_o_PAN_o | -.0345416 .0322446 -1.07 0.284 -.0977786 .0286955

_cons | 5.311455 .1252651 42.40 0.000 5.065789 5.55712

----

lngdppc | -.5277393 .0133562 -39.51 0.000 -.5539331 -.5015455

event_no_POL_o | .0062715 .0019132 3.28 0.001 .0025194 .0100236

event_o_POL_o | -.1381615 .0285505 -4.84 0.000 -.1941537 -.0821693

_cons | 5.268554 .1248047 42.21 0.000 5.023792 5.513317

----

lngdppc | -.5334128 .0133974 -39.81 0.000 -.5596873 -.5071382

event_no_PRT_o | .0056421 .0019251 2.93 0.003 .0018667 .0094174

event_o_PRT_o | .0460226 .032127 1.43 0.152 -.0169837 .1090289

_cons | 5.31987 .1252082 42.49 0.000 5.074316 5.565424

----

lngdppc | -.5330766 .0133967 -39.79 0.000 -.5593498 -.5068035

event_no_QAT_o | .0057739 .0019225 3.00 0.003 .0020036 .0095441

event_o_QAT_o | 0 (omitted)

_cons | 5.316983 .1252053 42.47 0.000 5.071435 5.562531

----

lngdppc | -.531655 .013336 -39.87 0.000 -.5578091 -.505501

event_no_ROM_o | .0068453 .001928 3.55 0.000 .0030642 .0106265

event_o_ROM_o | -.0589604 .014536 -4.06 0.000 -.0874678 -.030453

_cons | 5.303178 .1246405 42.55 0.000 5.058737 5.547618

----

lngdppc | -.5329801 .0133947 -39.79 0.000 -.5592492 -.5067109

event_no_SEN_o | .0056289 .0019254 2.92 0.004 .0018528 .009405

event_o_SEN_o | .0476529 .0324955 1.47 0.143 -.0160762 .111382

_cons | 5.31573 .125188 42.46 0.000 5.070216 5.561244

----

lngdppc	-.5331067	.0134011	-39.78	0.000	-.5593883	-.506825
event_no_SGP_o	**.0057681**	**.0019232**	**3.00**	**0.003**	**.0019964**	**.0095399**
event_o_SGP_o	**.0234093**	**.0988342**	**0.24**	**0.813**	**-.1704208**	**.2172393**
_cons	5.317246	.1252447	42.45	0.000	5.071621	5.562872

----

lngdppc	-.5332229	.0133996	-39.79	0.000	-.5595017	-.5069442
event_no_ZAF_o	**.0059486**	**.0019365**	**3.07**	**0.002**	**.0021507**	**.0097464**
event_o_ZAF_o	**-.006193**	**.0159478**	**-0.39**	**0.698**	**-.0374692**	**.0250832**
_cons	5.31834	.1252317	42.47	0.000	5.07274	5.56394

----

lngdppc	-.5331338	.013399	-39.79	0.000	-.5594114	-.5068561
event_no_ESP_o	**.0056906**	**.0019271**	**2.95**	**0.003**	**.0019111**	**.00947**
event_o_ESP_o	**.0232292**	**.0272364**	**0.85**	**0.394**	**-.0301859**	**.0766444**
_cons	5.317233	.1252245	42.46	0.000	5.071647	5.562819

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lngdppc	-.5351529	.0134123	-39.90	0.000	-.5614567	-.5088491
event_no_LKA_o	**.0059312**	**.0019216**	**3.09**	**0.002**	**.0021627**	**.0096998**
event_o_LKA_o	**-.1760016**	**.0788165**	**-2.23**	**0.026**	**-.3305738**	**-.0214295**
_cons	5.33643	.1253525	42.57	0.000	5.090594	5.582267

----

lngdppc	-.5330727	.0134002	-39.78	0.000	-.5593528	-.5067927
event_no_SWE_o	**.005769**	**.0019246**	**3.00**	**0.003**	**.0019945**	**.0095435**
event_o_SWE_o	**.0085195**	**.0455655**	**0.19**	**0.852**	**-.0808419**	**.097881**
_cons	5.316948	.1252382	42.45	0.000	5.071335	5.56256

----

lngdppc	-.5316752	.0134002	-39.68	0.000	-.5579552	-.5053951
event_no_CHE_o	**.0056187**	**.0019221**	**2.92**	**0.004**	**.0018493**	**.0093882**
event_o_CHE_o	**.144448**	**.0644242**	**2.24**	**0.025**	**.0181015**	**.2707945**
_cons	5.30389	.125238	42.35	0.000	5.058277	5.549502

----

lngdppc | -.5331546 .0133947 -39.80 0.000 -.5594239 -.5068853

event_no_TZA_o | .0060118 .0019312 3.11 0.002 .0022244 .0097992

event_o_TZA_o | -.0189512 .0194646 -0.97 0.330 -.0571244 .0192221

_cons | 5.31802 .125188 42.48 0.000 5.072506 5.563534

----

lngdppc | -.5338047 .0133565 -39.97 0.000 -.559999 -.5076104

event_no_THA_o | .0048823 .0019319 2.53 0.012 .0010935 .0086711

event_o_THA_o | .058139 .0144451 4.02 0.000 .0298099 .0864682

_cons | 5.323157 .1248268 42.64 0.000 5.078351 5.567963

----

lngdppc | -.5332529 .0134027 -39.79 0.000 -.5595377 -.506968

event_no_TTO_o | .0058136 .0019241 3.02 0.003 .0020401 .0095871

event_o_TTO_o | -.026463 .0572361 -0.46 0.644 -.1387125 .0857864

_cons | 5.318674 .1252629 42.46 0.000 5.073013 5.564335

----

lngdppc | -.5331942 .0134052 -39.78 0.000 -.5594841 -.5069043

event_no_TUN_o | .0058013 .001925 3.01 0.003 .0020261 .0095765

event_o_TUN_o | -.0080682 .0450454 -0.18 0.858 -.0964098 .0802733

_cons | 5.318081 .1252849 42.45 0.000 5.072377 5.563786

----

lngdppc | -.5331422 .0134003 -39.79 0.000 -.5594225 -.506862

event_no_TUR_o | .0058607 .0019334 3.03 0.002 .0020691 .0096524

event_o_TUR_o | -.0020718 .0182632 -0.11 0.910 -.037889 .0337453

_cons | 5.317604 .1252393 42.46 0.000 5.071989 5.563218

----

lngdppc | -.5331208 .0133998 -39.79 0.000 -.5594 -.5068417

event_no_GBR_o | .0058695 .0019344 3.03 0.002 .0020759 .0096631

event_o_GBR_o | -.0020341 .0173103 -0.12 0.906 -.0359826 .0319143

_cons | 5.317428 .1252343 42.46 0.000 5.071823 5.563033

----

lngdppc | -.5345749 .0134188 -39.84 0.000 -.5608914 -.5082584

event_no_USA_o | .0072274 .002101 3.44 0.001 .0031071 .0113478

event_o_USA_o | -.0016192 .0047289 -0.34 0.732 -.0108934 .0076551

_cons | 5.330144 .1253805 42.51 0.000 5.084252 5.576036

----

lngdppc | -.5330503 .013397 -39.79 0.000 -.559324 -.5067766

event_no_URY_o | .0056774 .0019251 2.95 0.003 .001902 .0094529

event_o_URY_o | .0403847 .0360329 1.12 0.263 -.0302817 .1110511

_cons | 5.316557 .1252085 42.46 0.000 5.071003 5.562111

APPENDIX III

OUTPUT EXIT BY COUNTRIES FROM STATA FOR THE EFFECT OF EVENTS ON LABOR PRODUCTIVITY (using capital-labor ratio, a human capital index and proportion of internet users).

I present the Stata order for the first country as an example.

.xtreg ln_productivity lnKL human_K share_internet_pop event_no_AUS_o event_o_AUS_o , fe i(exp)

```
Fixed-effects (within) regression              Number of obs     =      1,702
Group variable: exp                            Number of groups  =         67
R-squared:                                     Obs per group:
     Within  = 0.6906                                        min =         17
     Between = 0.7220                                        avg =       25.4
     Overall = 0.7087                                        max =         26
                                               F(5,1630)         =     727.59
corr(u_i, Xb) = 0.4540                         Prob > F          =     0.0000
-------------------------------------------------------------------------------
```

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3164679	.010839	29.20	0.000	.295208	.3377277
human_K	.2270911	.0288913	7.86	0.000	.1704232	.283759
share_internet_pop	.0551048	.0174411	3.16	0.002	.0208954	.0893142
event_no_AUS_o	**.0087556**	**.0012666**	**6.91**	**0.000**	**.0062713**	**.0112399**
event_o_AUS_o	**-.0001701**	**.0097247**	**-0.02**	**0.986**	**-.0192443**	**.018904**
_cons	6.244476	.1057872	59.03	0.000	6.036983	6.451969

----

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3167953	.0108423	29.22	0.000	.2955291	.3380616
human_K	.2266587	.0288922	7.84	0.000	.1699891	.2833284
share_internet_pop	.0551924	.017443	3.16	0.002	.0209795	.0894054
event_no_AUT_o	**.0085588**	**.001259**	**6.80**	**0.000**	**.0060893**	**.0110283**
event_o_AUT_o	**.0212936**	**.0202095**	**1.05**	**0.292**	**-.0183457**	**.0609329**
_cons	6.241493	.1058349	58.97	0.000	6.033906	6.449079

----

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3165377	.0108399	29.20	0.000	.2952761	.3377994
human_K	.2263354	.0288979	7.83	0.000	.1696545	.2830164
share_internet_pop	.0558764	.0174681	3.20	0.001	.0216142	.0901386
event_no_BEL_o	**.0086673**	**.0012598**	**6.88**	**0.000**	**.0061963**	**.0111384**
event_o_BEL_o	**-.0026081**	**.0176776**	**-0.15**	**0.883**	**-.0372813**	**.0320652**
_cons	6.245253	.1058362	59.01	0.000	6.037663	6.452842

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3166946	.0108326	29.24	0.000	.2954474	.3379419
human_K	.228391	.0288954	7.90	0.000	.1717149	.285067
share_internet_pop	.0545169	.0174389	3.13	0.002	.0203118	.088722
event_no_BOL_o	**.0087632**	**.0012597**	**6.96**	**0.000**	**.0062923**	**.0112341**
event_o_BOL_o	**-.0134662**	**.0144245**	**-0.93**	**0.351**	**-.0417587**	**.0148263**
_cons	6.238754	.1057725	58.98	0.000	6.03129	6.446219

<table>
<tr><th>ln_productivity</th><th>Coefficient</th><th>Std. err.</th><th>t</th><th>P>|t|</th><th colspan="2">[95% conf. interval]</th></tr>
<tr><td>lnKL</td><td>.3167794</td><td>.0108311</td><td>29.25</td><td>0.000</td><td>.2955351</td><td>.3380237</td></tr>
<tr><td>human_K</td><td>.2273943</td><td>.0288727</td><td>7.88</td><td>0.000</td><td>.1707628</td><td>.2840259</td></tr>
<tr><td>share_internet_pop</td><td>.054892</td><td>.0174305</td><td>3.15</td><td>0.002</td><td>.0207033</td><td>.0890806</td></tr>
<tr><td>event_no_BRA_o</td><td>.0088759</td><td>.0012653</td><td>7.01</td><td>0.000</td><td>.0063942</td><td>.0113577</td></tr>
<tr><td>event_o_BRA_o</td><td>-.0078267</td><td>.0097368</td><td>-0.80</td><td>0.422</td><td>-.0269247</td><td>.0112712</td></tr>
<tr><td>_cons</td><td>6.240434</td><td>.1057267</td><td>59.02</td><td>0.000</td><td>6.03306</td><td>6.447809</td></tr>
</table>

<table>
<tr><th>ln_productivity</th><th>Coefficient</th><th>Std. err.</th><th>t</th><th>P>|t|</th><th colspan="2">[95% conf. interval]</th></tr>
<tr><td>lnKL</td><td>.3168053</td><td>.0108397</td><td>29.23</td><td>0.000</td><td>.2955442</td><td>.3380664</td></tr>
<tr><td>human_K</td><td>.2263556</td><td>.0288915</td><td>7.83</td><td>0.000</td><td>.1696872</td><td>.2830241</td></tr>
<tr><td>share_internet_pop</td><td>.0553586</td><td>.0174407</td><td>3.17</td><td>0.002</td><td>.02115</td><td>.0895672</td></tr>
<tr><td>event_no_BGR_o</td><td>.008737</td><td>.0012648</td><td>6.91</td><td>0.000</td><td>.0062562</td><td>.0112178</td></tr>
<tr><td>event_o_BGR_o</td><td>-.0007103</td><td>.0107028</td><td>-0.07</td><td>0.947</td><td>-.0217029</td><td>.0202824</td></tr>
<tr><td>_cons</td><td>6.242048</td><td>.1057922</td><td>59.00</td><td>0.000</td><td>6.034545</td><td>6.449551</td></tr>
</table>

<table>
<tr><th>ln_productivity</th><th>Coefficient</th><th>Std. err.</th><th>t</th><th>P>|t|</th><th colspan="2">[95% conf. interval]</th></tr>
<tr><td>lnKL</td><td>.3166262</td><td>.0108405</td><td>29.21</td><td>0.000</td><td>.2953634</td><td>.3378889</td></tr>
<tr><td>human_K</td><td>.226716</td><td>.0288964</td><td>7.85</td><td>0.000</td><td>.170038</td><td>.283394</td></tr>
<tr><td>share_internet_pop</td><td>.0552733</td><td>.0174446</td><td>3.17</td><td>0.002</td><td>.0210571</td><td>.0894895</td></tr>
<tr><td>event_no_CMR_o</td><td>.0086116</td><td>.0012587</td><td>6.84</td><td>0.000</td><td>.0061427</td><td>.0110805</td></tr>
<tr><td>event_o_CMR_o</td><td>.0078755</td><td>.0213134</td><td>0.37</td><td>0.712</td><td>-.033929</td><td>.04968</td></tr>
<tr><td>_cons</td><td>6.243358</td><td>.1058076</td><td>59.01</td><td>0.000</td><td>6.035825</td><td>6.450891</td></tr>
</table>

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3167703	.0108439	29.21	0.000	.2955009	.3380398
human_K	.2266884	.0288937	7.85	0.000	.1700157	.283361
share_internet_pop	.0552275	.0174437	3.17	0.002	.0210131	.089442
event_no_CAN_o	**.0085639**	**.0012603**	**6.80**	**0.000**	**.0060919**	**.0110359**
event_o_CAN_o	**.0163774**	**.0167359**	**0.98**	**0.328**	**-.0164488**	**.0492035**
_cons	6.241612	.1058652	58.96	0.000	6.033966	6.449258

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3165598	.0108377	29.21	0.000	.2953026	.3378171
human_K	.2262244	.0288925	7.83	0.000	.1695541	.2828947
share_internet_pop	.0556959	.0174458	3.19	0.001	.0214774	.0899144
event_no_CHL_o	**.0087273**	**.0012627**	**6.91**	**0.000**	**.0062506**	**.0112039**
event_o_CHL_o	**-.0031849**	**.0126918**	**-0.25**	**0.802**	**-.0280788**	**.021709**
_cons	6.245341	.1058001	59.03	0.000	6.037823	6.45286

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.2981698	.0107586	27.71	0.000	.2770677	.3192718
human_K	.2449927	.0282441	8.67	0.000	.1895942	.3003913
share_internet_pop	.058321	.0170122	3.43	0.001	.0249529	.0916891
event_no_CHN_o	**.003561**	**.0013426**	**2.65**	**0.008**	**.0009275**	**.0061945**
event_o_CHN_o	**.033807**	**.0030017**	**11.26**	**0.000**	**.0279194**	**.0396945**
_cons	6.413367	.1048085	61.19	0.000	6.207793	6.618941

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3164993	.0108416	29.19	0.000	.2952343	.3377642
human_K	.2270568	.0288992	7.86	0.000	.1703733	.2837403
share_internet_pop	.0552365	.017443	3.17	0.002	.0210234	.0894495
event_no_COL_o	**.0086769**	**.0012622**	**6.87**	**0.000**	**.0062012**	**.0111525**
event_o_COL_o	**.0012998**	**.0129294**	**0.10**	**0.920**	**-.0240603**	**.0266599**
_cons	6.244166	.1058062	59.02	0.000	6.036635	6.451696

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.316575	.0108399	29.20	0.000	.2953135	.3378366
human_K	.2267551	.0288932	7.85	0.000	.1700834	.2834269
share_internet_pop	.0552214	.0174434	3.17	0.002	.0210076	.0894352
event_no_CRI_o	**.0086472**	**.0012586**	**6.87**	**0.000**	**.0061785**	**.0111159**
event_o_CRI_o	**-.0028885**	**.02187**	**-0.13**	**0.895**	**-.0457847**	**.0400078**
_cons	6.244011	.1058054	59.01	0.000	6.036482	6.45154

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3167588	.0108374	29.23	0.000	.295502	.3380156
human_K	.2265418	.0288864	7.84	0.000	.1698835	.2832001
share_internet_pop	.0556479	.0174425	3.19	0.001	.0214359	.08986
event_no_CYP_o	**.0085553**	**.0012573**	**6.80**	**0.000**	**.0060892**	**.0110214**
event_o_CYP_o	**.0412791**	**.0313855**	**1.32**	**0.189**	**-.0202811**	**.1028393**
_cons	6.242149	.1057778	59.01	0.000	6.034674	6.449623

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.316629	.0108409	29.21	0.000	.2953653	.3378927
human_K	.2267129	.0289037	7.84	0.000	.1700205	.2834052
share_internet_pop	.0552688	.0174646	3.16	0.002	.0210134	.0895241
event_no_DNK_o	**.0086088**	**.0012574**	**6.85**	**0.000**	**.0061425**	**.0110751**
event_o_DNK_o	**.0088725**	**.0394368**	**0.22**	**0.822**	**-.0684796**	**.0862245**
_cons	6.243324	.1058484	58.98	0.000	6.035711	6.450937

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3165225	.0108397	29.20	0.000	.2952613	.3377837
human_K	.2267569	.0288912	7.85	0.000	.1700891	.2834247
share_internet_pop	.0553911	.0174427	3.18	0.002	.0211787	.0896036
event_no_ECU_o	**.0086913**	**.0012618**	**6.89**	**0.000**	**.0062163**	**.0111663**
event_o_ECU_o	**-.0009242**	**.0135362**	**-0.07**	**0.946**	**-.0274744**	**.025626**
_cons	6.244471	.1058026	59.02	0.000	6.036948	6.451994

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166254	.0108396	29.21	0.000	.2953643	.3378865
human_K	.2264667	.0288986	7.84	0.000	.1697843	.283149
share_internet_pop	.0553959	.0174455	3.18	0.002	.0211778	.0896139
event_no_EGY_o	**.0086456**	**.0012591**	**6.87**	**0.000**	**.0061759**	**.0111153**
event_o_EGY_o	**-.0005475**	**.0202071**	**-0.03**	**0.978**	**-.0401821**	**.0390872**
_cons	6.243991	.1058097	59.01	0.000	6.036454	6.451529

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3168028	.0108399	29.23	0.000	.2955411	.3380645
human_K	.2269238	.0288904	7.85	0.000	.1702576	.28359
share_internet_pop	.054805	.0174497	3.14	0.002	.0205789	.0890311
event_no_FIN_o	**.0085946**	**.0012565**	**6.84**	**0.000**	**.0061301**	**.0110591**
event_o_FIN_o	**.1016704**	**.1103472**	**0.92**	**0.357**	**-.1147669**	**.3181077**
_cons	6.240878	.1058241	58.97	0.000	6.033312	6.448443

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3167654	.0108421	29.22	0.000	.2954994	.3380313
human_K	.226611	.0288933	7.84	0.000	.169939	.283283
share_internet_pop	.0553395	.0174433	3.17	0.002	.0211258	.0895532
event_no_FRA_o	**.0085259**	**.0012654**	**6.74**	**0.000**	**.0060439**	**.0110079**
event_o_FRA_o	**.0144898**	**.0106549**	**1.36**	**0.174**	**-.006409**	**.0353886**
_cons	6.241897	.1058288	58.98	0.000	6.034323	6.449472

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3164753	.0108428	29.19	0.000	.295208	.3377426
human_K	.2265706	.0288939	7.84	0.000	.1698976	.2832437
share_internet_pop	.0556263	.0174544	3.19	0.001	.0213908	.0898618
event_no_DEU_o	**.0086755**	**.0012622**	**6.87**	**0.000**	**.0061998**	**.0111512**
event_o_DEU_o	**.0011538**	**.0134796**	**0.09**	**0.932**	**-.0252853**	**.027593**
_cons	6.245463	.1058656	58.99	0.000	6.037817	6.45311

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3171497	.010847	29.24	0.000	.2958741	.3384253
human_K	.2253757	.0289112	7.80	0.000	.1686688	.2820826
share_internet_pop	.0555595	.0174403	3.19	0.001	.0213519	.0897672
event_no_GRC_o	**.0084933**	**.0012607**	**6.74**	**0.000**	**.0060205**	**.0109661**
event_o_GRC_o	**.0241924**	**.0144053**	**1.68**	**0.093**	**-.0040624**	**.0524473**
_cons	6.240692	.1057967	58.99	0.000	6.03318	6.448204

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3169162	.0108373	29.24	0.000	.2956597	.3381728
human_K	.2261736	.0288843	7.83	0.000	.1695193	.2828278
share_internet_pop	.0551966	.0174361	3.17	0.002	.0209972	.0893961
event_no_HUN_o	**.0085182**	**.0012581**	**6.77**	**0.000**	**.0060506**	**.0109858**
event_o_HUN_o	**.0360624**	**.0216449**	**1.67**	**0.096**	**-.0063924**	**.0785172**
_cons	6.24126	.1057672	59.01	0.000	6.033806	6.448714

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3173813	.0108387	29.28	0.000	.296122	.3386407
human_K	.2270352	.0288691	7.86	0.000	.1704107	.2836596
share_internet_pop	.0527582	.0174876	3.02	0.003	.0184577	.0870588
event_no_ISL_o	**.0086589**	**.0012558**	**6.90**	**0.000**	**.0061957**	**.011122**
event_o_ISL_o	**-.0799544**	**.0506863**	**-1.58**	**0.115**	**-.1793715**	**.0194627**
_cons	6.234479	.1058294	58.91	0.000	6.026903	6.442055

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3167551	.0108404	29.22	0.000	.2954924	.3380177
human_K	.2270852	.0288969	7.86	0.000	.1704062	.2837642
share_internet_pop	.0548817	.0174519	3.14	0.002	.0206513	.0891121
event_no_IND_o	**.0088869**	**.0013222**	**6.72**	**0.000**	**.0062935**	**.0114802**
event_o_IND_o	**.0060908**	**.0039382**	**1.55**	**0.122**	**-.0016337**	**.0138153**
_cons	6.240803	.105859	58.95	0.000	6.033169	6.448437

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3167155	.0108436	29.21	0.000	.2954467	.3379844
human_K	.2259369	.0289999	7.79	0.000	.169056	.2828179
share_internet_pop	.0555756	.0174707	3.18	0.001	.0213082	.0898429
event_no_IDN_o	**.008535**	**.0012788**	**6.67**	**0.000**	**.0060268**	**.0110432**
event_o_IDN_o	**.0105731**	**.0064078**	**1.65**	**0.099**	**-.0019952**	**.0231414**
_cons	6.244191	.1058383	59.00	0.000	6.036598	6.451785

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3175188	.0108736	29.20	0.000	.2961911	.3388464
human_K	.2268612	.0288871	7.85	0.000	.1702015	.283521
share_internet_pop	.0547587	.0174469	3.14	0.002	.020538	.0889793
event_no_IRN_o	**.0084684**	**.0012641**	**6.70**	**0.000**	**.0059889**	**.0109479**
event_o_IRN_o	**.0208742**	**.0123354**	**1.69**	**0.091**	**-.0033207**	**.0450691**
_cons	6.23268	.1063111	58.63	0.000	6.024159	6.441201

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3169857	.0108438	29.23	0.000	.2957164	.338255
human_K	.2259033	.0288999	7.82	0.000	.1692185	.2825881
share_internet_pop	.0556541	.0174443	3.19	0.001	.0214385	.0898697
event_no_IRL_o	**.0085647**	**.0012572**	**6.81**	**0.000**	**.0060989**	**.0110305**
event_o_IRL_o	**.0406339**	**.0336535**	**1.21**	**0.227**	**-.0253747**	**.1066426**
_cons	6.241052	.1058048	58.99	0.000	6.033524	6.44858

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166689	.0108399	29.21	0.000	.2954073	.3379306
human_K	.226592	.0288946	7.84	0.000	.1699174	.2832665
share_internet_pop	.0552694	.0174434	3.17	0.002	.0210556	.0894833
event_no_ISR_o	**.0086343**	**.0012577**	**6.87**	**0.000**	**.0061674**	**.0111011**
event_o_ISR_o	**-.005258**	**.0294875**	**-0.18**	**0.858**	**-.0630954**	**.0525794**
_cons	6.243202	.1058	59.01	0.000	6.035683	6.45072

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3163679	.0108382	29.19	0.000	.2951097	.3376261
human_K	.2271166	.0288857	7.86	0.000	.1704595	.2837737
share_internet_pop	.0557076	.0174414	3.19	0.001	.0214978	.0899175
event_no_ITA_o	**.008729**	**.0012604**	**6.93**	**0.000**	**.0062569**	**.0112011**
event_o_ITA_o	**-.008696**	**.0149566**	**-0.58**	**0.561**	**-.0380322**	**.0206401**
_cons	6.245503	.1057794	59.04	0.000	6.038025	6.452981

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.316203	.0108499	29.14	0.000	.2949217	.3374843
human_K	.2261219	.0288979	7.82	0.000	.169441	.2828029
share_internet_pop	.0566128	.0175143	3.23	0.001	.0222599	.0909657
event_no_JPN_o	**.0087853**	**.001274**	**6.90**	**0.000**	**.0062865**	**.0112841**
event_o_JPN_o	**.0021874**	**.0077894**	**0.28**	**0.779**	**-.0130908**	**.0174656**
_cons	6.249455	.1060368	58.94	0.000	6.041472	6.457438

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3169527	.0108286	29.27	0.000	.2957133	.3381921
human_K	.2305088	.0289248	7.97	0.000	.173775	.2872426
share_internet_pop	.0537116	.0174416	3.08	0.002	.0195013	.0879219
event_no_JOR_o	**.0084723**	**.0012571**	**6.74**	**0.000**	**.0060067**	**.0109379**
event_o_JOR_o	**.0661277**	**.0291088**	**2.27**	**0.023**	**.0090332**	**.1232222**
_cons	6.230182	.1058894	58.84	0.000	6.022489	6.437876

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3150508	.0108716	28.98	0.000	.293727	.3363746
human_K	.2313485	.0290025	7.98	0.000	.1744624	.2882346
share_internet_pop	.0541966	.0174413	3.11	0.002	.0199869	.0884064
event_no_KEN_o	**.0088715**	**.0012653**	**7.01**	**0.000**	**.0063898**	**.0113532**
event_o_KEN_o	**-.0076232**	**.0097471**	**-0.78**	**0.434**	**-.0267413**	**.0114949**
_cons	6.249894	.1057873	59.08	0.000	6.042401	6.457388

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3165961	.0108416	29.20	0.000	.2953313	.3378609
human_K	.226591	.028902	7.84	0.000	.1699021	.2832799
share_internet_pop	.0554453	.017468	3.17	0.002	.0211832	.0897075
event_no_KWT_o	**.0086062**	**.0012567**	**6.85**	**0.000**	**.0061412**	**.0110712**
event_o_KWT_o	**.0236362**	**.0798562**	**0.30**	**0.767**	**-.1329955**	**.1802678**
_cons	6.243966	.1058572	58.98	0.000	6.036335	6.451596

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166271	.0108404	29.21	0.000	.2953646	.3378896
human_K	.2266774	.0289116	7.84	0.000	.1699695	.2833852
share_internet_pop	.0552796	.0174454	3.17	0.002	.0210619	.0894973
event_no_MAC_o	**.0086112**	**.0012584**	**6.84**	**0.000**	**.006143**	**.0110794**
event_o_MAC_o	**.0077435**	**.0270407**	**0.29**	**0.775**	**-.0452947**	**.0607817**
_cons	6.243433	.1058429	58.99	0.000	6.03583	6.451035

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166408	.0108374	29.22	0.000	.295384	.3378976
human_K	.2274091	.0288977	7.87	0.000	.1707287	.2840896
share_internet_pop	.0548587	.0174457	3.14	0.002	.0206404	.0890769
event_no_MWI_o	**.0087078**	**.0012608**	**6.91**	**0.000**	**.0062349**	**.0111807**
event_o_MWI_o	**-.0044688**	**.0140951**	**-0.32**	**0.751**	**-.0321152**	**.0231776**
_cons	6.241586	.1057955	59.00	0.000	6.034076	6.449095

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166173	.0108402	29.21	0.000	.295355	.3378795
human_K	.2267653	.028896	7.85	0.000	.1700882	.2834425
share_internet_pop	.0552914	.0174444	3.17	0.002	.0210756	.0895073
event_no_MYS_o	**.0085802**	**.0012622**	**6.80**	**0.000**	**.0061044**	**.011056**
event_o_MYS_o	**.0118176**	**.0132802**	**0.89**	**0.374**	**-.0142305**	**.0378657**
_cons	6.243282	.1058052	59.01	0.000	6.035754	6.450811

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166282	.010837	29.22	0.000	.2953723	.3378841
human_K	.2267083	.0288867	7.85	0.000	.1700493	.2833672
share_internet_pop	.0552743	.0174392	3.17	0.002	.0210687	.08948
event_no_MLT_o	**.0086091**	**.0012563**	**6.85**	**0.000**	**.006145**	**.0110732**
event_o_MLT_o	**0**	**(omitted)**				
_cons	6.243344	.1057743	59.03	0.000	6.035876	6.450812

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3164461	.0108363	29.20	0.000	.2951915	.3377006
human_K	.2263035	.028884	7.83	0.000	.1696498	.2829571
share_internet_pop	.0553751	.0174367	3.18	0.002	.0211744	.0895757
event_no_MUS_o	**.0086646**	**.0012569**	**6.89**	**0.000**	**.0061993**	**.0111298**
event_o_MUS_o	**-.0387994**	**.0385194**	**-1.01**	**0.314**	**-.114352**	**.0367533**
_cons	6.246571	.1057901	59.05	0.000	6.039073	6.45407

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3164919	.0108351	29.21	0.000	.2952397	.3377441
human_K	.2269813	.0288811	7.86	0.000	.1703334	.2836293
share_internet_pop	.0551167	.0174358	3.16	0.002	.0209178	.0893157
event_no_MEX_o	**.008833**	**.0012676**	**6.97**	**0.000**	**.0063468**	**.0113192**
event_o_MEX_o	**-.0033159**	**.0091842**	**-0.36**	**0.718**	**-.0213299**	**.0146981**
_cons	6.244749	.1057565	59.05	0.000	6.037316	6.452182

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3165483	.0108446	29.19	0.000	.2952773	.3378192
human_K	.2268855	.0289033	7.85	0.000	.1701939	.2835771
share_internet_pop	.0552502	.0174445	3.17	0.002	.0210342	.0894662
event_no_MAR_o	**.008629**	**.001259**	**6.85**	**0.000**	**.0061595**	**.0110985**
event_o_MAR_o	**.0035692**	**.0198089**	**0.18**	**0.857**	**-.0352844**	**.0424228**
_cons	6.243838	.1058224	59.00	0.000	6.036276	6.4514

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3088931	.0108593	28.44	0.000	.2875933	.3301928
human_K	.2326034	.0286885	8.11	0.000	.1763332	.2888736
share_internet_pop	.0591896	.0173225	3.42	0.001	.0252129	.0931663
event_no_MMR_o	**.0082851**	**.0012482**	**6.64**	**0.000**	**.0058368**	**.0107334**
event_o_MMR_o	**.1167198**	**.021127**	**5.52**	**0.000**	**.0752807**	**.1581588**
_cons	6.315579	.1059058	59.63	0.000	6.107853	6.523305

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3165373	.0108416	29.20	0.000	.2952724	.3378023
human_K	.2265084	.0288973	7.84	0.000	.1698287	.2831882
share_internet_pop	.0554339	.0174472	3.18	0.002	.0212126	.0896553
event_no_NPL_o	**.0085614**	**.0012612**	**6.79**	**0.000**	**.0060877**	**.011035**
event_o_NPL_o	**.0147206**	**.0138197**	**1.07**	**0.287**	**-.0123857**	**.0418268**
_cons	6.244718	.1058457	59.00	0.000	6.037111	6.452326

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3166109	.0108398	29.21	0.000	.2953495	.3378724
human_K	.2265375	.0288969	7.84	0.000	.1698584	.2832166
share_internet_pop	.0554249	.0174474	3.18	0.002	.0212032	.0896466
event_no_NLD_o	**.0086375**	**.0012584**	**6.86**	**0.000**	**.0061692**	**.0111058**
event_o_NLD_o	**-.001187**	**.0236269**	**-0.05**	**0.960**	**-.0475292**	**.0451552**
_cons	6.24401	.1058133	59.01	0.000	6.036465	6.451554

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.316626	.0108445	29.20	0.000	.2953554	.3378965
human_K	.226714	.0289058	7.84	0.000	.1700176	.2834105
share_internet_pop	.0552732	.0174452	3.17	0.002	.0210558	.0894906
event_no_NER_o	**.0086098**	**.0012601**	**6.83**	**0.000**	**.0061383**	**.0110813**
event_o_NER_o	**.0084854**	**.0166091**	**0.51**	**0.609**	**-.024092**	**.0410627**
_cons	6.243358	.1058233	59.00	0.000	6.035794	6.450922

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3175092	.0107904	29.43	0.000	.2963447	.3386736
human_K	.2262765	.0287565	7.87	0.000	.1698729	.2826802
share_internet_pop	.0541021	.017363	3.12	0.002	.0200459	.0881583
event_no_NGA_o	**.0095351**	**.0012721**	**7.50**	**0.000**	**.00704**	**.0120301**
event_o_NGA_o	**-.0175279**	**.006689**	**-2.62**	**0.009**	**-.0306479**	**-.0044079**
_cons	6.23346	.1053263	59.18	0.000	6.026871	6.440049

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3166447	.0108398	29.21	0.000	.2953834	.337906
human_K	.2266346	.0288944	7.84	0.000	.1699606	.2833087
share_internet_pop	.0554813	.0174501	3.18	0.002	.0212543	.0897083
event_no_NOR_o	**.008594**	**.0012571**	**6.84**	**0.000**	**.0061283**	**.0110596**
event_o_NOR_o	**.0285404**	**.0459925**	**0.62**	**0.535**	**-.0616702**	**.1187509**
_cons	6.243239	.105801	59.01	0.000	6.035719	6.450759

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.316675	.0108187	29.27	0.000	.2954549	.3378951
human_K	.2255326	.0288416	7.82	0.000	.168962	.2821032
share_internet_pop	.0561291	.017413	3.22	0.001	.0219748	.0902834
event_no_PHL_o	**.0098768**	**.0013489**	**7.32**	**0.000**	**.0072311**	**.0125226**
event_o_PHL_o	**.0006287**	**.0033683**	**0.19**	**0.852**	**-.0059779**	**.0072352**
_cons	6.243864	.1055961	59.13	0.000	6.036746	6.450982

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166279	.0108404	29.21	0.000	.2953653	.3378906
human_K	.226708	.0288956	7.85	0.000	.1700317	.2833844
share_internet_pop	.0552735	.0174453	3.17	0.002	.0210559	.0894911
event_no_PAN_o	**.0086087**	**.0012587**	**6.84**	**0.000**	**.0061398**	**.0110776**
event_o_PAN_o	**.0087225**	**.0210191**	**0.41**	**0.678**	**-.0325048**	**.0499498**
_cons	6.243346	.1058079	59.01	0.000	6.035813	6.45088

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3174615	.0107998	29.40	0.000	.2962786	.3386444
human_K	.2243276	.0287884	7.79	0.000	.1678614	.2807938
share_internet_pop	.0532778	.0173841	3.06	0.002	.0191802	.0873754
event_no_POL_o	**.0083215**	**.0012542**	**6.63**	**0.000**	**.0058615**	**.0107815**
event_o_POL_o	**.0751427**	**.0184831**	**4.07**	**0.000**	**.0388896**	**.1113957**
_cons	6.239675	.1053917	59.20	0.000	6.032958	6.446393

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166187	.010839	29.21	0.000	.2953589	.3378785
human_K	.226669	.028892	7.85	0.000	.1699996	.2833384
share_internet_pop	.055525	.0174469	3.18	0.001	.0213044	.0897457
event_no_PRT_o	**.0086582**	**.0012589**	**6.88**	**0.000**	**.006189**	**.0111273**
event_o_PRT_o	**-.004074**	**.0199628**	**-0.20**	**0.838**	**-.0432295**	**.0350815**
_cons	6.243567	.1057942	59.02	0.000	6.03606	6.451074

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166282	.010837	29.22	0.000	.2953723	.3378841
human_K	.2267083	.0288867	7.85	0.000	.1700493	.2833672
share_internet_pop	.0552743	.0174392	3.17	0.002	.0210687	.08948
event_no_QAT_o	**.0086091**	**.0012563**	**6.85**	**0.000**	**.006145**	**.0110732**
event_o_QAT_o	**0**	**(omitted)**				
_cons	6.243344	.1057743	59.03	0.000	6.035876	6.450812

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.317178	.0108455	29.25	0.000	.2959054	.3384506
human_K	.225932	.0288904	7.82	0.000	.1692657	.2825982
share_internet_pop	.055392	.0174373	3.18	0.002	.0211901	.0895939
event_no_ROM_o	**.0084157**	**.0012666**	**6.64**	**0.000**	**.0059314**	**.0109001**
event_o_ROM_o	**.0201135**	**.0097594**	**2.06**	**0.039**	**.0009713**	**.0392558**
_cons	6.239015	.1058236	58.96	0.000	6.031451	6.44658

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166243	.0108399	29.21	0.000	.2953627	.3378859
human_K	.2268627	.0288977	7.85	0.000	.1701821	.2835433
share_internet_pop	.0551872	.0174457	3.16	0.002	.020969	.0894055
event_no_SEN_o	**.0086342**	**.0012586**	**6.86**	**0.000**	**.0061655**	**.0111028**
event_o_SEN_o	**.0011205**	**.0212023**	**0.05**	**0.958**	**-.040466**	**.0427071**
_cons	6.243073	.1058055	59.01	0.000	6.035543	6.450602

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3160906	.0108533	29.12	0.000	.2948027	.3373785
human_K	.2290634	.0290016	7.90	0.000	.1721792	.2859477
share_internet_pop	.0545252	.0174591	3.12	0.002	.0202805	.0887698
event_no_SGP_o	**.0086251**	**.0012564**	**6.86**	**0.000**	**.0061607**	**.0110895**
event_o_SGP_o	**-.0456073**	**.059021**	**-0.77**	**0.440**	**-.1613724**	**.0701578**
_cons	6.243699	.1057801	59.03	0.000	6.03622	6.451179

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.316561	.0108406	29.20	0.000	.295298	.337824
human_K	.2263998	.0289015	7.83	0.000	.1697119	.2830877
share_internet_pop	.0553837	.0174451	3.17	0.002	.0211666	.0896008
event_no_ZAF_o	**.0086855**	**.0012675**	**6.85**	**0.000**	**.0061994**	**.0111717**
event_o_ZAF_o	**.004127**	**.0098318**	**0.42**	**0.675**	**-.0151573**	**.0234113**
_cons	6.244864	.1058516	59.00	0.000	6.037244	6.452483

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3166495	.0108413	29.21	0.000	.2953852	.3379139
human_K	.2266301	.0289006	7.84	0.000	.1699438	.2833164
share_internet_pop	.0552682	.0174445	3.17	0.002	.0210522	.0894843
event_no_ESP_o	**.0086217**	**.0012598**	**6.84**	**0.000**	**.0061507**	**.0110926**
event_o_ESP_o	**.00606**	**.0180319**	**0.34**	**0.737**	**-.0293081**	**.0414281**
_cons	6.243345	.1058061	59.01	0.000	6.035814	6.450875

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3162854	.0108472	29.16	0.000	.2950094	.3375614
human_K	.2270508	.0288935	7.86	0.000	.1703785	.2837232
share_internet_pop	.055338	.0174415	3.17	0.002	.0211278	.0895482
event_no_LKA_o	**.0086113**	**.0012564**	**6.85**	**0.000**	**.0061469**	**.0110757**
event_o_LKA_o	**.0266651**	**.023219**	**1.15**	**0.251**	**-.0188772**	**.0722074**
_cons	6.245949	.10584	59.01	0.000	6.038352	6.453545

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3169343	.0108426	29.23	0.000	.2956674	.3382011
human_K	.2273431	.0288962	7.87	0.000	.1706655	.2840208
share_internet_pop	.0543378	.0174696	3.11	0.002	.0200726	.088603
event_no_SWE_o	**.0085549**	**.0012577**	**6.80**	**0.000**	**.0060881**	**.0110218**
event_o_SWE_o	**.0362375**	**.029998**	**1.21**	**0.227**	**-.0226011**	**.0950761**
_cons	6.238447	.1059126	58.90	0.000	6.030708	6.446186

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3165802	.0108489	29.18	0.000	.2953009	.3378596
human_K	.2267685	.0289006	7.85	0.000	.1700823	.2834546
share_internet_pop	.055283	.0174447	3.17	0.002	.0210666	.0894994
event_no_TZA_o	**.0086238**	**.0012636**	**6.82**	**0.000**	**.0061453**	**.0111023**
event_o_TZA_o	**.0072936**	**.0119422**	**0.61**	**0.541**	**-.01613**	**.0307172**
_cons	6.24375	.1058698	58.98	0.000	6.036095	6.451405

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.316436	.0108426	29.18	0.000	.2951691	.3377029
human_K	.2263937	.0288953	7.83	0.000	.1697177	.2830696
share_internet_pop	.0555302	.0174463	3.18	0.001	.0213107	.0897498
event_no_THA_o	**.0087176**	**.0012668**	**6.88**	**0.000**	**.0062328**	**.0112023**
event_o_THA_o	**.0018575**	**.0101269**	**0.18**	**0.854**	**-.0180057**	**.0217208**
_cons	6.246461	.1058938	58.99	0.000	6.038758	6.454163

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3165212	.0108379	29.21	0.000	.2952636	.3377789
human_K	.2266275	.0288876	7.85	0.000	.1699667	.2832883
share_internet_pop	.055131	.0174404	3.16	0.002	.0209231	.0893389
event_no_TTO_o	**.0086543**	**.0012572**	**6.88**	**0.000**	**.0061884**	**.0111202**
event_o_TTO_o	**-.0247394**	**.0350266**	**-0.71**	**0.480**	**-.0934412**	**.0439624**
_cons	6.244858	.1057893	59.03	0.000	6.03736	6.452355

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3168521	.0108397	29.23	0.000	.2955909	.3381133
human_K	.2260037	.0288965	7.82	0.000	.1693255	.2826818
share_internet_pop	.0554708	.0174408	3.18	0.001	.0212621	.0896795
event_no_TUN_o	**.0085714**	**.0012569**	**6.82**	**0.000**	**.0061061**	**.0110367**
event_o_TUN_o	**.0454502**	**.0381551**	**1.19**	**0.234**	**-.029388**	**.1202885**
_cons	6.242542	.1057798	59.01	0.000	6.035064	6.450021

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3174399	.0108505	29.26	0.000	.2961575	.3387224
human_K	.2258733	.0288856	7.82	0.000	.1692164	.2825301
share_internet_pop	.0553598	.0174348	3.18	0.002	.0211629	.0895567
event_no_TUR_o	**.0084128**	**.0012642**	**6.65**	**0.000**	**.0059332**	**.0108924**
event_o_TUR_o	**.0237745**	**.0112044**	**2.12**	**0.034**	**.0017979**	**.045751**
_cons	6.236178	.1058774	58.90	0.000	6.028508	6.443848

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3166908	.0108419	29.21	0.000	.2954252	.3379563
human_K	.2268434	.0288981	7.85	0.000	.1701621	.2835246
share_internet_pop	.0551072	.0174525	3.16	0.002	.0208754	.089339
event_no_GBR_o	**.0085678**	**.0012638**	**6.78**	**0.000**	**.0060891**	**.0110466**
event_o_GBR_o	**.0122972**	**.0120592**	**1.02**	**0.308**	**-.011356**	**.0359505**
_cons	6.242292	.105859	58.97	0.000	6.034658	6.449926

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ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
lnKL	.3164401	.0108069	29.28	0.000	.2952432	.3376371
human_K	.224094	.0288178	7.78	0.000	.1675701	.2806179
share_internet_pop	.0553986	.0173906	3.19	0.001	.0212882	.089509
event_no_USA_o	**.0101581**	**.0013439**	**7.56**	**0.000**	**.0075221**	**.0127942**
event_o_USA_o	**-.0016533**	**.0034584**	**-0.48**	**0.633**	**-.0084367**	**.00513**
_cons	6.252096	.1055152	59.25	0.000	6.045136	6.459055

----

ln_productivity	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnKL	.3165754	.0108428	29.20	0.000	.2953081	.3378427
human_K	.2268698	.0289044	7.85	0.000	.1701761	.2835634
share_internet_pop	.0552172	.0174463	3.16	0.002	.0209978	.0894366
event_no_URY_o	**.008624**	**.0012584**	**6.85**	**0.000**	**.0061556**	**.0110923**
event_o_URY_o	**.0036396**	**.0225834**	**0.16**	**0.872**	**-.0406559**	**.047935**
_cons	6.243579	.1058106	59.01	0.000	6.036039	6.451118

APPENDIX IV

Analysis of robustness.

Correlations between "life expectancy" with the "capital-labor ratio" and the "human capital index"

```
. corr lnKL human_K share_internet_pop life_expectancy
(obs=1,793)

             |     lnKL  human_K share_~p life_e~y
-------------+------------------------------------
        lnKL |   1.0000
     human_K |   0.5428   1.0000
share_inte~p |   0.0301   0.0273   1.0000
life_expec~y |   0.7147   0.7183   0.0391   1.0000
```

Given that "life expectancy" is highly correlated with both the "capital-labor" ratio and the "human capital index", I have substituted the last two variables by the first one, looking for a more parsimonious specification. Therefore, the labor productivity equations are now:

- Labor productivity equations.

$$lnLproduct_{it} = \beta_0 + \beta_1 life\_expect_{it} + \beta_1 internet\_share_{it} + \beta_2 temp_{it} + f_i + u_{it} \tag{4.3bis}$$

$$lnLproduct_{it} = \beta_0 + \beta_1 life\_expect_{it} + \beta_2 internet\_share_{it} + \beta_3 events_{it} + f_i + u_{it} \tag{4.4bis}$$

where $lnLproduct_{it}$ is the (logarithm) of labor productivity of country "i" in year "$life\_expect_{it}$ is life expectancy while $internet\_share_{it}$ is the ratio of Internet users to population, $temp_{it}$ and $events_{it}$ are our measures of climate change, f_i

are country fixed effects, and u_{it} is the usual error term. The explanatory variable "life expectancy" is measuring human capital in line with Aghion, et al. (2011) or Bloom et al. (2004).

Making the pararelism with the analysis in section 4.4, the impact of climate change on labor productivity (Equations [3bis] and [4bis]) can be seen in Table 2a. As shown, the proposed equations are adequate and explain more than 50% of the variation in labor productivity within countries (somewhat below of that obtained in the alternative equations). Both life expectancy and the percentage of internet users over the population have the correct (positive) sign and are highly significant. The increase in temperatures does not have a general impact on labor productivity, while the impact of events is around 1%. The results are perfectly in line with that of table 2 in the text.

The disaggregation by country and type of event appears in Table 4a. Regarding temperatures and focusing on the estimated significant parameters, I observe that for some countries, the rise in temperatures also increases labor productivity (the cases of Bulgaria, China, India, Indonesia, Mauritius, Myanmar, Nigeria, Panama, Poland, South Africa, Sri Lanka, and Trinidad and Tobago), while in others (Brazil, Iran, Italy, Kenya, Kuwait, Macao, Niger, and Qatar), higher temperatures have a negative impact on labor productivity. In this case, there is some differences with the estimated coefficients in the labor productivity specification of the text.

Focusing on events, similar to the alternative specification, only a few countries have a significant average impact (at least at the 5% level) on labor productivity: China, Myanmar, Niger, Poland, and Sri Lanka. In this case, if we disaggregate China from the rest, the average impact is null. This result reinforces the crucial role of China in the average result.

With regard to type of event, floods, epidemics, storms, and landslides impact labor productivity. Only epidemics affect it negatively (with no significant impact in the alternative specification). Similar to the results presented in the main text, all events (except epidemics) have a highly significant effect in China. Floods, storms, landslides, wildfires, and extreme temperatures have a positive effect, while insect infestations, and droughts have a negative effect. India is also affected by wildfires, floods, and storms (in all three cases in a positive way), as well as epidemics and insect infestations (in this case, negatively). The remaining countries do not present any generalized impact.

Again (as in the main text), I have carried out regressions decomposing the events for China, on the one hand, and the rest of the countries, on the other (Table 5a). As we can see, the influence of China on the average results obtained are perfectly in line with that of the alternative specification showed in the main text.

Table 4.2a. Labor productivity and climate change. Period 1990-2016. Fixed effects estimation.

	(1)	**(2)**
Dependent variable	**Log of labor productivity**	**Log of labor productivity**
Life_expect	0.049***	0.040***
	(0.002)	(0.002)
Internet_share	0.191***	0.207***
	(0.018)	(0.018)
$Temp_{it}$	0.005	
	(0.008)	
$Events_{it}$		0.010***
		(0.002)
constant	7.431***	7.528***
	(0.168)	(0.126)
Observations	1688	1703
Within-R2	0.527	0.541

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Table 4.4a. Impact of rising temperatures and extreme events on labor productivity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Temperature	Events	Wildfire	Flood	Extreme	Epidemic	Insect infestation	Storm	Drought	Landslide
Whole sample	0.005 (0.008)	0.010*** (0 .002)	NS	0.013***(0.002)	NS	-0.012*** (0.005)	NS	0.014*** (0.003)	NS	0.023***
Australia	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Austria	NS	NS		NS	NS			NS		NS
Belgium	NS	NS		NS	NS			NS		
Bolivia	NS	NS	NS	NS	NS	NS		NS	NS	NS
Brazil	-0.187** (0.093)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bulgaria	0.097** (0.039)	NS	NS	NS	NS			NS	NS	
Cameroon	NS	NS		NS		NS			NS	NS
Canada	NS	NS	NS	NS	NS	NS		NS		
Chile	NS	NS	NS	NS	NS	NS		NS		
China	0.792*** (0.068)	0.048*** (0.004)	0.198** (0.081)	0.074*** (0.007)	0.118***	-0.075* (0.043)	-0.672*** (0.144)	0.048*** (0.008)	-0.127*** (0.032)	0.113***(0.015)
Colombia	NS	NS	NS	NS		NS	NS	NS	NS	NS
Costa Rica	NS	NS	NS	NS				NS	NS	NS
Cyprus	NS	NS	NS		NS	NS		NS	NS	
Denmark	NS	NS						NS	NS	
Ecuador	NS	NS	NS	NS		NS			NS	NS
Egypt	NS	NS		NS	NS	NS		NS		
Finland	NS	NS		NS						
France	NS	NS	NS	NS	NS	NS		NS	NS	NS
Germany	NS	NS		NS	NS	NS		NS		NS
Greece	NS	NS	NS	NS	NS					
Hungary	NS	NS		NS	NS			NS	NS	
Iceland	NS	NS								NS
India	0.459** (0.190)	0.015* (0.08)	0.257** (0.102)	0.020*** (0.007)		-0.048*** (0.014)	-0.284* (0.155)	0.028* (0.015)	NS	NS
Indonesia	0.361*** (0.087)	0.009* (0.005)	NS	0.022** (0.010)	NS	NS		NS	NS	NS
Iran	-0.104** (0.045)	NS	NS	NS		NS		NS	NS	NS
Ireland	NS	NS		NS		NS		NS		
Israel	NS	NS	NS	NS		NS		NS	NS	
Italy	-0.135** (0.058))	NS	NS	NS	NS	NS		NS	NS	NS
Japan	NS	NS	NS	NS	NS	NS		NS		NS
Jordan	NS	NS		NS	NS			NS	NS	
Kenya	-0.246** (0.102)	NS		-0.039** (0.019)		NS			NS	NS
Korea	NS	NS	NS	NS	NS	NS		NS	NS	NS
Kuwait	-0.152** (0.045)	NS		NS		NS				
Macao	-0.182**(0.072)	NS				-0.243** (0.134)		NS		

Table 4.4a. (cont.). Impact of rising temperatures and extreme events on labor productivity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Temperature	Events	Wildfire	Flood	Extreme	Epidemic	Insect infestation	Storm	Drought	Landslide
Malawi	-0.181* (0.101)	NS		NS		NS			-0.107* (0.064)	
Malaysia	NS	NS	NS	NS		NS		NS	NS	NS
Malta	0.102* (0.060)									
Mauritius	0.297*** (0.068)	NS		NS		NS		-0.119* (0.062)		
Mexico	NS	NS	NS	NS	NS	NS		NS	NS	NS
Morocco	NS	NS		NS	NS		NS	NS	NS	
Myanmar	0.894** (0.103)	0.197*** (0.025)		0.192*** (0.063)		NS		0.446*** (0.069)		0.714***
Nepal	NS	NS	NS	NS	NS	NS		NS	NS	NS
Netherlands	NS	NS		NS	NS	NS		NS		
Niger	-0.396***	-0.094***		-0.196*** (0.041)		NS	NS	NS	-0.142** (0.062)	
Nigeria	0.290***	NS		NS	NS	NS	NS	NS		NS
Norway	NS	NS		NS				NS		
Panama	0.237** (0.098)	NS	NS	NS		NS		NS	0.261*** (0.101)	
Philippines	NS	NS	NS	NS		NS	NS	NS	NS	NS
Poland	0.093*** (0.037)	0.067*** (0.023)	NS	NS	0.084** (0.041)			NS		
Portugal	NS	NS	NS	NS	NS			NS	NS	
Qatar	-0.282***									
Romania	NS	NS		0.051** (0.019)	NS	NS		NS	-0.321** (0.137)	NS
Senegal	NS	NS		NS		NS	NS	NS	NS	
Singapore	NS	NS				NS				
South Africa	0.123** (0.065)	NS	NS	NS	NS	NS		NS	NS	NS
Spain	-0.112* (0.064)	NS	NS	NS	NS	NS		NS	NS	0.235* (0.140)
Sri Lanka	0.454*** (0.142)	0.075***(0.028)		0.080** (0.041)		NS		NS	NS	-0.292**
Sweden	NS	NS			NS	NS		NS		
Switzerland	NS	NS			NS					
Tanzania	NS	NS	NS	NS		NS	NS	NS	NS	NS
Thailand	NS	NS	NS	NS	NS	NS		NS	NS	NS
Trinidad and	0.209*** (0.097)	NS		-0.199* (0.109)				NS	NS	NS
Tunisia	NS	NS		NS						
Turkey	NS	NS	NS	NS	NS	NS		NS		NS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Temperature	Events	Wildfire	Flood	Extreme	Epidemic	Insect infestation	Storm	Drought	Landslide
United States	NS	NS	NS	NS	NS	NS		NS	NS	NS
Uruguay	NS	NS		NS	NS			NS	NS	

Note: NS: non-significant, *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Table 4.5a. Energy intensity, labor productivity and types of events.

	(1)	(2)
Dependent variable	**Log of primary energy consumption intensity**	**Log of Labor productivity**
Wildfire-no-China$_{ijt}$	0.006	0.003
	(0.011)	(0.009)
Wildfire-China$_{ijt}$	0.028	0.199**
	(0.103)	(0.080)
Flood-no-China$_{ijt}$	0.006*	0.005**
	(0.003)	(0.002)
Flood-China$_{ijt}$	0.041***	0.074***
	(0.010)	(0.007)
Ext_Temp-no-China$_{ijt}$	-0.019	0.006
	(0.012)	(0.008)
Ext_Temp -China$_{ijt}$	0.053	0.118***
	(0.050)	(0.035)
Epidemic-no-China$_{ijt}$	-0.004	-0.011**
	(0.007)	(0.005)
Epidemic-China$_{ijt}$	-0.076	-0.075*
	(0.059)	(0.003)
Insect-no-China$_{ijt}$	-0.003	0.018
	(0.037)	(0.035)
Insect-China$_{ijt}$	-0.509**	-0.673***
	(0.511)	(0.143)
Storm-no-China$_{ijt}$	-0.004	0.003
	(0.004)	(0.003)
Storm-China$_{ijt}$	0.018	0.048***
	(0.011)	(0.008)
Drought-no-China$_{ijt}$	0.035**	-0.008
	(0.016)	(0.012)
Drought-China$_{ijt}$	-0.059	-0.127***
	(0.044)	(0.002)
Landslide-no-China$_{ijt}$	0.026**	0.004
	(0.010)	(0.008)
Landslide-China$_{ijt}$	0.073***	0.132***
	(0.021)	(0.015)
Observations	2046	1703

Note: *significant at 10% level, ** significant at 5% level, ***significant at 1% level.

Standard errors are clustered by country.

Appendix V

OUTPUT EXIT BY COUNTRIES FROM STATA FOR THE EFFECT OF EVENTS ON LABOR PRODUCTIVITY (using life expectancy and proportion of internet users).

I present the Stata order for the first country as an example.

xtreg ln_productivity life_expectancy share_internet_pop event_no_AUS event_o_AUS , fe i(exp)

```
Fixed-effects (within) regression          Number of obs     =    1,703
Group variable: exp                        Number of groups  =       67
R-squared:                                 Obs per group:
     Within  = 0.5407                                  min =       17
     Between = 0.7553                                  avg =     25.4
     Overall = 0.7119                                  max =       26

                                           F(4,1632)         =   480.34
corr(ui, Xb) = 0.6730                      Prob > F          =   0.0000

------------------------------------------------------------------------------------

   ln_productivity | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]

   life_expectancy |   .0402253   .0017861    22.52   0.000     .0367221    .0437286

share_internet_pop |   .2066363   .0178353    11.59   0.000     .1716538    .2416188

   event_no_AUS_o |   .0106343   .0015509     6.86   0.000     .0075923    .0136762

    event_o_AUS_o |   .0028353     .01184     0.24   0.811    -.0203879    .0260585

            _cons |   7.530211   .1262869    59.63   0.000      7.28251    7.777913

-------------------+------------------------------------------------------------
```

life_expectancy | .040242 .0017862 22.53 0.000 .0367385 .0437454

share_internet_pop | .2066163 .0178376 11.58 0.000 .1716294 .2416033

event_no_AUT_o | .0105117 .0015409 6.82 0.000 .0074893 .0135341

event_o_AUT_o | .008112 .0246075 0.33 0.742 -.0401536 .0563776

_cons | 7.528827 .12629 59.62 0.000 7.281119 7.776534

----

life_expectancy | .0402 .0017862 22.51 0.000 .0366965 .0437034

share_internet_pop | .2074757 .017856 11.62 0.000 .1724527 .2424988

event_no_BEL_o | .0106069 .0015414 6.88 0.000 .0075836 .0136303

event_o_BEL_o | -.0098024 .0215212 -0.46 0.649 -.0520146 .0324098

_cons | 7.531733 .1262883 59.64 0.000 7.284029 7.779437

----

life_expectancy | .0403643 .0017874 22.58 0.000 .0368584 .0438702

share_internet_pop | .2060296 .0178334 11.55 0.000 .1710508 .2410084

event_no_BOL_o | .0106682 .0015421 6.92 0.000 .0076435 .0136929

event_o_BOL_o | -.0127343 .0175717 -0.72 0.469 -.0471997 .0217312

_cons | 7.520464 .1263654 59.51 0.000 7.272609 7.76832

----

life_expectancy | .04026 .0017856 22.55 0.000 .0367577 .0437624

share_internet_pop | .2065944 .0178323 11.59 0.000 .1716177 .2415711

event_no_BRA_o | .0106957 .0015499 6.90 0.000 .0076556 .0137358

event_o_BRA_o | -.0010574 .0118586 -0.09 0.929 -.0243171 .0222022

_cons | 7.527869 .1262471 59.63 0.000 7.280246 7.775492

----

life_expectancy | .0402415 .0017862 22.53 0.000 .0367379 .0437451

share_internet_pop | .2066361 .0178394 11.58 0.000 .1716456 .2416266

event_no_BGR_o | .0105185 .0015486 6.79 0.000 .0074809 .013556

event_o_BGR_o | .0093531 .0130331 0.72 0.473 -.0162103 .0349164

_cons | 7.528824 .1262914 59.61 0.000 7.281114 7.776534

----

life_expectancy | .0402437 .0017861 22.53 0.000 .0367405 .043747

share_internet_pop | .2066137 .0178377 11.58 0.000 .1716264 .2416009

event_no_CMR_o | .0105023 .0015405 6.82 0.000 .0074808 .0135239

event_o_CMR_o | .0104744 .025953 0.40 0.687 -.0404303 .0613791

_cons | 7.528684 .1262833 59.62 0.000 7.28099 7.776378

----

life_expectancy | .0402359 .0017863 22.53 0.000 .0367324 .0437395

share_internet_pop | .2066106 .0178372 11.58 0.000 .1716243 .2415968

event_no_CAN_o | .0105348 .0015424 6.83 0.000 .0075096 .0135601

event_o_CAN_o | .0049164 .0203751 0.24 0.809 -.0350478 .0448806

_cons | 7.529362 .1263029 59.61 0.000 7.281629 7.777095

----

life_expectancy | .0402118 .0017856 22.52 0.000 .0367095 .0437141

share_internet_pop | .2069663 .0178333 11.61 0.000 .1719877 .2419449

event_no_CHL_o | .0106765 .0015449 6.91 0.000 .0076462 .0137067

event_o_CHL_o | -.0069063 .0154529 -0.45 0.655 -.0372158 .0234032

_cons | 7.531004 .1262488 59.65 0.000 7.283377 7.77863

----

life_expectancy | .039401 .0017159 22.96 0.000 .0360355 .0427666

share_internet_pop | .2055824 .0171218 12.01 0.000 .1719995 .2391654

event_no_CHN_o | .0026541 .0016189 1.64 0.101 -.0005213 .0058295

event_o_CHN_o | .0484772 .0035393 13.70 0.000 .0415352 .0554193

_cons | 7.597914 .1213541 62.61 0.000 7.359888 7.83594

----

life_expectancy | .0402613 .0017857 22.55 0.000 .0367589 .0437637

share_internet_pop | .2065534 .0178327 11.58 0.000 .171576 .2415309

event_no_COL_o | .0106431 .0015445 6.89 0.000 .0076138 .0136724

event_o_COL_o | -.0044822 .0157386 -0.28 0.776 -.0353521 .0263878

_cons | 7.527894 .1262491 59.63 0.000 7.280267 7.775521

----

life_expectancy | .0402376 .0017859 22.53 0.000 .0367347 .0437405

share_internet_pop | .2065507 .0178361 11.58 0.000 .1715666 .2415348

event_no_CRI_o | .0105539 .0015403 6.85 0.000 .0075327 .0135751

event_o_CRI_o | -.0048133 .0266314 -0.18 0.857 -.0570487 .0474221

_cons | 7.52936 .1262744 59.63 0.000 7.281683 7.777037

----

life_expectancy | .0402577 .0017858 22.54 0.000 .0367549 .0437604

share_internet_pop | .2068932 .0178378 11.60 0.000 .1719058 .2418807

event_no_CYP_o | .0104514 .0015389 6.79 0.000 .0074329 .0134699

event_o_CYP_o | .0404573 .0382246 1.06 0.290 -.0345172 .1154317

_cons | 7.527579 .1262658 59.62 0.000 7.279919 7.775239

----

life_expectancy | .0402252 .0017861 22.52 0.000 .0367218 .0437285

share_internet_pop | .2069993 .0178469 11.60 0.000 .1719941 .2420044

event_no_DNK_o | .0105324 .0015385 6.85 0.000 .0075148 .01355

event_o_DNK_o | -.0186621 .0480007 -0.39 0.697 -.1128116 .0754875

_cons | 7.529976 .1262854 59.63 0.000 7.282277 7.777674

----

life_expectancy | .0402417 .0017855 22.54 0.000 .0367395 .0437438

share_internet_pop | .2067022 .0178321 11.59 0.000 .171726 .2416784

event_no_ECU_o | .0106477 .0015439 6.90 0.000 .0076194 .013676

event_o_ECU_o | -.0062866 .0164808 -0.38 0.703 -.0386123 .0260391

_cons | 7.528927 .1262415 59.64 0.000 7.281314 7.776539

----

life_expectancy | .0402305 .001786 22.53 0.000 .0367273 .0437336

share_internet_pop | .2066832 .0178361 11.59 0.000 .1716991 .2416674

event_no_EGY_o | .0105592 .0015408 6.85 0.000 .0075371 .0135813

event_o_EGY_o | -.0038623 .024605 -0.16 0.875 -.0521229 .0443984

_cons | 7.529658 .1262795 59.63 0.000 7.281971 7.777345

----

life_expectancy | .040246 .0017863 22.53 0.000 .0367425 .0437496

share_internet_pop | .2065738 .0178431 11.58 0.000 .1715761 .2415716

event_no_FIN_o | .0105006 .001538 6.83 0.000 .007484 .0135172

event_o_FIN_o | .0225602 .1343692 0.17 0.867 -.2409941 .2861144

_cons | 7.528525 .1262938 59.61 0.000 7.280809 7.77624

----

life_expectancy | .0402425 .0017861 22.53 0.000 .0367392 .0437457

share_internet_pop | .2065832 .0178392 11.58 0.000 .1715931 .2415734

event_no_FRA_o | .0105252 .0015488 6.80 0.000 .0074873 .013563

event_o_FRA_o | .0088965 .0129741 0.69 0.493 -.0165511 .0343441

_cons | 7.528812 .1262854 59.62 0.000 7.281114 7.776511

----

life_expectancy | .0401955 .0017861 22.50 0.000 .0366923 .0436988

share_internet_pop | .2072392 .0178418 11.62 0.000 .172244 .2422344

event_no_DEU_o | .0106544 .0015443 6.90 0.000 .0076254 .0136833

event_o_DEU_o | -.0065234 .0164078 -0.40 0.691 -.038706 .0256593

_cons | 7.532221 .1262854 59.64 0.000 7.284522 7.779919

----

life_expectancy | .040248   .001786   22.54   0.000   .0367449   .0437511

share_internet_pop | .206613   .0178366   11.58   0.000   .171628   .241598

event_no_GRC_o | .0104437   .0015437   6.77   0.000   .0074159   .0134715

event_o_GRC_o | .0180751   .0175229   1.03   0.302   -.0162946   .0524448

_cons | 7.528368   .1262766   59.62   0.000   7.280687   7.776049

----

life_expectancy | .0402375   .001786   22.53   0.000   .0367344   .0437406

share_internet_pop | .2066147   .0178365   11.58   0.000   .1716299   .2415996

event_no_HUN_o | .0104628   .0015402   6.79   0.000   .0074418   .0134838

event_o_HUN_o | .0224137   .0263662   0.85   0.395   -.0293013   .0741288

_cons | 7.529062   .1262766   59.62   0.000   7.281381   7.776743

----

life_expectancy | .0402618   .0017866   22.54   0.000   .0367576   .043766

share_internet_pop | .2060458   .0178949   11.51   0.000   .1709463   .2411453

event_no_ISL_o | .0105176   .0015383   6.84   0.000   .0075004   .0135348

event_o_ISL_o | -.0137966   .0617182   -0.22   0.823   -.1348518   .1072585

_cons | 7.527526   .1263099   59.60   0.000   7.27978   7.775273

----

life_expectancy | .0402678 .0017873 22.53 0.000 .0367622 .0437734

share_internet_pop | .2064054 .0178464 11.57 0.000 .1714011 .2414097

event_no_IND_o | .0106845 .0016203 6.59 0.000 .0075064 .0138627

event_o_IND_o | .0088806 .0047944 1.85 0.064 -.0005232 .0182844

_cons | 7.526865 .1263795 59.56 0.000 7.278982 7.774748

----

life_expectancy | .0402059 .0017871 22.50 0.000 .0367006 .0437111

share_internet_pop | .2067945 .0178386 11.59 0.000 .1718056 .2417834

event_no_IDN_o | .010329 .0015669 6.59 0.000 .0072556 .0134023

event_o_IDN_o | .014886 .0077697 1.92 0.056 -.0003537 .0301256

_cons | 7.531234 .1263466 59.61 0.000 7.283415 7.779052

----

share_internet_pop | .2068165 .0178458 11.59 0.000 .1718133 .2418196

event_no_IRN_o | .0105648 .0015476 6.83 0.000 .0075293 .0136003

event_o_IRN_o | .0051327 .0150113 0.34 0.732 -.0243108 .0345762

_cons | 7.532808 .1267967 59.41 0.000 7.284107 7.781509

----

life_expectancy | .040247 .001786 22.53 0.000 .0367439 .0437501

share_internet_pop | .2067185 .0178394 11.59 0.000 .1717279 .2417091

event_no_IRL_o | .0104813 .0015389 6.81 0.000 .0074628 .0134999

event_o_IRL_o | .0249001 .0409629 0.61 0.543 -.0554453 .1052456

_cons | 7.528351 .1262805 59.62 0.000 7.280662 7.77604

----

life_expectancy | .0402441 .0017863 22.53 0.000 .0367405 .0437477

share_internet_pop | .2066124 .0178379 11.58 0.000 .1716249 .2416

event_no_ISR_o | .0105014 .0015394 6.82 0.000 .0074821 .0135207

event_o_ISR_o | .0109347 .0359123 0.30 0.761 -.0595043 .0813738

_cons | 7.52866 .1262965 59.61 0.000 7.28094 7.77638

----

life_expectancy | .0402351 .0017851 22.54 0.000 .0367338 .0437364

share_internet_pop | .2072456 .0178339 11.62 0.000 .1722659 .2422253

event_no_ITA_o | .0106739 .0015423 6.92 0.000 .0076489 .013699

event_o_ITA_o | -.0139162 .0182072 -0.76 0.445 -.0496282 .0217957

_cons | 7.529607 .1262136 59.66 0.000 7.282049 7.777165

----

life_expectancy	.0400959	.0017847	22.47	0.000	.0365954	.0435963
share_internet_pop	.2095909	.0178617	11.73	0.000	.1745566	.2446252
event_no_JPN_o	**.0110622**	**.0015563**	**7.11**	**0.000**	**.0080097**	**.0141147**
event_o_JPN_o	**-.0101515**	**.0094614**	**-1.07**	**0.283**	**-.0287093**	**.0084063**
_cons	7.538748	.1261749	59.75	0.000	7.291266	7.78623

----

life_expectancy	.0402367	.0017863	22.53	0.000	.036733	.0437403
share_internet_pop	.2065454	.0178397	11.58	0.000	.1715543	.2415364
event_no_JOR_o	**.010519**	**.0015395**	**6.83**	**0.000**	**.0074994**	**.0135385**
event_o_JOR_o	**.0021776**	**.035374**	**0.06**	**0.951**	**-.0672057**	**.0715609**
_cons	7.529214	.1262997	59.61	0.000	7.281487	7.77694

----

life_expectancy	.0402476	.0017834	22.57	0.000	.0367495	.0437456
share_internet_pop	.2064945	.0178112	11.59	0.000	.1715593	.2414298
event_no_KEN_o	**.0109415**	**.0015485**	**7.07**	**0.000**	**.0079043**	**.0139787**
event_o_KEN_o	**-.0152606**	**.0117906**	**-1.29**	**0.196**	**-.0383868**	**.0078656**
_cons	7.528585	.1260943	59.71	0.000	7.281261	7.775908

----

life_expectancy	.0402316	.0017873	22.51	0.000	.0367259	.0437373
share_internet_pop	.2066992	.0178429	11.58	0.000	.1717018	.2416965
event_no_KOR_o	**.0104091**	**.0015352**	**6.78**	**0.000**	**.0073979**	**.0134204**
event_o_KOR_o	**-.0024146**	**.0145111**	**-0.17**	**0.868**	**-.030877**	**.0260478**
_cons	7.529733	.1263827	59.58	0.000	7.281844	7.777623

life_expectancy	.0402166	.0017859	22.52	0.000	.0367136	.0437195
share_internet_pop	.207236	.0178473	11.61	0.000	.17223	.2422421
event_no_KWT_o	**.0104816**	**.0015377**	**6.82**	**0.000**	**.0074655**	**.0134976**
event_o_KWT_o	**.0961805**	**.0971665**	**0.99**	**0.322**	**-.0944037**	**.2867647**
_cons	7.530446	.1262675	59.64	0.000	7.282782	7.778109

----

life_expectancy	.0402267	.001786	22.52	0.000	.0367237	.0437298
share_internet_pop	.2064063	.0178378	11.57	0.000	.171419	.2413936
event_no_MAC_o	**.0105532**	**.0015395**	**6.86**	**0.000**	**.0075336**	**.0135728**
event_o_MAC_o	**-.0117141**	**.0329065**	**-0.36**	**0.722**	**-.0762577**	**.0528294**
_cons	7.529896	.1262768	59.63	0.000	7.282214	7.777577

----

life_expectancy | .0405262 .00179 22.64 0.000 .0370153 .0440372

share_internet_pop | .2046525 .0178461 11.47 0.000 .1696489 .2396562

event_no_MWI_o | .0107424 .0015411 6.97 0.000 .0077196 .0137651

event_o_MWI_o | -.0226248 .0172053 -1.31 0.189 -.0563716 .011122

_cons | 7.508986 .1265483 59.34 0.000 7.260772 7.757201

----

life_expectancy | .0402446 .0017861 22.53 0.000 .0367414 .0437479

share_internet_pop | .2066432 .0178381 11.58 0.000 .1716552 .2416312

event_no_MYS_o | .0104748 .0015448 6.78 0.000 .0074448 .0135048

event_o_MYS_o | .013518 .0161724 0.84 0.403 -.0182029 .045239

_cons | 7.528576 .1262817 59.62 0.000 7.280885 7.776267

----

life_expectancy | .0402437 .0017855 22.54 0.000 .0367416 .0437459

share_internet_pop | .2066136 .0178321 11.59 0.000 .1716373 .2415899

event_no_MLT_o | .0105023 .0015374 6.83 0.000 .0074868 .0135177

event_o_MLT_o | 0 (omitted)

_cons | 7.528683 .1262431 59.64 0.000 7.281068 7.776299

----

life_expectancy | .0402109 .0017849 22.53 0.000 .0367099 .0437118

share_internet_pop | .206393 .0178253 11.58 0.000 .1714301 .2413559

event_no_MUS_o | .0105836 .0015377 6.88 0.000 .0075676 .0135996

event_o_MUS_o | -.061497 .0468873 -1.31 0.190 -.1534626 .0304685

_cons | 7.531283 .1262019 59.68 0.000 7.283748 7.778818

----

life_expectancy | .0402602 .001785 22.55 0.000 .0367591 .0437613

share_internet_pop | .2063165 .0178277 11.57 0.000 .1713488 .2412842

event_no_MEX_o | .0108019 .0015512 6.96 0.000 .0077593 .0138445

event_o_MEX_o | -.0052849 .0111834 -0.47 0.637 -.0272201 .0166504

_cons | 7.528235 .1262036 59.65 0.000 7.280696 7.775773

----

life_expectancy | .0403161 .001786 22.57 0.000 .0368129 .0438192

share_internet_pop | .2062689 .0178404 11.56 0.000 .1712763 .2412614

event_no_MAR_o | .0103536 .001529 6.77 0.000 .0073546 .0133526

event_o_MAR_o | -.0130412 .0241186 -0.54 0.589 -.0603479 .0342656

_cons | 7.523769 .126284 59.58 0.000 7.276073 7.771465

----

life_expectancy | .0396993 .0017583 22.58 0.000 .0362506 .0431481

share_internet_pop | .2099381 .0175504 11.96 0.000 .1755144 .2443619

event_no_MMR_o | .0098862 .0015149 6.53 0.000 .0069149 .0128575

event_o_MMR_o | .197424 .0252617 7.82 0.000 .1478752 .2469728

_cons | 7.566052 .1243103 60.86 0.000 7.322228 7.809877

----

life_expectancy | .0402385 .0017894 22.49 0.000 .0367287 .0437483

share_internet_pop | .2066444 .0178492 11.58 0.000 .1716347 .2416541

event_no_NPL_o | .010496 .0015433 6.80 0.000 .007469 .0135231

event_o_NPL_o | .0113059 .0168548 0.67 0.502 -.0217534 .0443653

_cons | 7.529036 .1264958 59.52 0.000 7.280924 7.777147

----

life_expectancy | .0402302 .0017861 22.52 0.000 .0367269 .0437335

share_internet_pop | .2067687 .0178385 11.59 0.000 .17178 .2417575

event_no_NLD_o | .0105461 .00154 6.85 0.000 .0075256 .0135667

event_o_NLD_o | -.0046708 .0287704 -0.16 0.871 -.0611017 .0517601

_cons | 7.529722 .1262863 59.62 0.000 7.282022 7.777422

----

life_expectancy | .0421251 .0018099 23.27 0.000 .0385751 .0456751

share_internet_pop | .1938826 .0178718 10.85 0.000 .1588285 .2289367

event_no_NER_o | .010935 .0015281 7.16 0.000 .0079378 .0139322

event_o_NER_o | -.0939202 .0205147 -4.58 0.000 -.1341582 -.0536822

_cons | 7.398201 .1278671 57.86 0.000 7.147401 7.649002

----

life_expectancy | .0402489 .0017822 22.58 0.000 .0367533 .0437445

share_internet_pop | .2061004 .0178 11.58 0.000 .1711872 .2410137

event_no_NGA_o | .011277 .0015618 7.22 0.000 .0082136 .0143404

event_o_NGA_o | -.0108569 .0081628 -1.33 0.184 -.0268675 .0051537

_cons | 7.527512 .1260088 59.74 0.000 7.280356 7.774668

----

life_expectancy | .0402434 .001786 22.53 0.000 .0367403 .0437465

share_internet_pop | .2067986 .0178445 11.59 0.000 .171798 .2417991

event_no_NOR_o | .0104866 .0015384 6.82 0.000 .0074691 .0135041

event_o_NOR_o | .0304215 .0560084 0.54 0.587 -.0794343 .1402773

_cons | 7.528609 .126277 59.62 0.000 7.280927 7.776291

----

life_expectancy | .0401471 .0017849 22.49 0.000 .0366462 .043648

share_internet_pop | .2074842 .0178244 11.64 0.000 .172523 .2424453

event_no_PHL_o | .0116596 .0016554 7.04 0.000 .0084127 .0149064

event_o_PHL_o | .0033606 .0041038 0.82 0.413 -.0046887 .0114098

_cons | 7.533885 .1261762 59.71 0.000 7.286401 7.78137

----

life_expectancy | .040246 .0017862 22.53 0.000 .0367425 .0437496

share_internet_pop | .2066253 .017838 11.58 0.000 .1716376 .241613

event_no_PAN_o | .0105108 .0015404 6.82 0.000 .0074895 .0135322

event_o_PAN_o | .0080195 .0255992 0.31 0.754 -.0421913 .0582303

_cons | 7.528545 .1262894 59.61 0.000 7.280838 7.776251

----

life_expectancy | .040203 .0017827 22.55 0.000 .0367064 .0436995

share_internet_pop | .2047582 .017818 11.49 0.000 .1698097 .2397068

event_no_POL_o | .0102524 .001538 6.67 0.000 .0072357 .0132692

event_o_POL_o | .0673264 .0225471 2.99 0.003 .023102 .1115508

_cons | 7.53148 .1260405 59.75 0.000 7.284262 7.778698

----

life_expectancy	.0402488	.0017858	22.54	0.000	.0367461	.0437515
share_internet_pop	.2068859	.0178386	11.60	0.000	.1718969	.2418749
event_no_PRT_o	**.0105708**	**.0015405**	**6.86**	**0.000**	**.0075492**	**.0135923**
event_o_PRT_o	**-.0071856**	**.0243106**	**-0.30**	**0.768**	**-.0548689**	**.0404977**
_cons	7.528353	.126262	59.62	0.000	7.2807	7.776005

----

life_expectancy	.0402437	.0017855	22.54	0.000	.0367416	.0437459
share_internet_pop	.2066136	.0178321	11.59	0.000	.1716373	.2415899
event_no_QAT_o	**.0105023**	**.0015374**	**6.83**	**0.000**	**.0074868**	**.0135177**
event_o_QAT_o	**0**	**(omitted)**				
_cons	7.528683	.1262431	59.64	0.000	7.281068	7.776299

----

life_expectancy	.0402816	.0017867	22.54	0.000	.0367771	.0437862
share_internet_pop	.2065082	.0178359	11.58	0.000	.1715246	.2414919
event_no_ROM_o	**.0103663**	**.0015512**	**6.68**	**0.000**	**.0073238**	**.0134089**
event_o_ROM_o	**.0183322**	**.0118799**	**1.54**	**0.123**	**-.0049692**	**.0416336**
_cons	7.52599	.1263297	59.57	0.000	7.278204	7.773775

----

life_expectancy	.0402596	.0017864	22.54	0.000	.0367558	.0437634
share_internet_pop	.2064959	.0178387	11.58	0.000	.1715067	.2414851
event_no_SEN_o	**.0105398**	**.0015403**	**6.84**	**0.000**	**.0075187**	**.0135609**
event_o_SEN_o	**-.0005569**	**.0258212**	**-0.02**	**0.983**	**-.051203**	**.0500892**
_cons	7.527654	.1262974	59.60	0.000	7.279932	7.775376

----

life_expectancy	.0402499	.0017859	22.54	0.000	.0367471	.0437528
share_internet_pop	.2065867	.0178355	11.58	0.000	.1716039	.2415695
event_no_SGP_o	**.0105224**	**.001538**	**6.84**	**0.000**	**.0075057**	**.013539**
event_o_SGP_o	**-.0349759**	**.0715908**	**-0.49**	**0.625**	**-.1753954**	**.1054436**
_cons	7.528289	.1262677	59.62	0.000	7.280625	7.775952

----

life_expectancy	.0402911	.0017918	22.49	0.000	.0367765	.0438056
share_internet_pop	.2064023	.0178486	11.56	0.000	.1713937	.241411
event_no_ZAF_o	**.0104328**	**.0015523**	**6.72**	**0.000**	**.007388**	**.0134775**
event_o_ZAF_o	**.0144075**	**.0119973**	**1.20**	**0.230**	**-.0091243**	**.0379393**
_cons	7.525336	.1266887	59.40	0.000	7.276847	7.773826

----

life_expectancy | .0402447 .0017861 22.53 0.000 .0367415 .0437479

share_internet_pop | .2065651 .0178397 11.58 0.000 .171574 .2415562

event_no_ESP_o | .0105207 .0015416 6.82 0.000 .0074971 .0135444

event_o_ESP_o | .006728 .0219571 0.31 0.759 -.0363389 .049795

_cons | 7.52869 .1262806 59.62 0.000 7.281 7.776379

----

life_expectancy | .0403936 .001784 22.64 0.000 .0368944 .0438928

share_internet_pop | .2054979 .0178204 11.53 0.000 .1705446 .2404512

event_no_LKA_o | .0102553 .0015241 6.73 0.000 .007266 .0132447

event_o_LKA_o | .0751853 .0282251 2.66 0.008 .0198241 .1305464

_cons | 7.51665 .1261614 59.58 0.000 7.269195 7.764106

----

life_expectancy | .0402263 .0017868 22.51 0.000 .0367216 .0437309

share_internet_pop | .2068522 .0178517 11.59 0.000 .1718375 .2418668

event_no_SWE_o | .0105245 .0015393 6.84 0.000 .0075053 .0135437

event_o_SWE_o | -.0014829 .0363976 -0.04 0.968 -.0728738 .0699079

_cons | 7.529873 .1263291 59.61 0.000 7.282089 7.777657

----

life_expectancy | .0402793 .0017866 22.55 0.000 .036775 .0437835

share_internet_pop | .2066919 .017854 11.58 0.000 .1716727 .2417112

event_no_CHE | .0102634 .0015265 6.72 0.000 .0072694 .0132575

event_o_CHE | -.0086991 .0209683 -0.41 0.678 -.0498267 .0324285

_cons | 7.52638 .126332 59.58 0.000 7.27859 7.77417

----

life_expectancy | .0402213 .0017861 22.52 0.000 .0367181 .0437246

share_internet_pop | .2067305 .0178355 11.59 0.000 .1717476 .2417135

event_no_TZA_o | .0106203 .0015464 6.87 0.000 .0075872 .0136535

event_o_TZA_o | .0001428 .0145304 0.01 0.992 -.0283574 .028643

_cons | 7.530358 .1262835 59.63 0.000 7.282663 7.778053

----

life_expectancy | .04017 .0017865 22.49 0.000 .0366659 .0436741

share_internet_pop | .2069074 .0178323 11.60 0.000 .1719308 .241884

event_no_THA_o | .0107283 .0015499 6.92 0.000 .0076884 .0137683

event_o_THA_o | -.0034944 .0123271 -0.28 0.777 -.0276731 .0206843

_cons | 7.534262 .1263252 59.64 0.000 7.286485 7.782038

----

life_expectancy | .0402311 .0017854 22.53 0.000 .0367291 .0437331

share_internet_pop | .206293 .0178334 11.57 0.000 .1713143 .2412717

event_no_TTO_o | .0105654 .0015384 6.87 0.000 .0075481 .0135828

event_o_TTO_o | -.0363968 .0426487 -0.85 0.394 -.1200487 .0472552

_cons | 7.52973 .1262385 59.65 0.000 7.282123 7.777336

----

life_expectancy | .0402366 .0017863 22.52 0.000 .0367328 .0437403

share_internet_pop | .2066693 .0178392 11.59 0.000 .1716792 .2416594

event_no_TUN_o | .0104919 .0015386 6.82 0.000 .0074741 .0135097

event_o_TUN_o | .0206381 .0464689 0.44 0.657 -.0705069 .1117831

_cons | 7.529191 .1263013 59.61 0.000 7.281461 7.776921

----

life_expectancy | .0402457 .001786 22.53 0.000 .0367427 .0437487

share_internet_pop | .2064389 .0178407 11.57 0.000 .1714458 .241432

event_no_TUR_o | .0105805 .0015475 6.84 0.000 .0075451 .0136159

event_o_TUR_o | .0043999 .0136346 0.32 0.747 -.0223433 .0311431

_cons | 7.528566 .1262742 59.62 0.000 7.28089 7.776243

----

life_expectancy	.04023	.0017862	22.52	0.000	.0367266	.0437334
share_internet_pop	.2067722	.0178393	11.59	0.000	.1717819	.2417625
event_no_GBR_o	**.0105811**	**.0015463**	**6.84**	**0.000**	**.0075482**	**.0136139**
event_o_GBR_o	**.0033978**	**.0146815**	**0.23**	**0.817**	**-.0253988**	**.0321944**
_cons	7.529683	.1262893	59.62	0.000	7.281977	7.777389

----

life_expectancy	.0400775	.0017824	22.48	0.000	.0365814	.0435736
share_internet_pop	.2060816	.0177929	11.58	0.000	.1711823	.2409809
event_no_USA_o	**.0122413**	**.0016473**	**7.43**	**0.000**	**.0090104**	**.0154723**
event_o_USA_o	**-.0008644**	**.0042137**	**-0.21**	**0.837**	**-.0091291**	**.0074004**
_cons	7.540707	.1260268	59.83	0.000	7.293515	7.787898

----

life_expectancy	.0402447	.001786	22.53	0.000	.0367416	.0437478
share_internet_pop	.2065636	.0178372	11.58	0.000	.1715774	.2415498
event_no_URY_o	**.0105363**	**.0015402**	**6.84**	**0.000**	**.0075155**	**.0135572**
event_o_URY_o	**-.0004549**	**.0274884**	**-0.02**	**0.987**	**-.0543711**	**.0534613**
_cons	7.52869	.1262756	59.62	0.000	7.281011	7.77637

APPENDIX VI

OUTPUT EXIT BY COUNTRIES FROM STATA FOR THE SPECIFIC IMPACT OF THE INCREASE IN TEMPERATURES ONCE INCLUDED THE ENERGY INTENSITY VARIABLE IN THE TRADE EQUATION.

I present the Stata order for the first country as an example. I have discarded all the irrelevant information (the coefficients of the globalization terms and the constant, for instance) showing the countries in alphabetical order (which does not necessarily coincide with the iso_3 nomenclature).

```
. ppmlhdfe trade agree_pta member_gatt_wto_joint temp_no_AUS temp_i_AUS _IyeaXint_1987-_IyeaXint_2016 ln_energy_per_gdp , a( exp#year imp#year exp#imp) cluster(exp#imp)
```

----

agree_pta | .1437648 .0561886 2.56 0.011 .0336372 .2538924

member_gatt_wto_joint | 1.259857 .1156147 10.90 0.000 1.033256 1.486458

temp_no_AUS | .0157175 .0094469 1.66 0.096 -.0027982 .0342331

temp_i_AUS | -.0532297 .027138 -1.96 0.050 -.1064192 -.0000403

ln_energy_per_gdp | -.7283728 .1509987 -4.82 0.000 -1.024325 -.4324209

----

agree_pta | .1429112 .0559749 2.55 0.011 .0332025 .25262

member_gatt_wto_joint | 1.260979 .1155531 10.91 0.000 1.034499 1.487458

temp_no_AUT | .0117878 .0094373 1.25 0.212 -.0067089 .0302845

temp_i_AUT | .0809106 .017578 4.60 0.000 .0464583 .1153629

ln_energy_per_gdp | -.727471 .1511538 -4.81 0.000 -1.023727 -.4312149

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agree_pta | .1380992 .0558409 2.47 0.013 .0286531 .2475453

member_gatt_wto_joint | 1.250196 .1158925 10.79 0.000 1.023051 1.477341

temp_no_BEL | .0352234 .0117296 3.00 0.003 .0122338 .0582131

temp_i_BEL | -.1180485 .0178833 -6.60 0.000 -.1530992 -.0829978

ln_energy_per_gdp | -.7262792 .1503675 -4.83 0.000 -1.020994 -.4315643

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agree_pta | .1425171 .0559879 2.55 0.011 .0327828 .2522513

member_gatt_wto_joint | 1.259924 .1155791 10.90 0.000 1.033393 1.486455

temp_no_BOL | .0145902 .0093995 1.55 0.121 -.0038325 .0330129

temp_i_BOL | .1940566 .0841217 2.31 0.021 .0291812 .3589321

ln_energy_per_gdp | -.7284556 .1510852 -4.82 0.000 -1.024577 -.4323342

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agree_pta | .1436604 .0560008 2.57 0.010 .0339008 .2534199

member_gatt_wto_joint | 1.262987 .1156212 10.92 0.000 1.036373 1.4896

temp_no_BRA | .013697 .0094047 1.46 0.145 -.0047358 .0321298

temp_i_BRA | .1168905 .0320464 3.65 0.000 .0540807 .1797002

ln_energy_per_gdp | -.7348594 .1516493 -4.85 0.000 -1.032087 -.4376323

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agree_pta | .1413594 .0560342 2.52 0.012 .0315344 .2511844

member_gatt_wto_joint | 1.251653 .1158268 10.81 0.000 1.024637 1.47867

temp_no_BGR | .0138083 .0093788 1.47 0.141 -.0045737 .0321904

temp_i_BGR | .2472661 .0466578 5.30 0.000 .1558184 .3387137

ln_energy_per_gdp | -.7225067 .1515794 -4.77 0.000 -1.019597 -.4254165

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agree_pta | .1424836 .0559957 2.54 0.011 .032734 .2522332

member_gatt_wto_joint | 1.259888 .1155824 10.90 0.000 1.033351 1.486426

temp_no_CMR | .0146422 .0094007 1.56 0.119 -.0037828 .0330673

temp_i_CMR | .0314577 .1940836 0.16 0.871 -.3489391 .4118545

ln_energy_per_gdp | -.7282952 .1510825 -4.82 0.000 -1.024411 -.4321789

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agree_pta | .1423536 .0559565 2.54 0.011 .0326808 .2520263

member_gatt_wto_joint | 1.259087 .1158547 10.87 0.000 1.032016 1.486158

temp_no_CAN | .0165154 .0105009 1.57 0.116 -.004066 .0370968

temp_i_CAN | .0034898 .0150161 0.23 0.816 -.0259412 .0329208

ln_energy_per_gdp | -.7278279 .1510278 -4.82 0.000 -1.023837 -.4318188

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agree_pta | .1418911 .0560425 2.53 0.011 .0320497 .2517324

member_gatt_wto_joint | 1.260412 .1155993 10.90 0.000 1.033841 1.486982

temp_no_CHL | .0143095 .0094038 1.52 0.128 -.0041215 .0327406

temp_i_CHL | .1200242 .0443355 2.71 0.007 .0331281 .2069203

ln_energy_per_gdp | -.7297143 .1511972 -4.83 0.000 -1.026055 -.4333732

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agree_pta | .1425872 .0562107 2.54 0.011 .0324163 .2527581

member_gatt_wto_joint | 1.261447 .1131607 11.15 0.000 1.039656 1.483238

temp_no_CHN | .0147855 .0096116 1.54 0.124 -.004053 .0336239

temp_i_CHN | .0123128 .0179212 0.69 0.492 -.0228121 .0474377

ln_energy_per_gdp | -.7281244 .151046 -4.82 0.000 -1.024169 -.4320798

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agree_pta | .1420179 .0560418 2.53 0.011 .0321779 .2518578

member_gatt_wto_joint | 1.260182 .1155954 10.90 0.000 1.033619 1.486745

temp_no_COL | .0143495 .009403 1.53 0.127 -.0040801 .0327792

temp_i_COL | .1009958 .0609521 1.66 0.098 -.0184681 .2204597

ln_energy_per_gdp | -.7288195 .1511181 -4.82 0.000 -1.025006 -.4326334

agree_pta | .1422037 .0560014 2.54 0.011 .032443 .2519644

member_gatt_wto_joint | 1.259809 .1155742 10.90 0.000 1.033288 1.48633

temp_no_CRI | .0145257 .0094005 1.55 0.122 -.0038989 .0329502

temp_i_CRI | .1946496 .1248139 1.56 0.119 -.0499812 .4392804

ln_energy_per_gdp | -.7285402 .1510975 -4.82 0.000 -1.024686 -.4323947

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agree_pta | .1423418 .0559939 2.54 0.011 .0325958 .2520878

member_gatt_wto_joint | 1.260037 .1156085 10.90 0.000 1.033449 1.486625

temp_no_DNK | .0167985 .0095645 1.76 0.079 -.0019476 .0355445

temp_i_DNK | -.0397444 .0150109 -2.65 0.008 -.0691652 -.0103237

ln_energy_per_gdp | -.7306079 .1511748 -4.83 0.000 -1.026905 -.4343107

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agree_pta | .1424918 .0559883 2.55 0.011 .0327567 .2522268

member_gatt_wto_joint | 1.259889 .1155801 10.90 0.000 1.033356 1.486422

temp_no_ECU | .0146586 .0093999 1.56 0.119 -.0037648 .033082

temp_i_ECU | .00624 .0491462 0.13 0.899 -.0900847 .1025647

ln_energy_per_gdp | -.728269 .151093 -4.82 0.000 -1.024406 -.4321321

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agree_pta | .1424259 .0559844 2.54 0.011 .0326986 .2521533

member_gatt_wto_joint | 1.260291 .1155485 10.91 0.000 1.03382 1.486762

temp_no_EGY | .013544 .009391 1.44 0.149 -.0048621 .0319501

temp_i_EGY | .2209565 .0721578 3.06 0.002 .0795298 .3623832

ln_energy_per_gdp | -.7278362 .1511465 -4.82 0.000 -1.024078 -.4315945

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agree_pta | .1422463 .0559953 2.54 0.011 .0324974 .2519951

member_gatt_wto_joint | 1.259392 .1156263 10.89 0.000 1.032769 1.486015

temp_no_FIN | .0177475 .0095759 1.85 0.064 -.0010208 .0365159

temp_i_FIN | -.067333 .0193689 -3.48 0.001 -.1052954 -.0293706

ln_energy_per_gdp | -.7289056 .1510169 -4.83 0.000 -1.024893 -.4329179

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agree_pta | .1416575 .055953 2.53 0.011 .0319916 .2513234

member_gatt_wto_joint | 1.258119 .1158178 10.86 0.000 1.031121 1.485118

temp_no_FRA | .017627 .0098902 1.78 0.075 -.0017575 .0370115

temp_i_FRA | -.0054322 .0170934 -0.32 0.751 -.0389347 .0280704

ln_energy_per_gdp | -.7273687 .1510264 -4.82 0.000 -1.023375 -.4313624

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agree_pta | .1428233 .0559112 2.55 0.011 .0332394 .2524072

member_gatt_wto_joint | 1.259644 .1154048 10.92 0.000 1.033455 1.485833

temp_no_DEU | .0120658 .0104771 1.15 0.249 -.008469 .0326006

temp_i_DEU | .0200794 .0165949 1.21 0.226 -.012446 .0526047

ln_energy_per_gdp | -.7248846 .1501831 -4.83 0.000 -1.019238 -.4305311

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agree_pta | .1425157 .0559862 2.55 0.011 .0327848 .2522465

member_gatt_wto_joint | 1.259487 .1156198 10.89 0.000 1.032877 1.486098

temp_no_GRC | .0152579 .0094046 1.62 0.105 -.0031749 .0336906

temp_i_GRC | -.0728943 .0482428 -1.51 0.131 -.1674485 .0216599

ln_energy_per_gdp | -.7276146 .1510664 -4.82 0.000 -1.023699 -.4315299

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agree_pta | .1425309 .055988 2.55 0.011 .0327963 .2522654

member_gatt_wto_joint | 1.260264 .1155997 10.90 0.000 1.033693 1.486835

temp_no_ISL | .0144983 .0094067 1.54 0.123 -.0039384 .032935

temp_i_ISL | .1474164 .0860859 1.71 0.087 -.0213089 .3161418

ln_energy_per_gdp | -.7291435 .1511793 -4.82 0.000 -1.025449 -.4328376

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agree_pta	.1450212	.0558966	2.59	0.009	.0354659	.2545764
member_gatt_wto_joint	1.266572	.1151545	11.00	0.000	1.040873	1.49227
temp_no_IND	**.0112295**	**.0095843**	**1.17**	**0.241**	**-.0075554**	**.0300144**
temp_i_IND	**.2916561**	**.0760744**	**3.83**	**0.000**	**.142553**	**.4407592**
ln_energy_per_gdp	-.7408531	.1513873	-4.89	0.000	-1.037567	-.4441393

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agree_pta	.1427828	.0560058	2.55	0.011	.0330135	.2525521
member_gatt_wto_joint	1.25718	.1157175	10.86	0.000	1.030378	1.483982
temp_no_IDN	**.0152435**	**.0093876**	**1.62**	**0.104**	**-.003156**	**.0336429**
temp_i_IDN	**-.2178094**	**.0606271**	**-3.59**	**0.000**	**-.3366364**	**-.0989825**
ln_energy_per_gdp	-.722615	.1509918	-4.79	0.000	-1.018554	-.4266765

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agree_pta	.1421855	.0559885	2.54	0.011	.0324499	.251921
member_gatt_wto_joint	1.256995	.1155997	10.87	0.000	1.030423	1.483566
temp_no_IRN	**.0159267**	**.0094032**	**1.69**	**0.090**	**-.0025033**	**.0343567**
temp_i_IRN	**-.2829613**	**.1078505**	**-2.62**	**0.009**	**-.4943443**	**-.0715782**
ln_energy_per_gdp	-.7243989	.1510814	-4.79	0.000	-1.020513	-.4282847

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agree_pta | .142459 .0559877 2.54 0.011 .0327252 .2521928

member_gatt_wto_joint | 1.260289 .1155783 10.90 0.000 1.03376 1.486819

temp_no_IRL | .0150373 .009506 1.58 0.114 -.003594 .0336686

temp_i_IRL | -.0296559 .0300317 -0.99 0.323 -.088517 .0292051

ln_energy_per_gdp | -.7301659 .1511784 -4.83 0.000 -1.02647 -.4338617

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agree_pta | .1429517 .0559884 2.55 0.011 .0332165 .252687

member_gatt_wto_joint | 1.263155 .1155475 10.93 0.000 1.036686 1.489624

temp_no_ISR | .0122017 .009379 1.30 0.193 -.0061809 .0305842

temp_i_ISR | .2071901 .0569578 3.64 0.000 .0955549 .3188253

ln_energy_per_gdp | -.7334697 .1513036 -4.85 0.000 -1.030019 -.4369202

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agree_pta | .1401454 .0559439 2.51 0.012 .0304975 .2497933

member_gatt_wto_joint | 1.253378 .1160511 10.80 0.000 1.025922 1.480834

temp_no_ITA | .0200347 .009508 2.11 0.035 .0013993 .0386701

temp_i_ITA | -.0596 .0218396 -2.73 0.006 -.1024049 -.0167951

ln_energy_per_gdp | -.7221311 .1510134 -4.78 0.000 -1.018112 -.4261504

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agree_pta | .14098 .0556477 2.53 0.011 .0319124 .2500476

member_gatt_wto_joint | 1.253152 .110879 11.30 0.000 1.035833 1.470471

temp_no_JPN | .023972 .0104051 2.30 0.021 .0035783 .0443657

temp_i_JPN | -.1497457 .0303798 -4.93 0.000 -.209289 -.0902025

ln_energy_per_gdp | -.6873999 .1501681 -4.58 0.000 -.9817239 -.3930758

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agree_pta | .1425313 .0559895 2.55 0.011 .0327938 .2522687

member_gatt_wto_joint | 1.260366 .1156008 10.90 0.000 1.033793 1.48694

temp_no_JOR | .014789 .0093992 1.57 0.116 -.0036331 .0332112

temp_i_JOR | -.0774753 .0554048 -1.40 0.162 -.1860666 .0311161

ln_energy_per_gdp | -.7285432 .1510904 -4.82 0.000 -1.024675 -.4324116

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agree_pta | .1424862 .0559879 2.54 0.011 .0327519 .2522206

member_gatt_wto_joint | 1.25987 .1155827 10.90 0.000 1.033332 1.486408

temp_no_KEN | .0146697 .0094001 1.56 0.119 -.0037541 .0330935

temp_i_KEN | -.0206183 .0544458 -0.38 0.705 -.12733 .0860934

ln_energy_per_gdp | -.7282802 .1510812 -4.82 0.000 -1.024394 -.4321664

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agree_pta | .1438876 .0573129 2.51 0.012 .0315564 .2562188

member_gatt_wto_joint | 1.259283 .1158342 10.87 0.000 1.032253 1.486314

temp_no_KOR | .0153782 .0096825 1.59 0.112 -.0035991 .0343556

temp_i_KOR | -.0018591 .0288586 -0.06 0.949 -.058421 .0547027

ln_energy_per_gdp | -.7257847 .1516606 -4.79 0.000 -1.023034 -.4285353

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agree_pta | .1424178 .0559925 2.54 0.011 .0326746 .252161

member_gatt_wto_joint | 1.260198 .1155965 10.90 0.000 1.033633 1.486763

temp_no_KWT | .0153736 .0094035 1.63 0.102 -.003057 .0338042

temp_i_KWT | -.2536682 .0787008 -3.22 0.001 -.407919 -.0994174

ln_energy_per_gdp | -.7299295 .1510126 -4.83 0.000 -1.025909 -.4339502

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agree_pta | .1425056 .055988 2.55 0.011 .0327711 .2522402

member_gatt_wto_joint | 1.259843 .1155758 10.90 0.000 1.033319 1.486367

temp_no_MAC | .0144632 .0093988 1.54 0.124 -.003958 .0328844

temp_i_MAC | .5904829 .2387611 2.47 0.013 .1225198 1.058446

ln_energy_per_gdp | -.7282665 .1510836 -4.82 0.000 -1.024385 -.432148

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agree_pta | .1425014 .0559903 2.55 0.011 .0327624 .2522404

member_gatt_wto_joint | 1.260119 .1155783 10.90 0.000 1.03359 1.486648

temp_no_MWI | .0145167 .0094007 1.54 0.123 -.0039084 .0329417

temp_i_MWI | .7795678 .3014485 2.59 0.010 .1887397 1.370396

ln_energy_per_gdp | -.728692 .1510909 -4.82 0.000 -1.024825 -.4325592

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agree_pta | .1425385 .0559801 2.55 0.011 .0328195 .2522576

member_gatt_wto_joint | 1.256248 .115584 10.87 0.000 1.029707 1.482788

temp_no_MYS | .0161519 .0094229 1.71 0.087 -.0023166 .0346205

temp_i_MYS | -.1693869 .0792222 -2.14 0.033 -.3246595 -.0141143

ln_energy_per_gdp | -.7185393 .1503011 -4.78 0.000 -1.013124 -.4239544

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agree_pta | .1425044 .0559886 2.55 0.011 .0327688 .2522399

member_gatt_wto_joint | 1.260024 .1155933 10.90 0.000 1.033465 1.486582

temp_no_MLT | .0145814 .0094042 1.55 0.121 -.0038505 .0330132

temp_i_MLT | .078455 .1002376 0.78 0.434 -.118007 .2749171

ln_energy_per_gdp | -.7286718 .1511618 -4.82 0.000 -1.024944 -.4324001

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agree_pta | .1425042 .0559893 2.55 0.011 .0327671 .2522413

member_gatt_wto_joint | 1.259726 .1156126 10.90 0.000 1.033129 1.486322

temp_no_MUS | .0146857 .0094032 1.56 0.118 -.0037443 .0331157

temp_i_MUS | -.0616166 .0769033 -0.80 0.423 -.2123443 .0891112

ln_energy_per_gdp | -.7279035 .1512127 -4.81 0.000 -1.024275 -.4315321

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agree_pta | .1319975 .0539576 2.45 0.014 .0262425 .2377526

member_gatt_wto_joint | 1.274256 .1134745 11.23 0.000 1.051851 1.496662

temp_no_MEX | .004778 .0096549 0.49 0.621 -.0141453 .0237013

temp_i_MEX | .3721955 .0975386 3.82 0.000 .1810232 .5633677

ln_energy_per_gdp | -.7433464 .1509232 -4.93 0.000 -1.03915 -.4475424

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agree_pta | .1424722 .055972 2.55 0.011 .0327691 .2521753

member_gatt_wto_joint | 1.263421 .1153935 10.95 0.000 1.037254 1.489588

temp_no_MAR | .0131966 .0093292 1.41 0.157 -.0050882 .0314814

temp_i_MAR | .5513536 .2075164 2.66 0.008 .144629 .9580782

ln_energy_per_gdp | -.7386125 .1509227 -4.89 0.000 -1.034416 -.4428094

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agree_pta | .1424587 .0559861 2.54 0.011 .032728 .2521893

member_gatt_wto_joint | 1.259911 .1155722 10.90 0.000 1.033394 1.486428

temp_no_MMR | .0144421 .0094045 1.54 0.125 -.0039903 .0328745

temp_i_MMR | .4216046 .3036406 1.39 0.165 -.1735202 1.016729

ln_energy_per_gdp | -.7285933 .1510711 -4.82 0.000 -1.024687 -.4324995

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agree_pta | .1425123 .0559873 2.55 0.011 .0327792 .2522455

member_gatt_wto_joint | 1.260572 .1156257 10.90 0.000 1.03395 1.487194

temp_no_NPL | .0147878 .0094015 1.57 0.116 -.0036389 .0332144

temp_i_NPL | -.4168689 .1325144 -3.15 0.002 -.6765923 -.1571454

ln_energy_per_gdp | -.7277116 .1510903 -4.82 0.000 -1.023843 -.43158

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agree_pta | .1429682 .0559325 2.56 0.011 .0333424 .252594

member_gatt_wto_joint | 1.260201 .1154262 10.92 0.000 1.03397 1.486432

temp_no_NLD | .010799 .0112413 0.96 0.337 -.0112335 .0328315

temp_i_NLD | .0507089 .0189497 2.68 0.007 .0135682 .0878496

ln_energy_per_gdp | -.7257104 .1510683 -4.80 0.000 -1.021799 -.429622

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agree_pta	.142482	.0559888	2.54	0.011	.032746	.252218
member_gatt_wto_joint	1.259857	.1155848	10.90	0.000	1.033315	1.4864
temp_no_NER	**.0146552**	**.0094002**	**1.56**	**0.119**	**-.0037689**	**.0330794**
temp_i_NER	**-.0527259**	**.1464241**	**-0.36**	**0.719**	**-.339712**	**.2342601**
ln_energy_per_gdp	-.728229	.1510978	-4.82	0.000	-1.024375	-.4320828

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agree_pta	.142462	.0559891	2.54	0.011	.0327254	.2521986
member_gatt_wto_joint	1.259997	.1155857	10.90	0.000	1.033453	1.486541
temp_no_NGA	**.01474**	**.0093945**	**1.57**	**0.117**	**-.0036729**	**.0331529**
temp_i_NGA	**-.0337897**	**.0491948**	**-0.69**	**0.492**	**-.1302097**	**.0626304**
ln_energy_per_gdp	-.7287083	.151145	-4.82	0.000	-1.024947	-.4324695

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agree_pta	.1425287	.0559928	2.55	0.011	.0327848	.2522725
member_gatt_wto_joint	1.259964	.1155736	10.90	0.000	1.033444	1.486484
temp_no_NOR	**.0151332**	**.0096817**	**1.56**	**0.118**	**-.0038427**	**.0341091**
temp_i_NOR	**.0024453**	**.0296829**	**0.08**	**0.934**	**-.0557322**	**.0606227**
ln_energy_per_gdp	-.7289083	.1510371	-4.83	0.000	-1.024936	-.432881

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agree_pta | .1424067 .0559811 2.54 0.011 .0326858 .2521276

member_gatt_wto_joint | 1.260043 .1155375 10.91 0.000 1.033593 1.486492

temp_no_PHL | .0143714 .0094054 1.53 0.127 -.0040629 .0328056

temp_i_PHL | .1110131 .0634097 1.75 0.080 -.0132676 .2352937

ln_energy_per_gdp | -.7286217 .1511098 -4.82 0.000 -1.024792 -.432452

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agree_pta | .1391709 .0559143 2.49 0.013 .0295809 .2487608

member_gatt_wto_joint | 1.250995 .1152862 10.85 0.000 1.025038 1.476952

temp_no_POL | .0048886 .0097077 0.50 0.615 -.0141382 .0239154

temp_i_POL | .2367004 .0258435 9.16 0.000 .1860479 .2873528

ln_energy_per_gdp | -.6911276 .1495331 -4.62 0.000 -.9842071 -.398048

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agree_pta | .1426842 .0559879 2.55 0.011 .0329499 .2524185

member_gatt_wto_joint | 1.260968 .1156377 10.90 0.000 1.034323 1.487614

temp_no_PRT | .0142316 .0094104 1.51 0.130 -.0042125 .0326756

temp_i_PRT | .0731483 .0409138 1.79 0.074 -.0070412 .1533379

ln_energy_per_gdp | -.7304884 .1513219 -4.83 0.000 -1.027074 -.4339029

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agree_pta | .142464 .0559788 2.54 0.011 .0327476 .2521805

member_gatt_wto_joint | 1.256801 .1156787 10.86 0.000 1.030075 1.483527

temp_no_QAT | .0144521 .0093961 1.54 0.124 -.0039641 .0328682

temp_i_QAT | .2312281 .1221167 1.89 0.058 -.0081162 .4705725

ln_energy_per_gdp | -.7223387 .1516476 -4.76 0.000 -1.019563 -.4251148

_cons | 11.73086 .104078 112.71 0.000 11.52687 11.93484

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agree_pta | .1421429 .0559976 2.54 0.011 .0323897 .2518962

member_gatt_wto_joint | 1.259401 .1155778 10.90 0.000 1.032873 1.48593

temp_no_ROM | .014354 .009396 1.53 0.127 -.0040618 .0327698

temp_i_ROM | .2257446 .0466574 4.84 0.000 .1342978 .3171915

ln_energy_per_gdp | -.7269512 .1511308 -4.81 0.000 -1.023162 -.4307403

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agree_pta | .1425349 .0559922 2.55 0.011 .0327921 .2522776

member_gatt_wto_joint | 1.259957 .1155832 10.90 0.000 1.033418 1.486496

temp_no_SEN | .0146029 .0094013 1.55 0.120 -.0038233 .0330291

temp_i_SEN | .1170488 .1040629 1.12 0.261 -.0869108 .3210084

ln_energy_per_gdp | -.7284981 .1511049 -4.82 0.000 -1.024658 -.432338

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agree_pta | .1470209 .0539562 2.72 0.006 .0412687 .2527732

member_gatt_wto_joint | 1.25018 .1146662 10.90 0.000 1.025438 1.474921

temp_no_SGP | .0207579 .0097796 2.12 0.034 .0015904 .0399255

temp_i_SGP | -.3258374 .1064258 -3.06 0.002 -.534428 -.1172467

ln_energy_per_gdp | -.7109194 .1502072 -4.73 0.000 -1.00532 -.4165188

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agree_pta | .1426687 .056071 2.54 0.011 .0327716 .2525658

member_gatt_wto_joint | 1.259945 .1155792 10.90 0.000 1.033414 1.486476

temp_no_ZAF | .0147558 .0094021 1.57 0.117 -.003672 .0331835

temp_i_ZAF | -.0040805 .0396941 -0.10 0.918 -.0818795 .0737184

ln_energy_per_gdp | -.7287582 .1512193 -4.82 0.000 -1.025143 -.4323738

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agree_pta | .1437335 .055978 2.57 0.010 .0340187 .2534484

member_gatt_wto_joint | 1.266104 .1154116 10.97 0.000 1.039902 1.492307

temp_no_ESP | .0099655 .0093778 1.06 0.288 -.0084147 .0283457

temp_i_ESP | .1492343 .0230211 6.48 0.000 .1041139 .1943548

ln_energy_per_gdp | -.7365232 .1511816 -4.87 0.000 -1.032834 -.4402128

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agree_pta | .1424517 .0559886 2.54 0.011 .032716 .2521873

member_gatt_wto_joint | 1.259736 .1155959 10.90 0.000 1.033172 1.4863

temp_no_LKA | .0146937 .0093992 1.56 0.118 -.0037284 .0331158

temp_i_LKA | -.0780103 .0687277 -1.14 0.256 -.2127142 .0566935

ln_energy_per_gdp | -.7279785 .151104 -4.82 0.000 -1.024137 -.4318201

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agree_pta | .1422804 .0559988 2.54 0.011 .0325249 .252036

member_gatt_wto_joint | 1.260067 .1156181 10.90 0.000 1.03346 1.486675

temp_no_SWE | .0200352 .0097833 2.05 0.041 .0008603 .03921

temp_i_SWE | -.0477473 .0127225 -3.75 0.000 -.072683 -.0228117

ln_energy_per_gdp | -.7327052 .1510746 -4.85 0.000 -1.028806 -.4366045

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agree_pta | .1422377 .0558943 2.54 0.011 .0326868 .2517885

member_gatt_wto_joint | 1.25724 .1153363 10.90 0.000 1.031185 1.483295

temp_no_CHE | .0083962 .0096811 0.87 0.386 -.0105783 .0273707

temp_i_CHE | .148859 .0362806 4.10 0.000 .0777502 .2199677

ln_energy_per_gdp | -.7073107 .1504525 -4.70 0.000 -1.002192 -.4124293

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agree_pta | .1424949 .0559882 2.55 0.011 .03276 .2522298

member_gatt_wto_joint | 1.259884 .1155807 10.90 0.000 1.033349 1.486418

temp_no_TZA | .014644 .0093999 1.56 0.119 -.0037794 .0330674

temp_i_TZA | .0192062 .0716386 0.27 0.789 -.1212028 .1596152

ln_energy_per_gdp | -.728294 .151082 -4.82 0.000 -1.024409 -.4321788

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agree_pta | .1421349 .0558597 2.54 0.011 .0326519 .251618

member_gatt_wto_joint | 1.265024 .1152829 10.97 0.000 1.039074 1.490974

temp_no_THA | .013138 .0094109 1.40 0.163 -.0053071 .031583

temp_i_THA | .1181079 .0489691 2.41 0.016 .0221302 .2140857

ln_energy_per_gdp | -.7430291 .1507159 -4.93 0.000 -1.038427 -.4476312

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agree_pta | .1425438 .0559868 2.55 0.011 .0328117 .2522759

member_gatt_wto_joint | 1.260299 .1155994 10.90 0.000 1.033728 1.486869

temp_no_TTO | .0144783 .0093989 1.54 0.123 -.0039431 .0328998

temp_i_TTO | .1571715 .1704217 0.92 0.356 -.1768488 .4911918

ln_energy_per_gdp | -.7292566 .1511829 -4.82 0.000 -1.02557 -.4329436

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agree_pta | .1425509 .0559897 2.55 0.011 .032813 .2522888

member_gatt_wto_joint | 1.259483 .1155667 10.90 0.000 1.032977 1.48599

temp_no_TUN | .014272 .0093942 1.52 0.129 -.0041403 .0326843

temp_i_TUN | .1943307 .0566983 3.43 0.001 .0832041 .3054573

ln_energy_per_gdp | -.7288836 .1511117 -4.82 0.000 -1.025057 -.4327102

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agree_pta | .1426781 .056001 2.55 0.011 .0329182 .2524379

member_gatt_wto_joint | 1.266362 .1155966 10.96 0.000 1.039797 1.492927

temp_no_TUR | .0091082 .0094348 0.97 0.334 -.0093836 .0276

temp_i_TUR | .2097031 .0369719 5.67 0.000 .1372395 .2821667

ln_energy_per_gdp | -.7417011 .1514663 -4.90 0.000 -1.03857 -.4448326

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agree_pta | .1425441 .0559804 2.55 0.011 .0328245 .2522638

member_gatt_wto_joint | 1.259866 .1155535 10.90 0.000 1.033386 1.486347

temp_no_GBR | .0144211 .009686 1.49 0.137 -.004563 .0334053

temp_i_GBR | .0170193 .0147461 1.15 0.248 -.0118826 .0459212

ln_energy_per_gdp | -.7278741 .1515495 -4.80 0.000 -1.024906 -.4308426

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agree_pta | .1424537 .0560588 2.54 0.011 .0325805 .252327

member_gatt_wto_joint | 1.25949 .114752 10.98 0.000 1.03458 1.4844

temp_no_USA | .0157315 .010668 1.47 0.140 -.0051773 .0366404

temp_i_USA | .0117535 .0229971 0.51 0.609 -.0333201 .0568271

ln_energy_per_gdp | -.7280383 .1507333 -4.83 0.000 -1.02347 -.4326064

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agree_pta | .1424969 .0559888 2.55 0.011 .0327609 .2522329

member_gatt_wto_joint | 1.259891 .1155898 10.90 0.000 1.033339 1.486443

temp_no_URY | .0146424 .0094004 1.56 0.119 -.003782 .0330668

temp_i_URY | .0205013 .0542504 0.38 0.706 -.0858275 .1268302

ln_energy_per_gdp | -.7283134 .1511157 -4.82 0.000 -1.024495 -.432132

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CHAPTER 5

CONCLUSIONS

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CONCLUSIONS

The unprecedented increase in average temperatures around the world in recent decades, added to the occurrence of more frequent and severe climate events, has led many scientists to issue a serious warning: we are in an era of climate change and its consequences are unpredictable.

The cause of climate change seems clear: human action. The increase in CO_2 emissions as a result of the acceleration and diffusion of economic activity throughout the world has been pointed out as the main determinant of this phenomenon. International trade, as a relevant factor in the dynamism of economic growth, especially in developing countries, is one of the variables that academics have considered in their analyses. However, not much attention has been paid to the impact that climate change can have on international trade. This has been the focus of this research.

To do this, I have divided the analysis into five parts. Chapter 1 is devoted to the introduction to the topic. In Chapter 2, I take an in-depth look at what the data tells us about rising temperatures and climate events in my sample of sixty-seven countries over the period 1986-2016. Chapter 3 focus on the econometric estimation of the impact of the climate change measures (temperatures and climate events) on international trade by using a well-established methodology in this field: the gravity equation. Finally, in Chapter 4, I try to untangle the channels through which the detected impact occurs. The conclusions reached are the following.

The increase in temperatures is widespread in the world and, in very few countries, it can be assessed that there is not an evident increase in the average temperature over the years. However, my analysis suggests that there is some geographic concentration, which is more evident in relative terms. In particular, Europe is the most affected continent and America the least affected one. In both cases, the warming phenomenon occurs less gradually than in Africa and Asia, which are in an average position. In any case, it is quite clear that, in percentage terms, Northern Europe (and Canada) has been the most affected.

Regarding the events, the rise is also pronounced although it seems that its evolution occurs in waves or, at least, in a less gradual way than temperatures. The events considered in this research have been wildfires, floods, extreme temperatures, epidemics, insect infestations, storms, droughts and landslides. Six of them are climate events and two are biological ones. Scientists believe that more frequent epidemics and insect infestations may also occur as consequence of climate change. The episodes of floods and storms are, by far, the most abundant and show a clear average increase over time. We have also detected a relatively robust increase in the sample period considered for wildfires and extreme temperature events, but not for the other events that present frequent changes. However, with data on the number of events we cannot discern their severity. The econometric estimation is necessary to investigate what its real impact is. Furthermore, an important feature of the data is that the increase in events has been concentrated in Asia, and most particularly, in China.

The econometric estimation is in Chapter 3. I estimate a theoretically-grounded gravity equation that considers all known biases in this empirical tool, even the inclusion of domestic floods. My variables of interest are the average annual temperatures and the number of events by country. The results obtained are that the rise in temperatures increases international flows with respect to domestic ones while, in the case of events, the opposite occurs. My estimations also suggest that there is heterogeneity across countries and types of events. In the latter case, China mainly drives the total result in relation to storms and Japan in relation to extreme temperature events. Regarding the impact on welfare, after a general equilibrium analysis, I find that the increase in temperatures increases it while the opposite occurs with respect to events. Insect infestations and extreme temperatures have a negative impact on welfare largely than the rest of the events. The analysis by countries shows very heterogeneous situations.

The literature establishes the possible causes of the impact of climate change on international trade. On the one hand, the damage and maintenance cost of the infrastructures. On the other hand, effects on labor productivity. Recently, in an in-depth study of the US case, an additional factor has been added: energy consumption is the only responsible for the real economic effects on economic variables, mainly because energy infrastructures are strongly affected. With this information in hand, I have tried to unravel the factors that explain the estimated impact of climate change on international trade derived from the analysis in Chapter 3. To do this, I have used the variables energy intensity (energy consumption over GDP) and labor productivity for my econometric analysis. The results obtained suggest that the increase in energy efficiency derived from rising temperatures (especially in cold countries) is a key factor in this regard. Furthermore, labor productivity does not appear to be a relevant variable in any of the cases and the estimated coefficients are counterintuitive. Upon further analysis, it seems that the Chinese government´s management of disasters after 1998 might be a reasonable explanation.

To conclude, this research demonstrates that climate change does indeed have an impact on international trade flows. Firstly, because increasing temperatures improve (on average) energy efficiency in countries with a high influence on bilateral trade flows, such as Germany. Secondly, climate (and biological) phenomena, some of which have clearly increased as a consequence of climate change, generally have an impact on reducing international trade in relative terms and, consequently, welfare. China, the largest exporter in the world, appears as the country that most influences this result but it seems that for an unexpected reason since it is not mainly due to energy or labor inefficiency but rather to the need to react on the part of the Chinese government to the disasters that take place in its territory.