Comparative Advantage, Misallocation of Resources, and Hurricanes *

Martino Pelli* Jeanne Tschopp^ℵ

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Abstract

The comparative advantage of countries evolves over time, yet firms do not continuously adapt their production structure to this evolution. This slow adaptation may be due to high adjustment costs, such as those associated with the disposal of existing physical capital. In practice, these costs may explain why we observe that countries export goods at both ends of the comparative advantage spectrum. This article investigates what happens if the cost of adjusting to the dynamics of comparative advantage is unexpectedly reduced. We use hurricanes to evaluate whether a negative exogenous shock to firms' physical capital leads to a reorganization of exports towards comparative advantage industries. Using a panel of 46 countries and 4-digit industries over the period 1980-2000, we show that the effect of hurricanes on exports is monotonically increasing in comparative advantage. Specifically, export levels drop for industries with a low comparative advantage and grow for industries with a high comparative advantage. Our results also indicate that the process of shifting resources towards higher comparative advantage industries intensifies within the three years following the shock. These findings suggest that if the opportunity cost of adjustment decreases, firms do not confine themselves to an inefficient production, but instead tend to restructure and move up the spectrum of comparative advantage.

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*Department of Economics, University of Sherbrooke, 2500 Blvd de l'Université, Sherbrooke, Q.C., Canada, J1K 2R1; Martino.Pelli@USherbrooke.ca; +1 (819) 821-8000 (ext 61358).

ℵDepartment of Economics, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada; jtschopp@economics.ryerson.ca; +1 (416) 979 5000 (ext 3362).

1 Introduction

Comparative advantage is an important determinant of a country's export pattern. According to trade theory, countries should specialize in comparative advantage industries as it will lead to gains from trade and to economic growth. In practice, although export success is highly concentrated in industries with high export capabilities, countries, especially those at lower levels of development, export goods at both ends of the comparative advantage spectrum (e.g. OECD, 2011; Imbs & Wacziarg, 2003; Cadot et al., 2011, for conclusions along these lines). One possible reason for the absence of specialization is that comparative advantage is not a static phenomenon and that, due to adjustment costs, firms do not adapt their production and export patterns to shifts in comparative advantage.

Due to changing institutions, factor endowments or technology (Blum, 2010), comparative advantage evolves over time (Hanson et al., 2014) and a high comparative advantage industry may gradually move down the ladder of comparative advantage, or vice versa. The steel industry in the United States provides a good illustration of this dynamics as the country progressively lost its comparative advantage after World War II but still accounts for an important fraction of world steel production today. Although aligning export patterns to comparative advantage would be beneficial to the economy, adjustment costs, as such as those associated with the disposing of existing physical capital, investing in new capital, technology, building new network structures or acquiring skills, may prevent firms from switching towards industries or product lines with higher comparative advantage. If continuously adjusting to the dynamics of comparative advantage is too costly, a country may stick to a production and export structure that does not completely align with comparative advantage, therefore, giving rise to misallocation of resources and production leapfrogging, where adjustments only happen periodically.[1]

The goal of this paper is to evaluate whether a reduction in these adjustment costs leads to a reorganization of exports towards comparative advantage industries. We focus on the capital aspect of the adjustment costs and propose to use hurricanes as a negative shock on existing physical capital.[2] In what follows, the term capital refers to physical capital at the firm level (e.g. machinery, computers, buildings) and not to public capital (e.g. roads, bridges, hospitals), assets or labor inputs.

The rationale for using hurricanes is that they are completely exogenous to economic activity. First, hurricanes are unpredictable: the frequency of occurrence of hurricanes is stationary, hence the incidence of a hurricane does not provide any information on the probability

[1]For works documenting resources misallocation and examining the reasons for persistent misallocation, see e.g. Banerjee et al. (2003), Banerjee & Moll (2010).

[2]Documenting resources misallocation or identifying which type of cost prevents firms from reallocating resources is beyond the scope of this paper. Instead, the main focus of the paper is to evaluate whether a reduction in these costs can help reducing misallocation.

of the next event (Elsner & Bossak, 2001; Pielke et al., 2008). Moreover, although they tend to occur in coastal areas, hurricanes are erratic phenomena which hit firms and industries randomly. To the extent that hurricanes do not target their victims, they can be considered widespread exogenous phenomena. Finally, as will be argued later on, it does not appear that the possibility of a hurricane strike changes firms' investment or location decisions.

By destroying existing capital, hurricanes reduce the cost of disposing of existing capital. In that sense, hurricanes reduce the opportunity cost of adjusting to the dynamics of comparative advantage and create an 'opportunity' for reconstruction and reducing resources misallocation. The specific mechanism we have in mind is the following. Suppose that the physical capital of firms is destroyed randomly. What do firms do? Depending on the magnitude of the destruction, one could envisage several courses of action: for instance, a firm could exit for good, do nothing, substitute capital for other inputs or replace destroyed capital with the same level of capital. Alternatively, a firm could build back better, either in the same industry or in an industry or product line with relatively higher comparative advantage. While all these choices would lead to a decrease in exports in the affected industry, it is only if firms build back better that one would observe an increase in exports in comparative advantage industries and, as a consequence, a shift of exports towards comparative advantage industries. Our main objective is to evaluate whether the data support such a build-back better mechanism, i.e. whether, following a shock that destroys capital, firms tend to stick to an inefficient production and export structure, or whether they seize the 'opportunity' to reinvest in industries that align more closely with comparative advantage.

The mechanism in which we are interested is specific to capital destruction at the firm level and ideally, one would want to work with a panel of firms for a wide range of countries with information on firm-specific location, industrial activity at a fine level of disaggregation, exports and capital stock. Since firm-level data that meet these criteria are hardly available for a cross-country comparison, we work with a panel of 46 countries and 4-digit manufacturing industries over the period 1980-2000, and use hurricanes as a proxy for capital destruction. Our identification strategy consists in regressing the logarithm of industry-country-specific exports towards the US on a country-specific measure of hurricanes, an industry-country-specific term capturing comparative advantage and the interaction of the former two variables. The approach of interacting industry-specific with country-specific variables has been used in the past to explain patterns of trade.[3] For instance, Rajan & Zingales (1998) uses such a functional form to examine whether industries that rely more heavily on external financing grow faster in countries with better financial markets, Nunn (2007) tests whether countries with better contract enforcement specialize in contract-intensive industries and Levchenko (2007) asks if countries with better institutions specialize in goods which depend strongly on institutions.

[3] For the theoretical foundation of this approach, see Costinot (2009a,b).

To measure hurricanes, we use an index that reflects the destructive potential of hurricanes in a country in a given year. This index was first proposed by Yang (2008) and possesses the convenient features of being weighted by both wind-speed and population density along the path of hurricanes.[4] These features are important because they allow to account for the economic activity of the areas a hurricane strikes. One may not expect any effects on exports if a strong hurricane crosses a desertic region. At the same time, even if a hurricane strikes an urban area, effects may be negligible if winds are not strong.

This paper does not aim at identifying the sources of comparative advantage and therefore chooses to adopt the traditional Balassa index of revealed comparative advantage. This choice allows us to remain agnostic as to whether comparative advantage stems from Heckscher-Ohlin differences in countries' endowments, Ricardian differences in technology across countries, differences in institutional settings (Costinot, 2009b) or economies of scale (Krugman, 1979). The Balassa index of comparative advantage is often criticized for being contaminated by country-specific geographical characteristics, demand-side effects and distorting trade policies, and, therefore, for not truly reflecting countries' natural comparative advantage. For this reason, in the robustness section, we also use a relatively new measure of comparative advantage, introduced in Hanson et al. (2014), which cleanses the Balassa index from all these country-specific confounding factors and show that the main results remain the same.

The advantage of an analysis at the industry level, as opposed to one at the firm level, is that data availability enables a cross-country exploration of the dynamics of trade. However, the limitation of such an aggregated approach is that it makes it more difficult to isolate the effects of a build-back mechanism from other channels through which hurricanes could affect exports differentially across industries. For example, the literature on natural disasters documents that in the aftermath of hurricanes, official development assistance, lending from multilateral institutions and migrants' remittances increase while other financial flows such as bank and trade-related lending, foreign direct investments and portfolio investments tend to drop (see e.g. Yang, 2008), likely because the expected rate of returns decrease or because of an increased perception of risk. If the outflow of private investments is more pronounced in comparative disadvantage industries, then a shift towards comparative advantage industries may reflect another type of mechanism whereby firms at the bottom of the distribution are forced to exit due to the lack of financial resources. In addition to this mechanism, we carefully consider a set of four other alternative channels and show that the main findings do not capture any of these alternatives. These four alternative mechanisms are discussed in details in the robustness section and are related to economics growth, changes in the exchange rate, destruction of transport infrastructures and pre-existing trends in exports within industry-country pairs.

Results suggest that in the aftermath of a hurricane, exports are affected differentially

[4] As we argue later on, population density is highly correlated with industrial production.

across the spectrum of comparative advantage. Most importantly, hurricanes lead to monotone changes in export levels by comparative advantage percentiles, with export levels dropping at the bottom of the distribution and growing at the upper tail of the distribution. Results from a dynamic specification also suggest that the process of shifting resources towards comparative advantage industries occurs within three years and intensifies over this three-years period. Overall, it appears that if the opportunity arises, firms do not stick to an inefficient production but instead tend to reinvest and move up the ladder of comparative advantage. These results are consistent with the Schumpeterian concept of creative destruction in the sense that hurricanes create an environment of restructuring in which existing technologies of production are weeded out and space for switching towards more productive segments of the economy is created. Finally, results also indicate that the reallocation of resources is driven by drastic changes in industries with the lowest comparative advantage. This finding may be consistent with a story in which firms in low comparative advantage industries undertake drastic changes and copy the production process of firms in industries whose export success is the highest.

While the key contribution of this paper is to use exogenous variation to identify the presence of a build-back better mechanism, the paper also contributes to studies testing for multiple equilibria and to the literatures on the within-country effects of extreme weather events and on the effectiveness of adjustment policies.

According to economic theory, if a system receives a shock sufficiently strong to send it over a certain threshold, the system may then converge to a different equilibrium. Davis & Weinstein (2002, 2008) use the case of the bombings of Japanese cities during WWII and reach the conclusion that there is no empirical evidence supporting multiple equilibria. Instead, the authors find that Japanese cities suffered directly in the aftermath of the massive bombings but then recovered and returned to their pre-war era equilibrium in terms of population, industry-specific and aggregate production. We observe that in the aftermath of a hurricane, export patterns tend to change permanently in favor of industries with higher comparative advantage. Therefore, contrary to what Davis & Weinstein (2002, 2008) find, our results support multiple equilibria and suggest that the authors' findings may be very specific to the Japanese situation.

This paper also contributes to our knowledge on the within-country effects of extreme weather events, which is particularly important in the current context of climate change and global warming. The frequency and intensity of hydro-meterological disasters (i.e. hurricanes, flood, wild fires and droughts) has increased dramatically since 1960 (e.g. EM-DAT, World Development Indicators 2009) and so have the costs related to extreme weather events.[5] For instance, Munich RE reports that the costs associated with extreme weather events has increased from a yearly average of 8.8 billions USD in the 1960s to 57.5 billions USD in

[5]See Emanuel (2005); Elsner (2006, 2007); Hoyos et al. (2006); Webster et al. (2005); Scott et al. (2004).

2005. According to the Stern (2007), the cost of hurricanes will reach 0.5% to 1% of current world GDP by 2050. The bulk of the rise in damage is due to a surge in natural disasters, of which hurricanes are the most costly (Bevere et al., 2011) and relevant form: 35% of the global population is affected by hurricanes (Hsiang & Narita, 2012) and worldwide, hurricanes caused approximately 280 billion dollars of damage over the period 1970-2002 (EM-DAT). A large and growing literature has analyzed the impact of hurricanes on a variety of economic outcomes.[6] Given their devastating potential, it appears useful to also understand the export dimension of a country's recovery in the aftermath of a hurricane.

Finally, this paper also informs on the effectiveness of adjustment policies. There exist several policies aiming at promoting comparative-advantage-based trade and facilitating the adjustment of an economy to the dynamics of comparative advantage. These policies, which include for instance investing in transportation infrastructures, training, education or promoting capital accumulation and credit access, are generally classified as broad-based and targeted industrial policies. It is often argued that broad-based policies are more effective, for the reason that targeted policies, by their very nature, raise the question of which industry to target and involve a political game of thrones, which may work against long-term economic growth and welfare (see e.g. OECD, 2011; Harrison & Rodríguez-Clare, 2010; Rodrik, 2009). Nevertheless, evaluating these adjustment policies is inherently difficult because they are endogenous to the economic activity, i.e. it is difficult to estimate causal effects of these adjustment policies because not only do these policies affect exports, but also because these policies are implemented precisely in response to particular export patterns. Since hurricanes are widespread exogenous shocks that reduce the opportunity cost of adjusting to the dynamics of comparative advantage, this paper also informs on the effectiveness of broad-based adjustment policies. Our results tend to suggest that undiscriminating policies can be successful at promoting comparative-advantage-based trade.

This paper is organized as follows. Section 2 discusses the exogeneity of hurricanes with respect to economic activity. Data are described in Section 3. The paper discusses the identification strategy, the main results, alternative mechanisms and the dynamics of the adjustment in Section 4. The last section concludes.

2 The exogeneity of hurricanes to economic activity

Can hurricane strikes really be considered exogenous to economic activity? The question lies at the heart of our identification strategy and deserves to be backed up by some evidence.

We begin with two important considerations. First, it has been shown that the frequency

[6] See for instance Skidmore & Toya (2002); Belasen & Polachek (2008); Hsiang (2010); Cuaresma et al. (2008); Miguel & Roland (2011); Strömberg (2007); Yang (2008); Banerjee et al. (2010); Udry (1994); Maccini & Yang (2009); Besley & Burgess (2002); Hsiang et al. (2011); Hsiang & Jina (2014); Groen & Polivka (2008).

of occurrence of hurricanes is stationary, which means that the occurrence of a hurricane does not provide any information on the probability of observing a similar event in the same location in the future (Elsner & Bossak, 2001; Pielke et al., 2008). Second, hurricanes are erratic phenomena. Although hurricanes generally hit coastal areas and forecasting techniques are constantly improving, it is still very difficult to predict their exact path. Therefore, even though governments engage in ex-ante disaster risk reduction activities, it does not appear that the possibility of a hurricane strike changes firms' investment or location decisions.

Evidence suggests that individuals have internalized this erratic behavior. For instance, Lindell et al. (2007) show that the perceived probability of being affected by a hurricane does not increase significantly even after being hit by a hurricane. Along similar lines, Wu & Lindell (2014) use an experimental setting and show that decision makers tend to wait until it is too late in order to evacuate areas at risk of being hit. Dessaint & Matray (2014) analyse firms' behaviour and find that managers tend to react to hurricanes in their vicinity by increasing cash holdings for a short period of time only. Observing these types of drastic, yet temporary, changes in behavior in the aftermath of a hurricane suggests that managers do not internalize the disaster risk into their decision making process. These observations are important in relation to the mechanism investigated in this paper. If investment decisions were affected by the probability of being struck by a hurricane, then observing a shift towards comparative advantage industries could reflect a mechanism different from the one we seek to uncover, whereby, for instance, firms await the catastrophy to invest in new physical capital. In such a case, the expectation of a catastrophy would compromise the optimal path of investments and lead to misallocation of resources.

Consistent with the aforementioned findings, anecdotal evidence does not suggest that hurricane-prone areas are deserted or occupied by a cluster of specific industries. For instance, in India, a high concentration of firms is found in hurricane-prone areas. Figure 8 in the Appendix shows hurricanes' best tracks in India for the period 1970-2000.[7] The figure indicates that the majority of hurricanes' activity takes place in the north-east, north-west and southern tip of the country. Figure 9 in the Appendix shows a high concentration of firms in hurricane-prone areas, i.e. in the metropolitan area of Kolkata, the plains leading to New Delhi in the north east of the country, the highly industrialized Gujarat in the north west, and the equally highly industrialized southern parts of Kerala and Tamil Nadu in the south.

Another example are the Philippines, where the majority of manufacturing activities is located on the northern island which tends to be more prone to hurricanes than the southern island. Figure 10 in the Appendix shows hurricanes' best tracks in the northwestern Pacific Ocean over the period 1980-2005. The red box indicates that the southern part of the Philippines is rarely hit by hurricanes, if at all. Figure 11 in the Appendix presents the

[7] A hurricane *best track* reports the position, the strength of the wind and the diameter characterizing the eye of a hurricane at intervals of six hours.

gross value added in the manufacturing sector for 2012. The figure shows that the majority of the manufacturing activities are located around Manila, despite a particularly high disaster risk in the area. Instead, low gross value added in manufacturing is observed in the relatively safer southern island. According to the Department of Trade and Industry of the Philippines, in 2014, roughly 33% of the Philippines' GDP was generated in Manila, of which 12.5% came from manufacturing. The industries found in and around Manila are chemicals, textiles, clothing, electronic goods, food, beverages, and tobacco products.[8] One could argue that the southern part of the country is mountainous and therefore less suitable to industrial activities, yet this is not the case. If individuals' location decisions were affected by hurricanes, one would expect the Philippines' economic activity to be clustered in the safer South instead. Moreover, although we cannot be sure without knowing the industrial composition of firms across regions, given the variety of industries found in the area of Manila, it seems also plausible to suppose that firms in comparative advantage industries do not systematically self-select outside of risky areas. This is important to our identification strategy; if firms in comparative advantage industries did systematically self-select into hurricane-safe areas, then observing a reorganization of exports towards comparative advantage industries would simply reflect a mechanical reallocation of resources from risky to safer areas and not necessarily a build-back better mechanism.

3 Data

3.1 Hurricanes

The term *hurricane* typically describes severe tropical storms over the Atlantic or the East Pacific Ocean (i.e. storms with a wind speed exceeding 74 miles/119 kilometers per hour).[9] The same event in the Western Pacific is known as a *typhoon* – or *tropical cyclone* – over the Indian Ocean and in Oceania. Hurricanes always originate in tropical areas, but can end up in temperate areas, i.e. the US Atlantic coast or the temperate coast of East Asia and Japan.

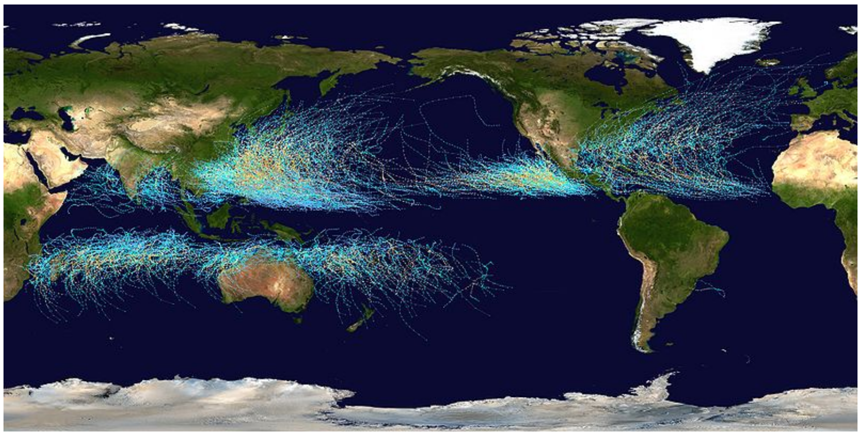
We measure hurricanes using an index constructed in Yang (2008). The raw data used to build the index come from two US government agencies: the NOAA Tropical Prediction Center

[8] *http://www.dti.gov.ph/rog/index.php/metro-manila*

[9] The formation of a hurricane requires a set of particular conditions. First, to a depth of 50 meters, the ocean needs to reach at least 79.7°F (26.5°C). At this temperature, water creates instability in the overlying atmosphere. Second, the water vapor needs to cool rapidly while rising in the atmosphere. This condensation releases the heat which powers the hurricane. Third, high humidity is required: disturbances in the troposphere form more easily if it contains a lot of moisture. Fourth, the storm's circulation should not be disrupted by high amounts of wind shear. Wind shear refers to the variation of wind over either horizontal or vertical distances. Finally, the Coriolis effect should be strong enough to deflect winds blowing toward the low-pressure center and to create a circulation, i.e. the distance from the equator needs to be greater than 555 km – or 5 degrees of latitude. The Coriolis effect is caused by the rotation of the earth and the inertia of the mass experiencing the effect.

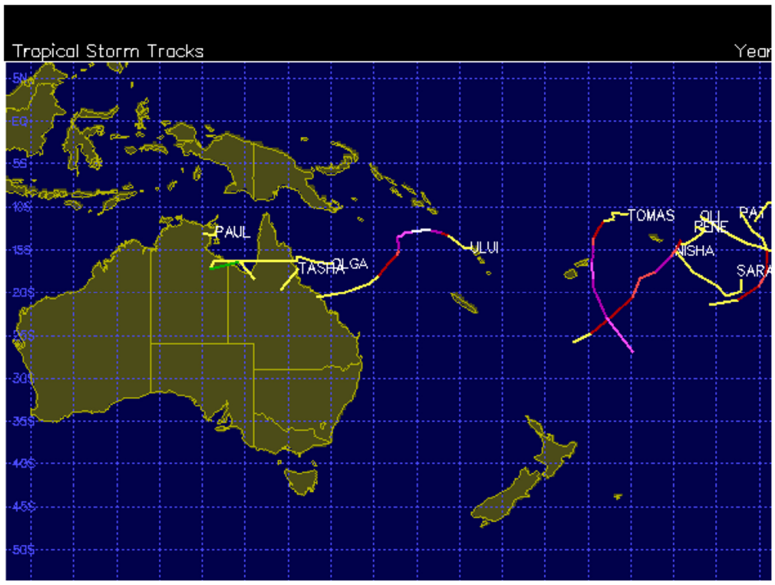
(for Atlantic and Eastern North Pacific hurricanes) and the Naval Pacific Meteorology and Oceanography Center/Joint Typhoon Warning Center (for hurricanes in the Indian Ocean, Western North Pacific, and Oceania). These centers provide *best tracks* for each hurricane. Figure 1 shows all best tracks over the period 1985-2005 and Figure 2 focuses on the best tracks for Oceania in 2010.

Figure 1: Best tracks, over the period 1985-2005.



Source: National Hurricane Center (NOAA).

Figure 2: Best tracks, Oceania, 2010.



Source: Naval Pacific Meteorology and Oceanography Center.

The index proposed by Yang (2008) is a country-year-specific measure that reflects the destructive potential of hurricanes in a country in a given year, taking into account both their force and the population density along their path. This measure, denoted H_{ct}, is defined as

$$H_{ct} = \frac{\sum_l \sum_s x_{lsct}}{L_{ct}}, \tag{1}$$

where c, t, l and s are country, time, individual and hurricane subscripts, respectively, and where L denotes population. x_{lsct} captures individual l's affectedness by hurricane s in country c at time t and is given by

$$x_{lsct} = \frac{(w_{lsct} - 33)^2}{(w^{MAX} - 33)^2}, \tag{2}$$

where w_{lsct} and w^{MAX} are hurricane-s wind speed and the maximum wind speed observed in the sample, respectively. The number 33 represents the hurricane wind speed threshold (in knots); i.e. the threshold above which a storm becomes a hurricane. The wind speeds above this threshold (as captured by $(w_{lsct} - 33)$ and $(w^{MAX} - 33)$) are squared in order to capture the force exerted by the wind on built structures. Therefore, individual affectedness x_{lsct} varies between 0 (when a storm just makes it to the hurricane level) and 1 (for the strongest hurricane in our sample).[10] Individuals within a 0.25-degree-square worldwide grid are treated homogeneously with respect to wind exposure. Taking this information into account, the storm index H_{ct} can theoretically vary between 0 and the total number of hurricanes within a year. Consider for instance the case of Nicaragua which experienced only one hurricane, Cesar, in 1996. For that country and particular year, the maximum value the hurricane index could possibly take is one. For this maximum to be reached, Cesar should be the strongest hurricane ever observed in the entire sample and have affected *all* individuals in Nicaragua in 1996 in the exact same way. In general, a value of 1 is highly unlikely as a hurricane rarely hit the entire surface (and thus, population) of a country and even if it would, since wind speeds change as the hurricane progresses, it is still highly improbable that all individuals would be affected similarly.

Hurricanes inflict damages in three different ways: through the force exerted by wind, surges and precipitation. The index focuses on wind speed and, therefore, is well suited to the study of the effect of hurricanes on economic activity. The focus on wind speed renders the hurricane measure exogenous to economic activity. Indeed, whereas floodings may be caused by excessive deforestation, wind destruction does not depend on land usage. The identification of the desired effect requires locating regions whose manufacturing activity is touched. Worldwide data on the location of industrial production does not exist at the same

[10] Equation (2) may give the impression that the index treats symmetrically a storm characterized by winds at, for instance, 34 knots and one with winds at 32 knots. This is not the case as tropical storms are classified as hurricanes only if their wind speed reaches 33 knots. Therefore, the database does not contain any data point with winds speeds lower than 33 knots.

resolution level as for population. Yet, industrial production is usually located in the vicinity of urban areas, making population density a good proxy for industrial production.[11] Indeed, a storm with extremely high winds passing through a scarcely populated area is unlikely to affect the manufacturing industry. At the same time, a hurricane crossing a densely populated area will be weighted more heavily in the index even if characterized by a low wind speed. Finally, expressing the index in per capita terms is convenient because it allows us to account for the size of the country. Consider a large country like China and a small one like Belize, and a strong hurricane crossing only one of the 0.25-degree-square grids. The hurricane will likely have a smaller impact on the Chinese economy then on the one of Belize. Normalizing the index by population size makes the impact of hurricanes on aggregate economic activity comparable across countries.

Table 1 shows summary statistics for the hurricane index, H_{ct}, by country over the period 1980-2000. Countries are ranked in ascending order according to their mean value for H_{ct}. The overall mean and the maximum values are 0.019 and 0.282, respectively. China, Mexico, Vietnam and the Philippines experienced hurricanes every year of the sample. The statistics suggest that, on average, the destructive potential of hurricanes in the Philippines (average of 0.04) is 40 times higher than that in Mexico (average of 0.001), 20 times higher than that in China (average of 0.002) and 7 times higher than that in Vietnam (average of 0.006). Countries like Barbados and Trinidad and Tobago highlight the advantage of using a continuous variable over a count one to measure hurricanes. For example, both countries experienced hurricanes in two out of the twenty years included in the sample. A count variable would treat both countries identically, although the index indicates that the destructive potential of hurricanes was on average 47 times larger in Trinidad and Tobago than it is in Barbados. Figure 3 provides a visual characterization of the hurricane measure H_{ct}. The boxplot shows the interquartile variation, median, range and outliers of the destructive potential of hurricanes for each country in our sample. Countries are ranked in ascending order according to their mean value for H_{ct}. The figure stresses a large amount of variation in the hurricane measure across countries.

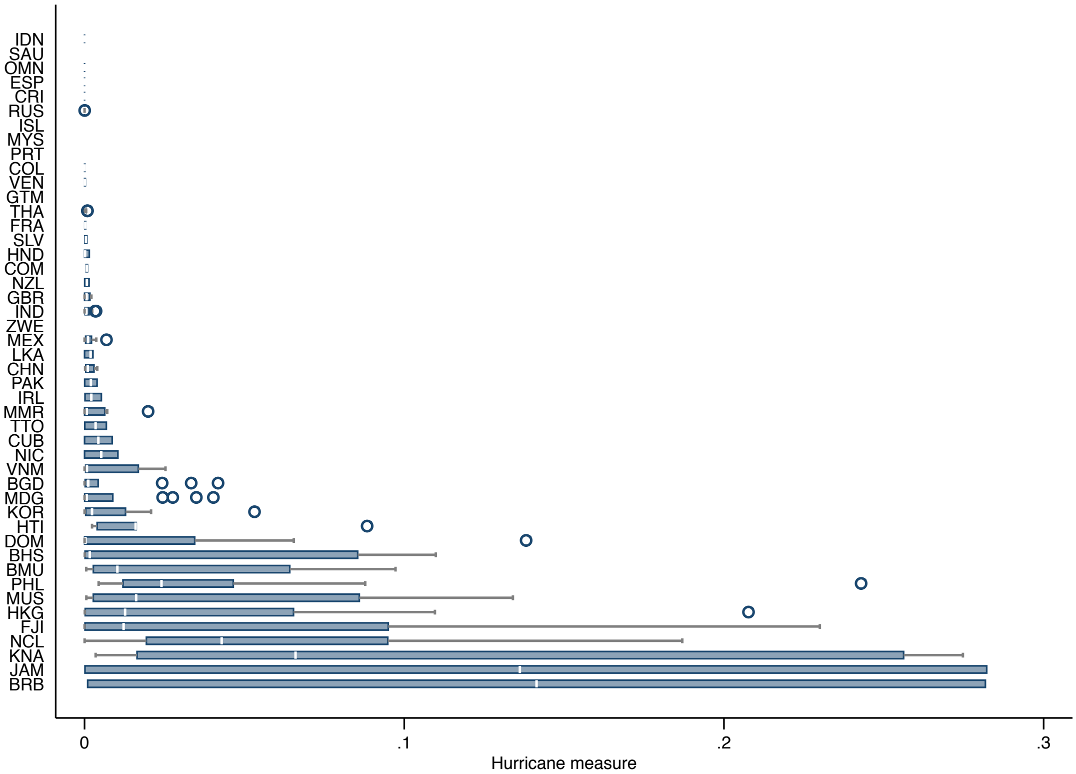
[11] For instance, in 2010 in the Philippines, the correlation between population density and industrial GDP (at the regional level) equals to 86.5%.

Table 1: Summary statistics for hurricanes, 1980-2000

Country	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Nb. of years with hurricanes**	**Country size (in km^2)**
All 46 countries	0.019	0.047	0.000	0.282		
Indonesia	0.000	0.000	0.000	0.000	2	1,919,440
Saudi Arabia	0.000	-	0.000	0.000	1	2,149,690
Spain	0.000	0.000	0.000	0.000	2	505,370
Russia	0.000	0.000	0.000	0.000	10	17,075,400
Costa Rica	0.000	0.000	0.000	0.000	2	51,100
Oman	0.000	0.000	0.000	0.000	4	212,460
Iceland	0.000	-	0.000	0.000	1	103,001
Malaysia	0.000	-	0.000	0.000	1	330,803
Portugal	0.000	-	0.000	0.000	1	92,090
Colombia	0.000	0.000	0.000	0.000	3	1,141,748
Venezuela	0.000	0.000	0.000	0.000	3	916,445
Guatemala	0.000	-	0.000	0.000	1	108,890
Thailand	0.000	0.000	0.000	0.001	12	513,120
France	0.000	0.000	0.000	0.000	2	674,843
El Salvador	0.000	0.000	0.000	0.001	2	21,040
Honduras	0.001	0.001	0.000	0.001	3	112,492
Comoros	0.001	0.000	0.000	0.001	2	2,170
New Zealand	0.001	0.001	0.000	0.001	3	268,021
United Kingdom	0.001	0.001	0.000	0.002	4	243,610
India	0.001	0.001	0.000	0.004	20	3,287,263
Zimbabwe	0.001	-	0.001	0.001	1	390,757
Mexico	0.001	0.002	0.000	0.007	21	1,972,550
Sri Lanka	0.002	0.001	0.000	0.003	3	65,610
China	0.002	0.001	0.000	0.004	21	9,640,821
Pakistan	0.002	0.003	0.000	0.004	2	796,095
Ireland	0.003	0.003	0.000	0.005	3	84,421
Myanmar	0.003	0.006	0.000	0.020	13	676,578
Trinidad and Tobago	0.003	0.005	0.000	0.007	2	5,128
Vietnam	0.006	0.006	0.000	0.025	21	331,698
Bangladesh	0.008	0.014	0.000	0.042	15	147,570
Madagascar	0.008	0.013	0.000	0.040	19	587,040
Republic of Korea	0.009	0.014	0.000	0.053	16	100,210
Cuba	0.010	0.020	0.000	0.067	11	109,886
Nicaragua	0.010	0.015	0.000	0.031	4	130,373
Haiti	0.025	0.036	0.002	0.088	5	27,750
Dominican Republic	0.026	0.051	0.000	0.138	8	48,730
Bahamas	0.029	0.046	0.000	0.110	10	13,939
Bermuda	0.032	0.042	0.001	0.097	8	53.3
Philippines	0.040	0.052	0.004	0.243	21	299,764
Mauritius	0.041	0.051	0.001	0.134	11	2,040
Hong Kong	0.046	0.071	0.000	0.208	9	80.4
Fiji	0.060	0.082	0.000	0.230	11	18,274
New Caledonia	0.061	0.055	0.000	0.187	11	18,575
Saint Kitts and Nevis	0.114	0.120	0.003	0.275	6	261
Jamaica	0.139	0.141	0.000	0.282	3	10,991
Barbados	0.141	0.199	0.001	0.282	2	430

Note: There are 46 countries for which we have data on exports and hurricanes. The column **Min.** represents the minimum value of a hurricane in a given country. Values of 0.000 denote values smaller than 0.001.

Figure 3: Boxplot hurricanes



Note: Countries with no boxplot are countries with less than three relatively small hurricanes over the period 1980-2000. Isocodes can be found in Table 12 of the Appendix.

3.2 Exports and comparative advantage

Export data are taken from the NBER United Nations bilateral trade data. The data cover a large set of countries for the period 1962 to 2000 and contains trade data, disaggregated at the 4-digit level.[12] The analysis of this paper covers the years 1980-2000 and focuses on manufacturing exports from 46 countries.[13] The analysis is restricted to the manufacturing sector because the mechanism of interest directly relates to physical capital destruction. Finally this paper only uses industries with positive export values over the entire period.[14] Given that hurricanes only tend to hit specific areas in a country, it is unlikely that they would lead to the disappearance of an entire industry. Including in the sample only industries caracterized

[12]We decided to use trade data disaggregated at the 4-digit level instead of the 6-digit level since good quality data at the 6-digit level are available only starting in 1995.

[13]The sample is limited to countries which experienced at least one hurricane over the period under consideration and for which the hurricane index is available.

[14]Note that taking a longer time period would imply losing a significant number of observations, possibly because of changes in technology and consumption habits.

by positive export flows over the entire period also partly deals with the high volatility which characterizes export data. Industries with low export values are usually characterized by a high frequency of entry/exit and often related to reporting errors. Another advantage of our sample is the absence of zero trade flows which are usually difficult to deal with.

Table 13 of the Appendix shows summary statistics for the manufacturing sector, both in terms of the share of manufacturing exports in total exports and of manufacturing production in GDP, by country, over the period 1980-2000. The share of manufacturing exports varies from a minimum of 0.7% for Nicaragua to a maximum value of 98.4% for Bermuda. Even though the variability seems high, on average manufacturing exports represent the 49% of total export values. This number is larger than the value representing the share of the manufacturing sector in GDP, which averages to 17%.

Comparative advantage This paper uses the traditional Balassa index of revealed comparative advantage. This measure is given by the proportion of country c's exports in industry i normalized by the proportion of world exports in that particular industry. That is,

$$\text{Balassa}_{ict} = \frac{\frac{X_{ict}}{\sum_i X_{ict}}}{\frac{X_{it}}{\sum_i X_{it}}}, \tag{3}$$

where X_{ict} denotes exports of industry i in country c towards the world at time t and X_{it} is aggregate exports of industry i at time t. A value of the index larger than 1 indicates that country c has a comparative advantage in industry i. Instead, if its value is between 0 and 1, the country has a comparative disadvantage in that industry. In what follows, the paper uses the logarithm of the Balassa index to measure comparative advantage, that is:

$$\text{CA}_{ict} = \log \text{Balassa}_{ict}, \tag{4}$$

where CA_{ict} denotes comparative advantage. Figure 12 of the Appendix shows the distribution of the Balassa measure, expressed in logs, by year, across countries and industries. The figure shows that, taken across countries and industries, the distribution of comparative advantage moves slowly over the years and tends to become more concentrated as one moves towards the year 2000. Columns (1) through (4) of Table 14 in the Appendix show summary statistics of the Balassa measure for every country this paper covers, over the period 1980-2000. The table shows considerable variation in comparative advantage across countries.

The main advantage of using the Balassa measure is that it is based on a broad definition of comparative advantage, therefore allowing us to be agnostic about the sources of comparative advantage. One limitation of this measure, however, is that it is affected by country-specific geographical characteristics, demand-side attributes or policies that may distort trade. Therefore, the Balassa index may reflect part of these confounding factors in addition to any underlying comparative advantage. In Section 4.3, we test the robustness of the main results to an alternative measure of comparative advantage, recently developed by Hanson et al. (2014).

Dependent variable The dependent variable is given by the log of industry-country-specific exports towards the U.S. Focusing on one single destination country has the advantage of removing destination-specific demand-side confounds. Another reason for this restriction is that, since it is constructed using country-industry exports, the Balassa measure of comparative advantage might be endogenous. Using exports towards one single destination market, as opposed to all trading partners, alleviates potential reverse causality. Table 15 in the Appendix reports the summary statistics for country-specific exports towards the US as a share of country-specific aggregate exports.

4 Empirical Strategy

4.1 Identification

The main specification regresses the logarithm of industry-country exports towards the US on the index of hurricanes, the logarithm of the Balassa measure of revealed comparative advantage, the interaction of the two variables and an entire set of country, industry and year dummies, as well as industry and country trends:

$$\log X_{ict,US} = \alpha H_{ct} + \beta CA_{ic(t-1)} + \gamma \left(H_{ct} \times CA_{ic(t-1)} \right) + d_c + d_i + d_t + \tau_i + \tau_c + \varepsilon_{ict},$$

where $X_{ict,US}$ denotes exports of country c in industry i towards the US at time t. d_c, d_i and d_t denote country, industry and time dummies, respectively. τ_{it} and τ_{ct} are industry and country trends, respectively. ε_{ict} is the error term.

Since the paper only focuses on industries for which exports are strictly positive over the entire period, the sample does not contain zero trade flows. Note that the lagged value of comparative advantage is used in the regression. This choice ensures that measured comparative advantage is not affected by current hurricanes or by the dependent variable (although focusing on one single destination market should already filter out reverse causality concerns).

The coefficient α captures the marginal effect of hurricanes on the dependent variable for industries whose measured comparative advantage (expressed in logs) is zero. Thus, a negative coefficient would imply that hurricanes cause a decrease in export values for industries whose $CA_{ict} = 0$. The coefficient β captures the importance of comparative advantage on export flows. Since CA_{ict} is increasing in comparative advantage, β is expected to be positive if countries tend to specialize in the production and export of industries for which they have a comparative advantage. Whether hurricanes affect industries differentially depends on γ, the coefficient on the interaction term. The way hurricanes shape export patterns, however, is given by the marginal effect of hurricanes on exports for each level of comparative advantage. The marginal effect depends on both coefficients α and γ, and is computed as follows:

$$\alpha + \gamma CA_{ic(t-1)}. \tag{5}$$

If resources shift from comparative disadvantage to comparative advantage industries, one would expect the marginal effects of hurricanes on exports to be monotonically increasing with comparative advantage, which can only occur if $\alpha < 0$ and $\gamma > 0$. For example, $\alpha > 0$ and $\gamma < 0$ would generate a monotonically decreasing function and imply a movement of exports down the scale of comparative advantage. Two positive coefficients would imply the marginal effect to be U-shaped, and vice versa.

4.2 Baseline results

Table 2 presents the baseline results. All columns include industry, country and year dummies in addition to industry and country trends. Standard errors are clustered at the country level. The first and second columns only include the measure of hurricanes and comparative advantage, respectively. Both variables are introduced jointly in column (3). Column (4) corresponds to a specification that includes the interaction of both variables.

Table 2: Baseline results

Dependent variable	log $\text{exports}_{ict,US}$			
	(1)	(2)	(3)	(4)
Hurricane_{ct}	0.062		-0.19	-3.59^{***}
	(0.45)		(0.42)	(1.00)
$\text{Balassa}_{ic(t-1)}$		0.89^{***}	0.89^{***}	0.89^{***}
		(0.016)	(0.016)	(0.016)
$\text{Balassa}_{ic(t-1)}$*Hurricane_{ct}				0.89^{***}
				(0.22)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes
Observations	68325	68325	68325	68325
R^2	0.54	0.78	0.78	0.78

Notes: Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.

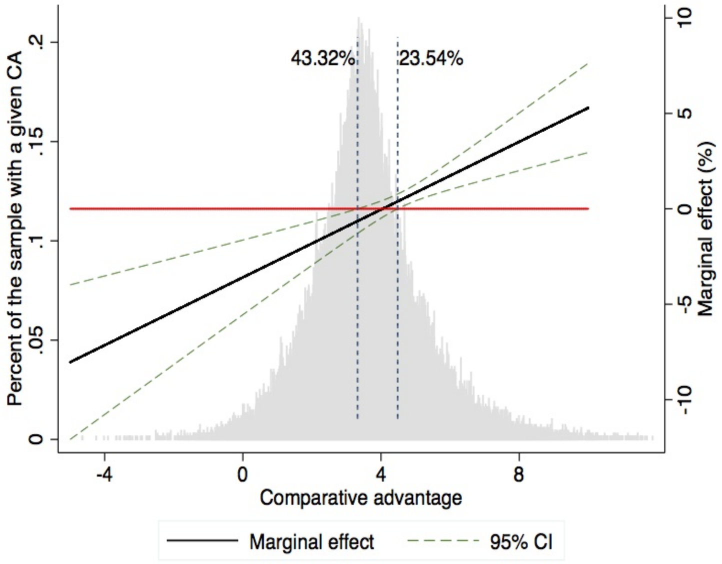
Unlike the estimates obtained on the hurricane index, the coefficients on the measure of comparative advantage are positive, statistically significant and remarkably stable across specifications. When the Balassa index is excluded, the coefficient on the hurricane measure is positive, yet statistically insignificant. The coefficient becomes negative when the variable capturing comparative advantage is added and, finally, negative and statistically significant at the 1% level when the interaction term is included. This result suggests that the estimate in column (3) may mask heterogeneous effects across industries. The coefficient on the interaction term is positive and statistically significant at the 1% level, indicating that industries are indeed affected differentially by hurricanes.[15]

Interpreting the magnitude of α or γ alone makes little sense as the marginal effect ought to be computed using the estimates of both coefficients. The signs of the estimates obtained in column (4) suggest, however, that the marginal effects of hurricanes on exports are monotonically increasing with comparative advantage. Therefore, it appears that exports tend to shift towards comparative advantage industries in the aftermath of a hurricane. However, at this stage it remains unclear whether export levels increase or decrease over the entire spectrum of comparative advantage, or whether they drop at the bottom of the distribution of comparative advantage and grow as one moves towards the upper tail of the distribution.

To obtain a more complete picture on how exports are affected in each industry, the paper uses equation (5) to compute the marginal effect at each level of comparative advantage. The results are presented in Figure 4. The gray histogram in the background shows the distribution of comparative advantage across countries, industries and years. The black line corresponds to the marginal effect of hurricanes on export levels for each level of comparative advantage and the green dashed lines correspond to the 95% confidence interval. Export values of industries located at the bottom 43.32% and the top 23.54% of the distribution are affected in a statistically significant manner. The figure shows that the marginal effects are monotonically increasing, with export levels dropping at bottom 43.32% and growing at the top 23.54% of the distribution. This evidence is suggestive of a build back better mechanism leading to a reorganization of production and exports from comparative disadvantage towards industries with relatively higher comparative advantage. These results are consistent with the idea of creative destruction as it appears that if the opportunity araises, firms do not stick to

[15] Table 16 in the Appendix verifies whether the baseline results are driven by extreme values. The table shows the results obtained when values of the Balassa measure below the 10th percentile and above the 90th percentile are dropped from the sample. The coefficient on the interaction term is robust to these changes both in terms of sign and statistical significance. If at all, the magnitude of the estimate increases after we cut off the tails of the distribution. Table 17 in the Appendix, shows the results obtained when current values of the comparative advantage measure are used instead of lagged values. The results are basically unchanged. Thus, this table shows two things. First, comparative advantage changes slowly, and second hurricanes do not seem to affect comparative advantage. Finally, Table 18 in the Appendix replaces each value of comparative advantage by its percentile value corresponding to its rank in the distribution of comparative advantage. The goal of this exercise is to verify whether the baseline estimates are the mechanical result of the fact that the comparative advantage measure takes negative and positive values. Table 18 suggests that this is not case.

Figure 4: Marginal effects



Notes: The black line is given by $\alpha + \gamma \cdot CA_{cit}$ $\forall$ $CA_{cit} \in [-5, 12]$. The range is generated at intervals of 0.01 and reflects the range of comparative advantage observed in the data.

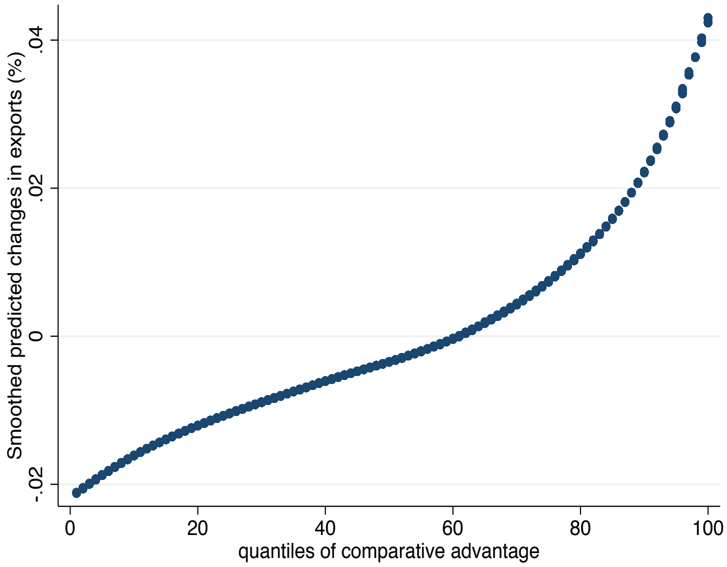
an inefficient production but instead tend to reinvest and move up the ladder of comparative advantage. In that sense, a negative shock on existing capital seems to help reducing the misallocation of resources.

The right-hand side vertical axis shows that the magnitude of the marginal effects can be large, especially at the extremes of the comparative advantage distribution. Although the magnitude of these effects appears to be large, one needs to bear in mind that the measure of hurricanes is relatively small, with a maximum value of 0.282.[16]

To get a better idea of the average total effects over the spectrum of comparative advantage, Figure 5 plots smoothed predicted changes in exports, by quantile of comparative advantage. The figure is obtained by carrying out a locally weighted regression of the predicted total effects on comparative advantage and suggests that on average, exports tend to respond negatively up to the 60th quantile and thereafter, positively. The shape of the curve also shows that industries at both extremes of the distribution respond more abruptly than

[16]Figure 13 in the Appendix shows the predicted total effects on exports for each level of comparative advantage. These effects are computed using each of the values of the hurricane index in the sample. In contrast with Figure 4, the right axis exhibits much smaller numbers in magnitude, which is to be expected given the range of values that the hurricane index can take. Each series of dots in the figure represents a hurricane-country-year triplet. Flatter curves represent weaker hurricanes, while steeper curves represent larger ones. For instance, in Figure 14 in the Appendix, the red curve represents the predicted total effects of hurricanes on exports for Hong Kong in 1995.

Figure 5: Smoothed total effects



those in the middle of the distribution. This finding might indicate that when capital is destroyed and firms are given the opportunity for reconstruction, firms at the very bottom of the distribution undertake drastic changes and invest in modes of production that are considerably more efficient or, at least, that they invest in those industries whose export success is the largest.

4.3 Robustness

The first part of this section investigates a series of alternative mechanisms which may potentially interfere with the baseline estimates. In the second part of this section, the paper tests the robustness of the baseline estimates to an alternative measure of comparative advantage. The last part of this section compares the baseline estimates to those obtained when restricting the sample to a subset of countries, namely islands and then countries with isolated episodes.

4.3.1 Alternative mechanisms

In what follows, the paper includes additional variables to the main specification to test whether the baseline estimates capture alternative mechanisms through which hurricanes may affect exports differentially. Five alternative channels are considered: the first one relates to economic growth, the second one to changes in the exchange rate, the third one to foreign aid and investments, the fourth one to the destruction of transportation infrastructures and the last one to the trend in exports of each industry in each country. The inclusion of additional controls tends to result in a decrease in the number of observations, which may render the comparison of the new coefficients to the baseline estimates difficult. For this reason, before presenting any new specification, the paper first presents the estimates obtained when running the baseline specification on the sample of observations that is left when introducing each of these additional controls.

The first alternative channel this paper considers is related to economic growth. A recent literature on natural disaster (see e.g. Hsiang & Jina, 2014) shows that hurricanes can affect economic growth. Another strand of the literature argues that the patterns of trade are correlated to economic development of a country. For example, OECD (2011) shows that countries at lower levels of development tend to export goods produced at all ends of the comparative advantage distribution while richer economies tend to concentrate production in industries with a clear comparative advantage. If hurricanes have a positive impact on economic growth, at least in the long run, then our results may just reflect a shift towards higher stages of economic development. To test for this alternative channel, the paper controls for GDP and GDP per capita.[17] Nevertheless, note that since there is no clear consensus in the natural disaster literature on how hurricanes affect economic growth, it is not entirely clear whether and how omitting these two variables would bias the baseline results. Results are reported in columns (2) and (3) of Table 3. Adding these two controls does not alter the qualitative aspect of the baseline results. Although the coefficients on both the hurricane index and the interaction term slightly decrease in magnitude, the sign and statistical significance of the estimates is preserved.

[17]Data on GDP and GDP per capita are taken from the World Development Indicators.

The second alternative mechanism relates to changes in the exchange rate. It is possible that a country experiences a currency devaluation in the aftermath of a hurricane. If the devaluation benefits comparative advantage industries disproportionately more, then the baseline estimate may capture the effect of the currency devaluation instead of a build-back mechanism. This possibility is examined in column (5) of Table 3 by controling for the real effective exchange rate (REER).[18] Although the coefficient on the REER does not have the expected sign, controlling for the REER does not alter the estimates of interest, suggesting that the baseline estimates do not capture the effect of variations in the exchange rate.

The third channel this paper examines relates to financial flows. The literature on the impact of natural disasters on financial flows documents an increase in official development assistance, lending from multilateral institutions and migrants' remittances in the aftermath of a hurricane (see e.g. Yang, 2008). However, evidence suggests that private financial flows, such as bank and trade-related lending, foreign direct investments and portfolio investments, tend to decrease, possibly because of a decrease in the expected rate of returns or an increase in the perception of risk. Omitting financial flows from the main specification may bias the baseline estimates if the inflow of foreign aid targets comparative advantage industries specifically, or if private investments are prone to leave comparative disadvantage industries to a larger extent. In such a case, the baseline results could reflect the fact that at the bottom of the distribution of comparative advantage, firms tend to exit for good for the reason that they simply do not have the resources to reinvest. Alternatively, the baseline results could capture a flow of new entries or an expansion of firms at the top of the distribution. Table 4 investigates this third channel and sequentially includes official development assistance, lending from multilateral institutions, migrants' remittances, bank and trade-related lending, foreign direct investments and portfolio investments in the baseline specification.[19] The estimates on each of these controls is statistically insignificant and more importantly does not alter the baseline estimates. Therefore, it does not appear that omitting any of these financial flows from the baseline specification creates a significant bias.

The fourth mechanism examined relates to the destruction of transport infrastructure. Besides destroying capital and production structures of firms, hurricanes can severely damage transportation systems. By causing delays, partial closures and diversions of air, water and land transportation, hurricanes can inflate trade costs, at least temporarily. Models of heterogenous firms and trade show that, by reducing firms' exporting profitability, an increase in trade costs causes the least productive firms to exit the export market (e.g. Melitz, 2003). If, as shown by Bernard et al. (2007), this effect is magnified for comparative disadvantage in-

[18]Exchange rate data are from the IMF. The real effective exchange rate is the ratio of the nominal effective exchange rate (NEER) to a price deflator. The NEER is expressed on the base 2005=100 and measures the value of a currency against a weighted average of several foreign currencies. An increase in the REER indicates that exports become more costly and imports cheaper.

[19]Each of the controls is taken from the World Development Indicators and expressed in 2000 US$.

dustries, the baseline estimates may reflect part of the temporary negative effect of increased transport costs rather than build-back better forces. This paper evaluates this possibility using the following proxies of infrastructure capital: million tons per kilometer transported by railways and by air freight, investments in transport with private participation, and capital formation in the public sector.[20] Results are shown in Table 5. In general, controlling for infrastructure capital does not alter the qualitative aspect of the results; the estimates of interest preserve their sign and statistical significance. Interestingly, the inclusion of the railway variable causes the coefficient on the hurricane index to grow from -2.69 to -5.17, indicating that the baseline estimate may be biased upward. This result suggests a negative correlation between rail transport and hurricanes that could reflect the fact that countries with better-developed rail systems suffer less from hurricanes. In fact, greater availability of alternative routes likely enables firms to divert the delivery of goods and limits the delays caused by the catastrophe.[21] Column (3) also suggests that the coefficient on the hurricane index may suffer from a bias, although a smaller one in magnitude, likely because a smaller share of manufacturing goods is airfreighted. Nevertheless, although Table 5 suggests that the baseline estimates may be slightly biased, controlling for transport infrastructures only reinforces the main result and corroborate the build-back better mechanisms this paper seeks to identify.

Finally, the paper investigates whether the baseline estimates capture an already existing trend of exports at the industry-country level. The reason why this may be the case is that, by construction, the traditional Balassa measure of comparative advantage reflects the export success of an industry in a country. If export success tends to correlate with the trend of exports of each industry in each country, then the baseline estimates may be capturing an existing trend effect rather than a reallocation of exports towards the top of the distribution of comparative advantage. In such a case, the baseline estimates would indicate that hurricanes simply accelerate the decline or the growth of an already declining or growing industry, rather than inciting firms to build back better. The paper tests this possibility in Table 6 by sequentially introducing one-digit, two- and three-digits industry-country trends to the baseline specification.[22] Although the magnitude of the estimates somewhat decrease as one moves towards higher levels of industrial disaggregation, the qualitative aspect of the results remains unaltered, suggesting that our baseline estimates are not the result of an industry-country-specific trend.

[20] Each of these variables is taken come from the World Development Indicators. Note that the million tons per kilometer transported by rail captures country-specific track density. This measure is adjusted to the size of the country through the country fixed effects. Capital formation in the public sector includes all kinds of public infrastructures, as for example schools or hospitals.

[21] Interacting the railway variable with the hurricane index leads to similar results.

[22] We restrict ourselves to a maximum of three-digits industry-country trends as using four-digits industry-country trends would absorb all the identifying variation.

Table 3: Controlling for economic growth

	(1)	(2)	(3)	(4)	(5)
Hurricane$_{ct}$	-3.70***	-2.86***	-2.92***	-3.71***	-3.71***
	(0.95)	(0.79)	(0.79)	(1.07)	(1.07)
Balassa$_{ic(t-1)}$	0.88***	0.89***	0.89***	0.88***	0.88***
	(0.016)	(0.015)	(0.015)	(0.028)	(0.028)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$	0.92***	0.86***	0.86***	0.91***	0.91***
	(0.20)	(0.19)	(0.19)	(0.24)	(0.24)
GDP per capita		1.63**			
		(0.67)			
GDP			1.75***		
			(0.63)		
Real effective exchange rate					0.000068***
					(0.00000063)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes	yes
Observations	67640	67640	67640	43521	43521
R^2	0.78	0.78	0.78	0.76	0.76

Notes: Standard errors are clustered at the country level. (***) denotes significance at the 1% level, (**) at the 5% level and (*) at the 10% level.

Table 4: Controlling for financial flows

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Hurricane_{ct}	-3.28**	-3.07***	-2.14**	-2.33**	-2.53***	-2.37***	-2.54***	-2.15***	-3.38***	-3.42***	-3.23***	-3.49***
	(1.30)	(1.03)	(1.00)	(0.90)	(0.76)	(0.60)	(0.75)	(0.54)	(1.02)	(1.04)	(0.97)	(0.94)
$\text{Balassa}_{ic(t-1)}$	0.86***	0.86***	0.89***	0.89***	0.86***	0.86***	0.86***	0.86***	0.89***	0.89***	0.88***	0.88***
	(0.011)	(0.011)	(0.023)	(0.023)	(0.018)	(0.018)	(0.017)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)
$\text{Balassa}_{ic(t-1)}$*Hurricane_{ct}	0.76***	0.72***	0.62***	0.63***	0.65***	0.63***	0.66***	0.62***	0.90***	0.90***	0.84***	0.86***
	(0.24)	(0.20)	(0.20)	(0.19)	(0.19)	(0.16)	(0.19)	(0.16)	(0.23)	(0.23)	(0.20)	(0.20)
Development assistance		0.064										
		(0.075)										
Migrants' remittances				0.062								
				(0.050)								
Lending from multilateral institutions						0.092						
						(0.068)						
Bank and trade-related lending								0.077*				
								(0.044)				
Portfolio investments										0.0070		
										(0.017)		
Foreign direct investments												0.048
												(0.035)
Industry, country, year dummies; Industry, country trends	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	36810	36810	37326	37326	28401	28401	28205	28205	59572	59572	62295	62295
R^2	0.82	0.82	0.77	0.77	0.83	0.83	0.83	0.83	0.78	0.78	0.78	0.78

Notes: Standard errors are clustered at the country level. (***) denotes significance at the 1% level, (**) at the 5% level and (*) at the 10% level.

Table 5: Controlling for transport infrastructures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hurricane_{ct}	-2.69**	-5.17**	-3.47***	-3.45***	-1.60***	-1.55**	-2.51***	-2.25***
	(1.30)	(1.92)	(0.83)	(0.83)	(0.55)	(0.65)	(0.81)	(0.67)
$\text{Balassa}_{ic(t-1)}$	0.89***	0.89***	0.88***	0.88***	0.99***	0.99***	0.86***	0.86***
	(0.018)	(0.018)	(0.017)	(0.017)	(0.022)	(0.022)	(0.015)	(0.015)
$\text{Balassa}_{ic(t-1)}$*Hurricane_{ct}	0.86***	0.80**	0.93***	0.93***	0.29**	0.29**	0.70**	0.69***
	(0.29)	(0.30)	(0.22)	(0.22)	(0.12)	(0.12)	(0.26)	(0.25)
Railways, goods transported		0.53*						
(log, mio ton-km)		(0.28)						
Air transport, freight				0.22				
(log, million ton-km)				(0.19)				
Investment in transport with private participation						0.0057		
(log, defl USD)						(0.013)		
Capital formation, public sector								0.072*
(% of GDP)								(0.041)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes	yes	yes	yes	yes
Observations	57668	57668	63949	63949	11641	11641	19419	19419
R^2	0.78	0.78	0.78	0.78	0.85	0.85	0.85	0.85

Notes: Standard errors are clustered at the country level. (***) denotes significance at the 1% level, (**) at the 5% level and (*) at the 10% level.

Table 6: Controlling for industry-country trends

	(1)	(2)	(3)	(4)
Hurricane_{ct}	-3.59***	-3.00***	-2.29***	-1.66***
	(1.00)	(0.74)	(0.64)	(0.60)
$\text{Balassa}_{ic(t-1)}$	0.89***	0.86***	0.82***	0.76***
	(0.016)	(0.015)	(0.015)	(0.016)
$\text{Balassa}_{ic(t-1)}\text{*Hurricane}_{ct}$	0.89***	0.74***	0.57***	0.41**
	(0.22)	(0.15)	(0.11)	(0.16)
Industry, country and year dummies;				
Industry and country trends	Yes	Yes	Yes	Yes
1 digit industry-country trends	No	Yes	No	No
2 digits industry-country trends	No	No	Yes	No
3 digits industry-country trends	No	No	No	Yes
Observations	68325	68325	68325	68325
R^2	0.78	0.79	0.82	0.85

Notes: Standard errors are clustered at the country level. (***) denotes significance at the 1% level, (**) at the 5% level and (*) at the 10% level.

4.3.2 An alternative measure of comparative advantage: Hanson, Lind and Muendler (2014)

In what follows, the robustness of the baseline results is checked using an alternative measure of comparative advantage, recently proposed by Hanson et al. (2014). The rationale behind this exercise is that the Balassa index of comparative advantage may be contaminated by country-specific geographical components, idiosyncratic demand conditions in neighboring countries or distorting trade policies, and may therefore not be reflecting countries' natural comparative advantage. For instance, part of the share of exports going from Mexico to the US may simply be explained by the fact that the two countries share a common border and not by any specific comparative advantage.

Hanson et al. (2014) argue that these confounding factors can be filtered out using a gravity model. For each industry-year pair, their approach consists in running a series of gravity regressions on standard gravity controls, exporter and importer dummies. The coefficients on exporter dummies are then used to compute a comparative advantage measure in the spirit of the Balassa index. The main advantage of this relatively new measure over the Balassa index is that it does not mechanically reflect export success. Therefore, the measure is more closely related to countries' natural comparative advantage and is also unlikely to correlate with pre-existing industry-country-specific trends.

Following Hanson et al. (2014), this paper estimates the following gravity model:

$$\ln X_{iAIt} = k_{iAt} + m_{iBt} - \eta_{it} C_{ABt} + u_{iABt}, \tag{6}$$

where subscripts A and B represent an exporting and importing country, respectively. u is an error term and C is a matrix containing the standard determinants of trade costs used in gravity models.[23] Since the gravity regressions are run for each industry-year pair, the coefficients η on these variables are allowed to vary across industries and years. The variables k and m denote an entire set of exporter-industry-year and importer-industry-year dummies, respectively. The coefficients on the exporter-industry-year dummies are retrieved and subsequently used to estimate export capability.

Note that, as in Hanson et al. (2014), the omitted category is the importer-industry-year dummy for the US. For this reason, the estimates on the exporter-industry-year dummies are given by:

$$k_{iAt}^{OLS} = k_{iAt} + m_{iUSt}, \tag{7}$$

[23] As Hanson et al. (2014), we include the log distance between exporter and importer, the time difference and the square of the time difference between exporter and importer, a contiguity dummy, a regional trade agreement dummy, a dummy for both countries being members of GATT, a common official language dummy, a common prevalent language dummy, a colonial relationship dummy, a common empire dummy, and a common currency dummy. All these variables come from CEPII and are industry-invariant.

and do not exactly identify k_{iAt}, the underlying export capability. Since m_{iUSt} is industry-time-specific, this problem can be solved by first averaging out k_{iAt}^{OLS} over exporters and then, by substracting this average from each of the estimates on the exporter-industry-year dummies. That is, the underlying export capability determined as follows:

$$\hat{k}_{iAt} = k_{iAt}^{OLS} - \frac{1}{N}\sum_{A'=1}^{N} k_{iA't}^{OLS}, \tag{8}$$

where N is the total number of exporters. Taking deviations from the mean therefore removes the omitted importer-industry-year category, as well as any global industry-time-specific factors as such as industry-specific total factor productivity growth, demand changes or variations in producer price index. The advantage of Hanson et al. (2014)'s approach is that it enables one to construct a measure of comparative advantage using trade data exclusively, while controlling for standard gravity variables and industry-year-specific factors.[24]

Table 7 presents the estimates obtained using Hanson et al. (2014)'s measure of comparative advantage in place of the Balassa index. Results are similar to those obtained with the baseline specification, with the exception of the coefficient on the hurricanes measure which is still negative, yet smaller in magnitude and imprecisely estimated. Importantly, the coefficient on the interaction term grows from 0.89 to 1.17 and remains statistically significant at the 1% level. If anything, using this alternative measure of comparative advantage reinforces the baseline findings that exports shift towards comparative advantaged industries in the aftermath of a shock that destroys capital at the firm level.

[24] Columns (5) to (8) of Table 14 in the Appendix show summary statistics of the Hanson et al. (2014) measure of comparative advantage by country across industries and years. The statistics of Table 14 present substantial differences between the traditional Balassa measure and that proposed by Hanson et al. (2014). Overall, the average of the Hanson et al. (2014)'s measure is lower. For some countries, the average of this measure is negative, which suggests that for those countries, on average, trade occurs in industries with comparative disadvantage. This table indicates that, in general, countries are less well aligned with comparative advantage than originally suggested by the Balassa measure. Figure 15 in the Appendix shows the distribution of this alternative measure by year, pooling all the countries and industries together. The figure displays a drastic change in the distribution between 1983 and 1984, where it becomes more dispersed.

Table 7: Using Hanson et al. (2014) measure of comparative advantage

Dependent variable	log exports$_{ict,US}$			
	(1)	(2)	(3)	(4)
Hurricane$_{ct}$	0.062		0.59***	−1.04
	(0.45)		(0.18)	(0.64)
Hanson$_{ic(t-1)}$		0.77***	0.77***	0.76***
		(0.030)	(0.030)	(0.030)
Hanson$_{ic(t-1)}$*Hurricane$_{ct}$				1.17***
				(0.29)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes
Observations	68325	68325	68325	68325
R^2	0.54	0.70	0.70	0.70

Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.

4.3.3 Islands and isolated episodes

This paper uses data aggregated at the industry-country level. For this reason, one would expect the baseline results to be driven by countries for which hurricanes are not limited to coastal areas but instead hit regions that represent a larger fraction of aggregate exports. Regional data on exports disaggregated at a the industry level are hardly, if not, available. Nevertheless, one indirect way of testing this hypothesis consists in running the baseline specification on a sample made up of islands and another one that includes continental countries only. In columns 1 to 3 of Table 8, the paper compares the baseline estimates with those obtained when restricting the sample to islands versus continental countries. Results suggest that the baseline estimates are indeed identified by a sub-sample of small countries for which the affected geographical areas presumably represent an important proportion of production. This findings do not mean that there are no effects of hurricanes on exports in continental countries but rather suggests that in those countries the affected areas do not represent a fraction of aggregate production that is sufficiently large to identify an effect.

The last two columns of the same table restrict the sample to countries with isolated versus frequent episodes of hurricanes. One is more likely to have a proper natural experiment and would expect larger effects in countries subject to more isolated hurricanes. For instance, countries that are hit by frequent episodes may be better prepared, have more solid infrastructures and be therefore less affected by hurricanes. Or alternatively, one could expect weaker effects in those countries because firms do not have time to adopt inefficient production structures and are constantly on an adjustment path.

To test this hypothesis, the paper separates countries with isolated from those with frequent episodes. The first sample of countries is selected as follows. A country belongs to the first sample if it only experienced one or multiple isolated episode(s) of hurricanes over the period 1980-2000, and to the second sample otherwise. An isolated episode is defined as one or multiple hurricane(s) within a time window of three years, preceded and followed by three years without hurricanes. This choice of three years is based on Yang (2008) and on the estimates of the dynamic specification obtained in the next subsection, according to which most of the adjustment takes place within three years in the aftermath of a hurricane. That way, by leaving a window of three years before and after an episode (i.e. six years between two episodes), a country has time to adjust back to its new steady state. According to these selection criteria, the paper retains 17 countries: *Bermuda, Comoros, Dominican Republic, El Salvador, France, Haiti, Hong Kong, Indonesia, Irland, Jamaica, New Zealand, Nicaragua, Saint Kitts and Nevis, Sri Lanka, Trinidad and Tobago, Thailand, United Kingdom.* The same list of countries will be used later on for the event study analysis. Results suggest that the baseline estimates are indeed driven by countries with isolated episodes of hurricanes. For countries with successive hurricanes, the coefficients of interest have the expected signs but are smaller in magnitude and statistically insignificant, suggesting that in those countries the reallocation potential induced by one additional hurricane episode is muted and more difficult to detect.

Table 8: Islands and isolated episodes

Dependent variable	log exports$_{ict,US}$				
		Islands / continental countries		**Countries with isolated / frequent episodes**	
	(1) All sample	(2) Islands	(3) Continent	(4) Isolated	(5) Frequent
Hurricane$_{ct}$	−3.59***	−3.73***	0.19	−4.82***	−1.57
	(1.00)	(1.05)	(5.63)	(1.25)	(1.47)
Balassa$_{ic(t-1)}$	0.89***	0.83***	0.90***	0.88***	0.88***
	(0.016)	(0.034)	(0.018)	(0.032)	(0.017)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$	0.89***	0.87***	0.21	1.20***	0.54
	(0.22)	(0.28)	(1.12)	(0.31)	(0.34)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes	yes
Observations	68325	13737	54588	34387	33938
R^2	0.78	0.83	0.78	0.80	0.81

Notes: Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.

4.4 Dynamics

4.4.1 Dynamic specification

Reallocating resources and reorganizing production can take time. Yang (2008) shows that the bulk of the adjustment in the aftermath of a hurricane occurs within three years. To evaluate the dynamics of the adjustment this paper also runs a series of dynamic specifications including up to three lags of the three variables of interest.

Table 9 reports results for these dynamic specifications. Column (1) corresponds to the static specification and columns (2), (3) and (4) show the results obtained with one lag, two and three lags. The estimates obtained in column (4) suggest that the results in column (1) capture effects that extend over several years. As can be seen, the current period estimates remain statistically significant at the 5% level at least but become smaller in magnitude. Over the years the coefficients on the hurricane index stays negative and both the Balassa measure and the interaction term remain positive.

To evaluate the dynamics of the adjustment, these estimates are used to compute the cumulative effects one, two and three years after the hurricane strike. These cumulative effects are shown at the bottom of Table 9. The magnitude of the estimate on the hurricane measure grows over time, from around -2 to -6. This is also the case for the coefficient on the interaction term which increases from 0.6 to 1.7. These results therefore suggest that the reallocation of resources towards comparative advantage industries is a dynamic process that intensifies over a three-years period of time.

Figure 6 presents a visual representation of this process. The y-axis of the contour plot shows the number of years after the hurricane strike. Comparative advantage is shown on the x-axis and the spectrum of colors captures the cumulative marginal effects. Bluish colors indicate a negative effects and redish colours represent positive effects. As for the static specification, whichever year one looks at, exports are affected negatively at the bottom of the comparative advantage distribution and positively at the top, indicating a reorganization of exports towards the upper tail of the distribution. The evolution of the spectrum of colors over the years informs on the dynamics of the adjustment. The patch of intense blue in the top left corner and red in the top right corner suggest that the reallocation of resources becomes stronger over the years. The histogram of the distribution of comparative advantage reported at the bottom of the figure shows that the strong effects observed in the third year that follows the hurricane strike only affect industries at the tails of the distribution.

Finally, to gain a better understanding of what is happening to industries located at different points of the distribution of comparative advantage, Figure 7 plots the evolution of the cumulative marginal effects over the years at different percentiles of the distribution. The figure tells us that the reorganization really occurs at the bottom and top quartile of the distribution, while industries in the middle of the distribution are only minimally affected.

Consistent with Figure 5 which shows that industries at both extremes of the distribution respond more abruptly, these findings suggest that the reallocation of resources towards to upper tail of the distribution is driven by far-reaching changes for firms in the most inefficient industries.

Table 9: Dynamic specification

	(1)	(2)	(3)	(4)
Hurricane_{ct}	-3.59***	-3.17***	-2.38**	-1.90**
	(1.00)	(1.17)	(0.97)	(0.83)
$\text{Balassa}_{ic(t-1)}$	0.89***	0.71***	0.69***	0.69***
	(0.016)	(0.024)	(0.025)	(0.028)
$\text{Balassa}_{ic(t-1)}$*Hurricane_{ct}	0.89***	0.82***	0.66***	0.56***
	(0.22)	(0.24)	(0.20)	(0.20)
$\text{Hurricane}_{c(t-1)}$		-1.55	-1.04	-0.34
		(1.09)	(1.10)	(0.93)
$\text{Balassa}_{ic(t-2)}$		0.19***	0.087***	0.080***
		(0.024)	(0.010)	(0.010)
$\text{Balassa}_{ic(t-2)}$*$\text{Hurricane}_{c(t-1)}$		0.51**	0.42*	0.29
		(0.22)	(0.23)	(0.22)
$\text{Hurricane}_{c(t-2)}$			-2.42***	-2.11***
			(0.72)	(0.67)
$\text{Balassa}_{ic(t-3)}$			0.13***	0.048***
			(0.023)	(0.011)
$\text{Balassa}_{ic(t-3)}$*$\text{Hurricane}_{c(t-2)}$			0.58***	0.49***
			(0.15)	(0.15)
$\text{Hurricane}_{c(t-3)}$				-1.84**
				(0.88)
$\text{Balassa}_{ic(t-4)}$				0.11***
				(0.025)
$\text{Balassa}_{ic(t-4)}$*$\text{Hurricane}_{c(t-3)}$				0.31**
				(0.15)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes
Cumulative effects after :				
One year				
Hurricane		-4.726**	-3.427*	-2.232
		[0.035]	[0.095]	[0.195]
Balassa		0.900***	0.780***	0.771***
		[0.000]	[0.000]	[0.000]
Balassa*Hurricane		1.324***	1.077**	0.851**
		[0.004]	[0.012]	[0.039]
Two years				
Hurricane			-5.850**	-4.343*
			[0.029]	[0.060]
Balassa			0.914***	0.819***
			[0.000]	[0.000]
Balassa*Hurricane			1.655***	1.344**
			[0.002]	[0.011]
Three years				
Hurricane				-6.180**
				[0.010]
Balassa				0.932***
				[0.000]
Balassa*Hurricane				1.658***
				[0.004]
Observations	68325	65475	62595	59621
R^2	0.78	0.78	0.78	0.78

Notes: Standard errors, in parentheses, are clustered at the country level. p-values in brackets. (***) denotes significance at the 1% level, (**) at the 5% level and (*) at the 10% level. The dependent variable is sitc4 export towards the US for 1980-2000.

Figure 6: Marginal effects one to three years after the hurricane

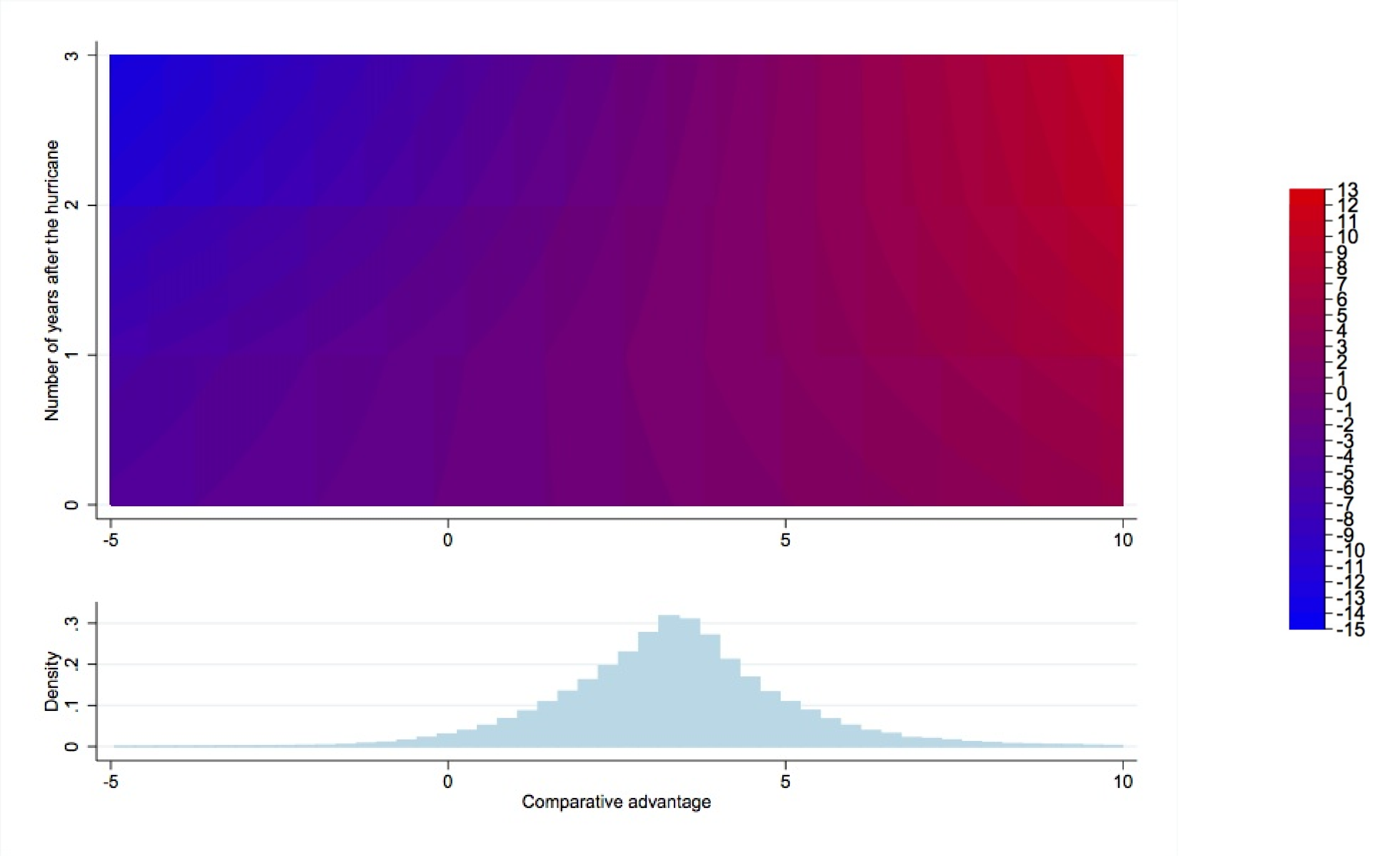
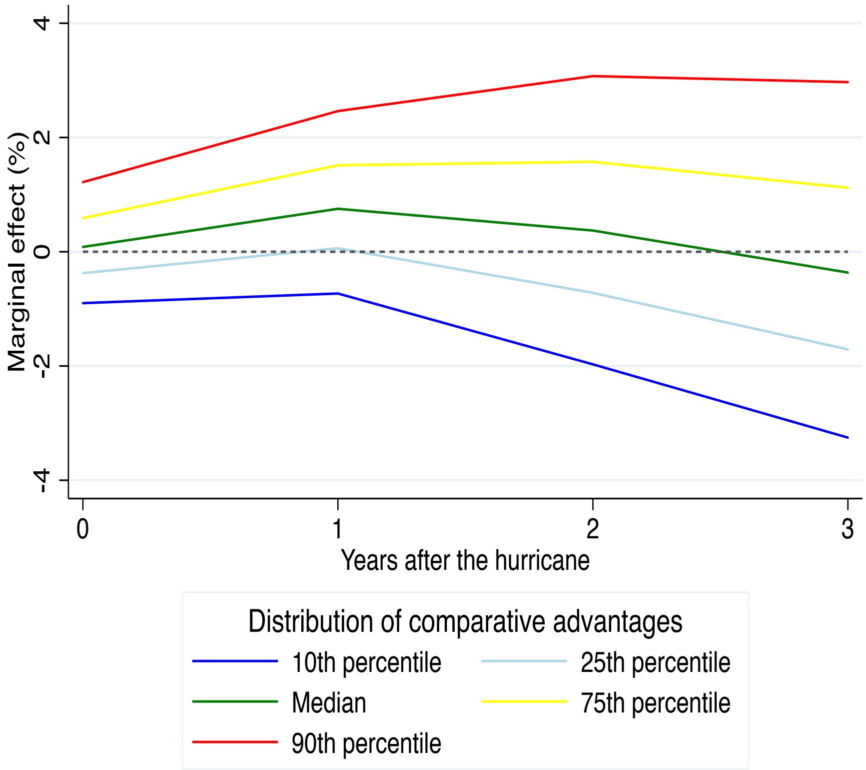


Figure 7: Marginal effects after one to three years after the hurricane



4.4.2 Event study

This subsection proposes an exercise similar to that performed in Subsection 4.3.3 and evaluates the dynamics of the adjustment for countries which experienced isolated episodes of hurricanes. As in Subsection 4.3.3, one would expect the long-term effects to be more pronounced in countries with isolated hurricanes. To evaluate whether this is indeed the case, the paper adopts an event study methodology similar to that of Trefler (2004) and Manova (2008).

Trefler (2004) investigates the long-term effects of the Canada-U.S. Free Trade Agreement on various indicators of the Canadian economy. Manova (2008) applies the same methodology to study the impact of financial liberalization on trade flows. The main difference between the approach used in this paper and that used in Trefler (2004) and Manova (2008) resides in the definition of an event. While trade or financial liberalizations are one-time occurrences, hurricanes are repeated phenomena and thus, a country may experience more than one unique event over the period of time under consideration. In this paper, an event is defined in the exact same way as isolated episodes are defined in Subsection 4.3.3: an event consists of one or multiple hurricane(s) within a time window of three years, preceded and followed by three years without hurricanes. Table 10 lists the countries considered in the event study, the number of events in each country and the date of each event.

Table 10: Events

Country	**Number of events**	**Event 1**	**Event 2**
Bermuda	1	1995	-
Comoros	2	1983	1996
Dominican Republic	1	1987	-
El Salvador	2	1988	1996
France	1	1993-1995	-
Haiti	1	1987-1988	-
Hong Kong	1	1983	-
Indonesia	1	1983	-
Irland	2	1986	1996
Jamaica	1	1988	-
New Zealand	1	1996-1997	-
Nicaragua	1	1996	-
Saint Kitts and Nevis	1	1989	-
Sri Lanka	1	1992	-
Trinidad and Tobago	1	1993	-
Thailand	1	1985	-
United Kingdom	2	1986	1995-1996

The event study approach consists in estimating the following equation:

$$\Delta \log \overline{X}_{ic\tau,US} = \delta \Delta \overline{H}_{c\tau} + \zeta \Delta \overline{CA}_{ic\tau} + \eta \Delta (\overline{H}_{c\tau} * \overline{CA}_{ic\tau}) + \Delta \upsilon_{ic\tau}, \tag{9}$$

where δ and η capture the long-term effects the paper seeks to estimate and $\Delta\upsilon_{ic\tau}$ is the error term. Since identification is achieved using a first-difference estimation, one advantage of the event study over a panel approach is that it allows one to remove all industry-country-specific unobservable effects that may interfere with the estimate of interest. τ denotes the three-years time window before and after the event and bars denote an average over the time window τ. Thus, if $\tau = 1$ ($\tau = 0$) after (before) the event, then $\Delta \log \overline{X}_{ic\tau,US} = \log \overline{X}_{ic1,US} - \log \overline{X}_{ic0,US}$, where $\overline{X}_{ic1,US}$ ($\overline{X}_{ic0,US}$) is the average of exports of industry i in country c taken over the three years following (preceding) the event. Similarly, $\Delta\overline{CA}_{ic\tau} = \overline{CA}_{ic1} - \overline{CA}_{ic0}$, where $\overline{CA}_{ic1}$ ($\overline{CA}_{ic0}$) is the average of the Balassa measure of comparative advantage taken over the three years following (preceding) the event. Finally, $\Delta\overline{H}_{c\tau} = \overline{H}_{c1} - 0$, where $\overline{H}_{c1}$ measures the average of the hurricane index taken over the year(s) of the event. For example, in the case of New Zealand, $\Delta\overline{H}_{c\tau}$ is given by the average of the hurricane index over the years 1996-1997.

Results are shown in Table 11.[25] The first column shows the baseline estimates, the second one shows the cumulative effects three years after the hurricane strikes and the last column presents the estimates obtained using an event study approach. The estimates obtained in the event study confirm the results of the previous subsection. The coefficient on the interaction term is statistically significant at the 1% level and remarkably similar to the one obtained from the dynamic specification (1.57 versus 1.66). The coefficient on the hurricane index stays negative and highly statistically significant, yet its magnitude double in the event study specification. This larger value can be explained by at least two factors. First, the vast majority of the event study countries (see table 10) are island or other small countries where the destructive potential of hurricanes is the largest. Second, by virtue of the event study methodology, these countries experience hurricanes only sporadically. Consequently, these countries are unlikely to be adjusting to a previous hurricane at the time of the event and are more prone to larger effects. As for the Balasa index, it is not statistically significant anymore. Overall, this alternative way of investigating the long term impact of a hurricane strike confirms the results obtained in the previous subsection and suggests that the effects of interest become stronger as time passes and reconstruction gets underway.

[25] Controlling for alternative mechanisms such as economic growth, changes in the exchange rate, financial flows or transport infrastructures does not alter the estimates obtained in the event study.

Table 11: Event study

Dependent variable	log exports$_{ict,US}$		
	(1)	(2)	(3)
	Baseline	Cumulative effects after three years	Event study
Hurricane$_{ct}$	-3.59^{***}	-6.180^{**}	-14.2^{***}
	(1.00)	[0.010]	(3.66)
Balassa$_{ic(t-1)}$	0.89^{***}	0.932^{***}	-0.000014
	(0.016)	[0.000]	(0.000075)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$	0.89^{***}	1.658^{***}	1.57^{***}
	(0.22)	[0.004]	(0.46)
Industry, country and year dummies; Industry and country trends	yes	yes	NA
Observations	68325	59621	2180
R^2	0.78	0.78	0.015

Notes: Standard errors, in parentheses, are clustered at the country level. p-values in brackets. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.

5 Conclusion

This paper uses hurricanes to evaluate whether an exogenous shock on existing physical capital leads to a reorganization of exports towards comparative advantage industries. Our results suggest that hurricanes lead to monotone changes in export levels by comparative advantage percentiles. In particular, the marginal and total effects of hurricanes on exports are monotonically increasing in comparative advantage, with export levels decreasing at the bottom of the comparative advantage distribution and increasing at the upper tail of the distribution. We also find that industries at both extremes of the distribution respond more abruptly, while industries in the middle of the distribution are only minimally affected. These results are robust to a series of possible alternative mechanisms and alternate definition of comparative advantage. Finally, results from a dynamic specification show that the effects of hurricanes on exports are not temporary but that the process of shifting resources towards comparative advantage industries intensifies over the three-years period following a hurricane. This dynamic impact is consistent with a time-consuming reconstruction process.

This paper also contributes to the literature on multiple equilibria. Our results are of particular interest in light of the results of Davis & Weinstein (2002, 2008). While Japanese cities converged back to the same equilibrium after the heavy bombings suffered during WWII, the countries in our sample seem to converge towards a new equilibrium, at least in terms of export mix, in the aftermath of a hurricane. The paper also relates to the literature on the within-country effects of extreme weather events. A large body of research studies the impact of hurricanes on, inter alia, economic growth, international financial flows, real estate markets and labor markets. This paper adds to this literature by looking at the impact of hurricanes on export patterns, a dimension that has been understudied to date. Finally, hurricanes, by virtue of their randomness, can serve the purpose of overcoming the endogeneity concerns that often plague the assessment of whether widespread adjustment policies are successful in encouraging comparative-advantage-based trade. The comparison of hurricanes to widespread adjustment policies hinges on the premise that, by destroying existing capital, hurricanes reduce the cost of adjusting to the dynamics of comparative advantage.

To conclude, one possible interpretation of our main findings is that the reallocation of resources towards comparative advantage industries is driven by drastic changes for firms in the most inefficient industries. That is, when capital is destroyed and firms are given the opportunity for reconstruction, firms at the bottom of the distribution undertake important changes and invest in modes of production or industries that are considerably more efficient or at least, in industries that have achieved great export success. Thus, if the opportunity arises, firms do not stick to an inefficient production but instead tend to reinvest and move up the ladder of comparative advantage. In other words, our results are consistent with a build-back better mechanism and Schumpetarian creative destruction.

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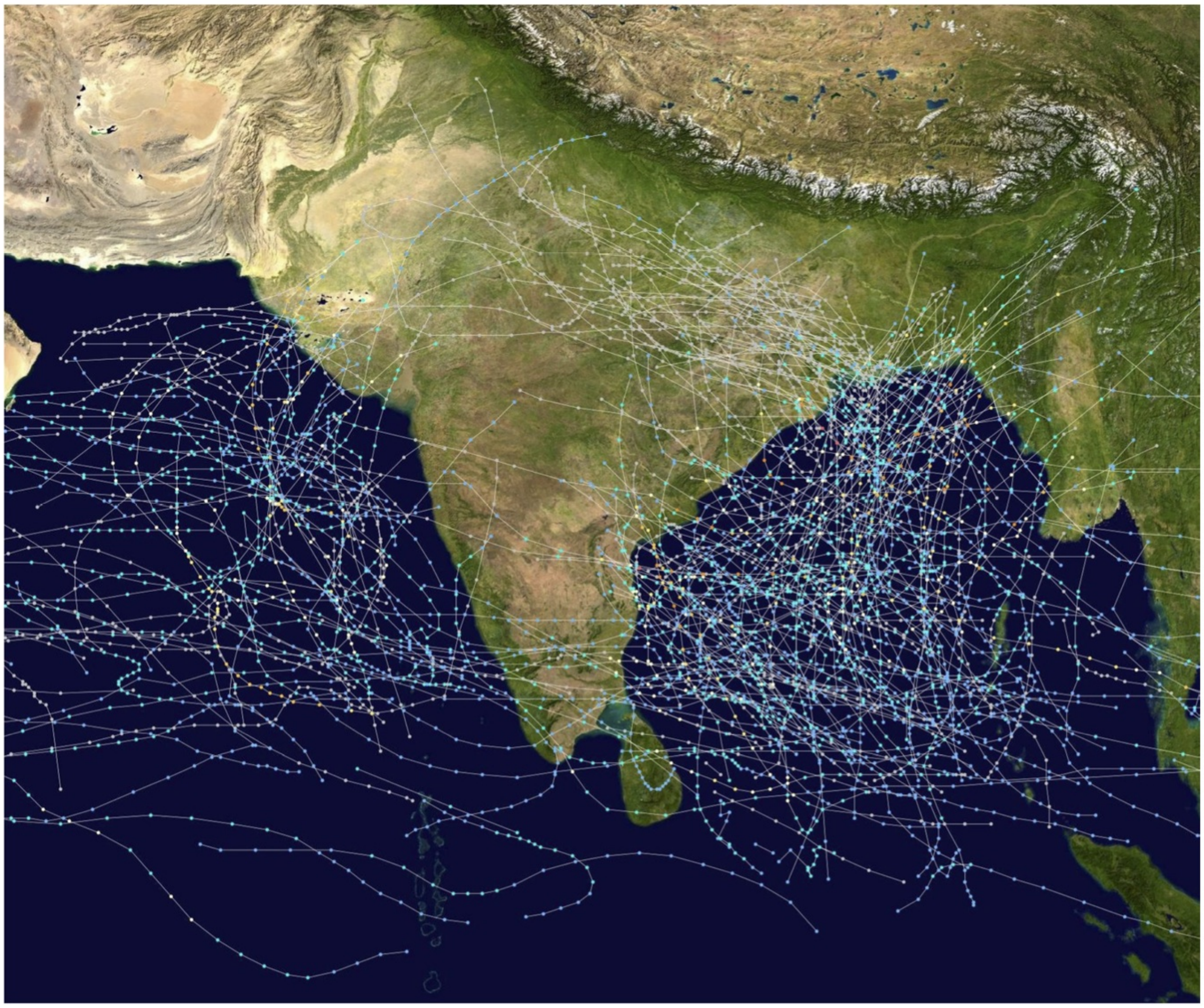
Appendix

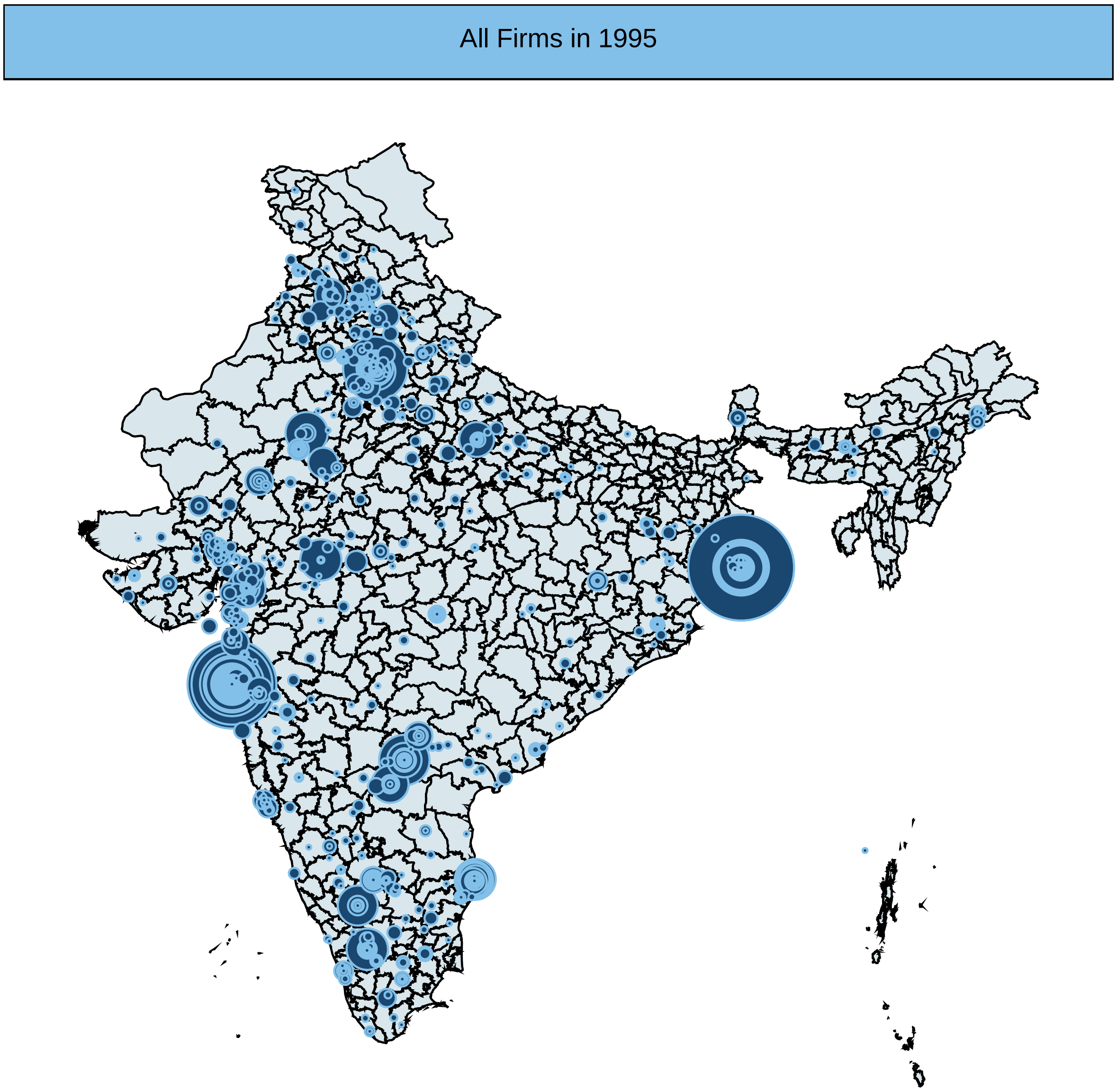
Figures

Figure 8: India best tracks, 1970-2005



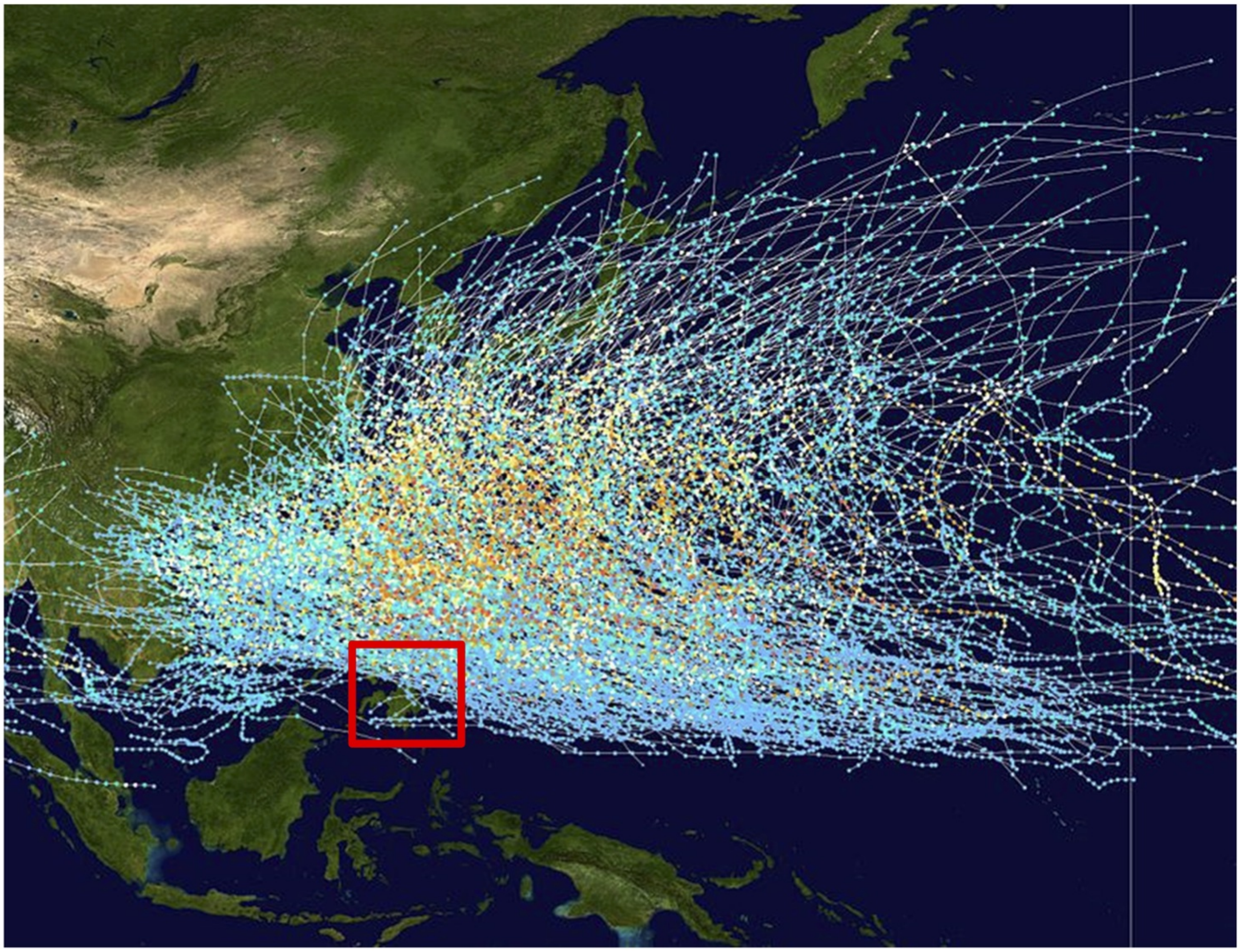
Notes: The figure shows the tracks of all tropical cyclones over India between 1970 and 2005. Source: National Hurricane Center (NOAA).

Figure 9: India firms' location, 1995



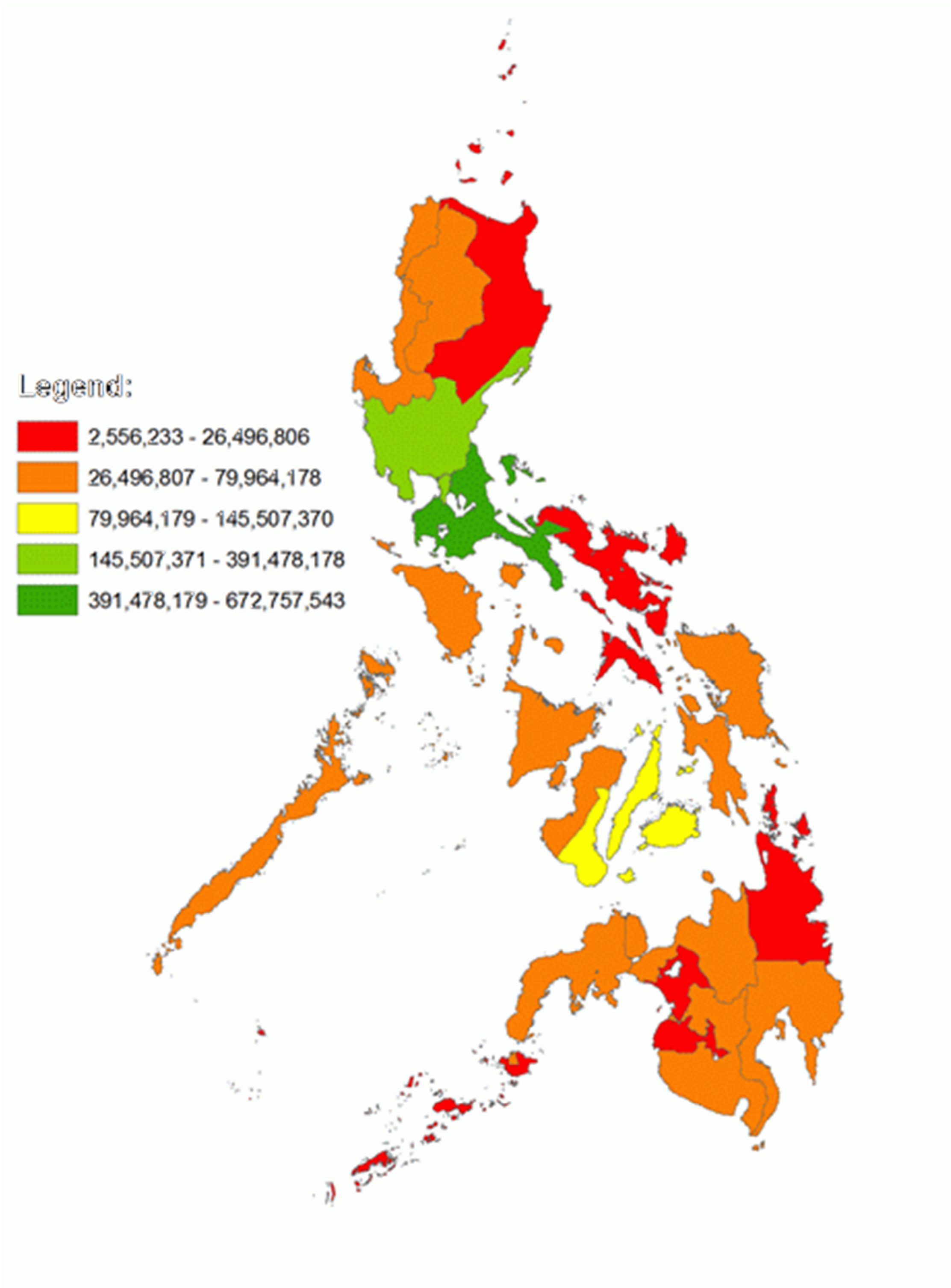
Notes: The figure shows the location of firms included in the PROWESS database for 1995. The diameter of the circles is proportional to the number of firms in a given PIN code (the equivalent of an Indian ZIP code). Source: PROWESS and authors calculations.

Figure 10: Northwestern Pacific Ocean best tracks, 1980-2005



Notes: The figure shows the tracks of all tropical cyclones in the northernwestern Pacific Ocean between 1980 and 2005. The vertical line to the right is the International Date Line. Source: National Hurricane Center (NOAA).

Figure 11: Philippines gross value added in the manufacturing sector, 2012



Source: http://www.nscb.gov.ph/grdp/2012/dataCharts/default.asp.

Figure 12: Distribution of the Balassa measure of comparative advantage

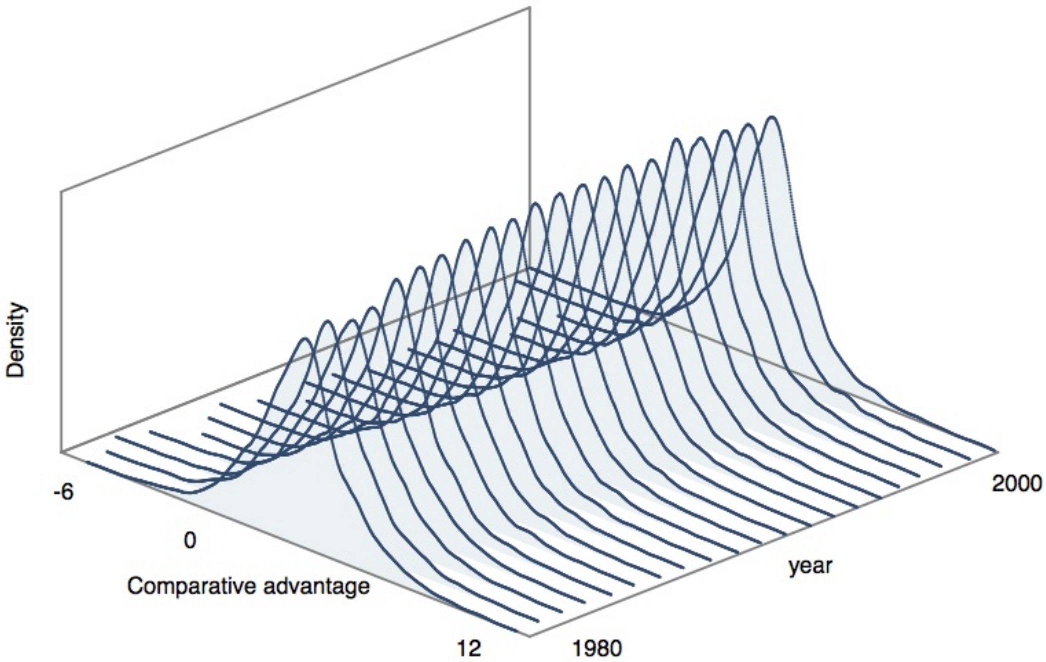


Figure 13: Total effects

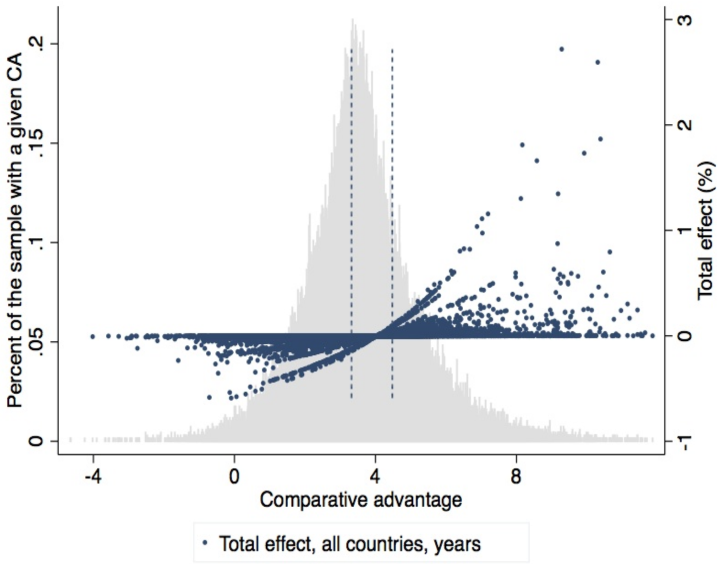


Figure 14: Total effects for Hong Kong

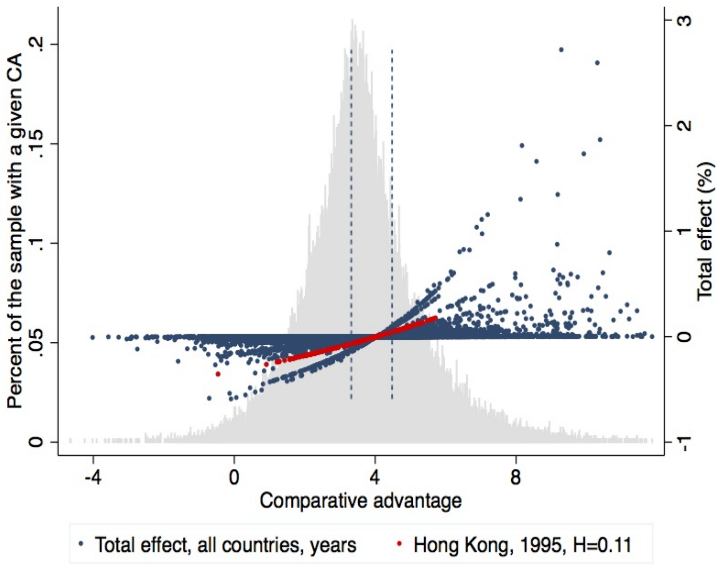
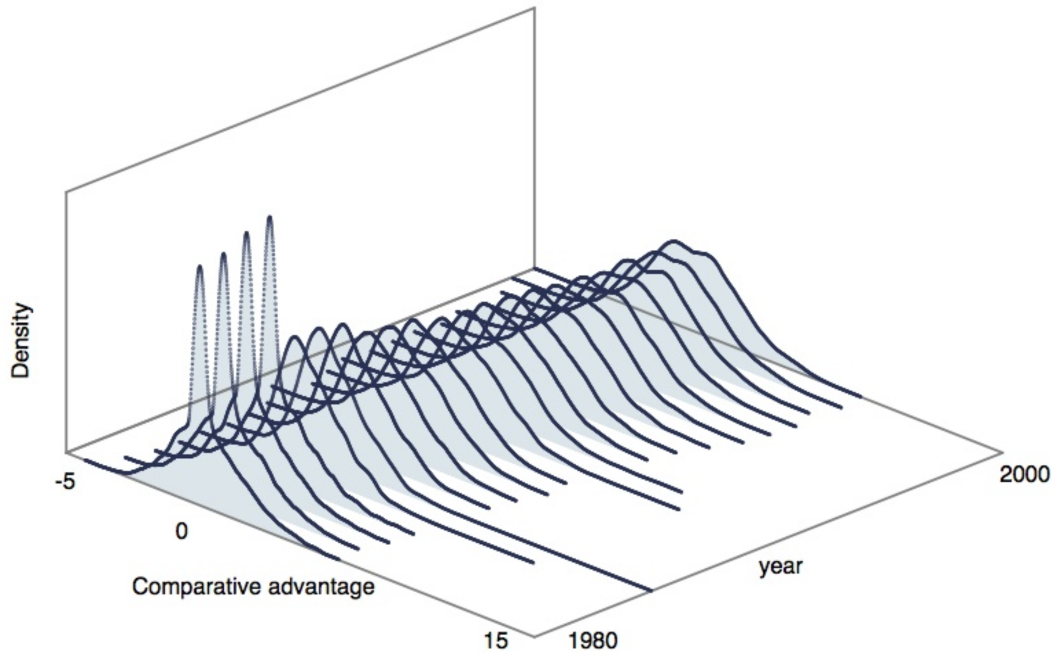


Figure 15: Distribution of Hanson et al. (2014) measure of comparative advantage



Tables

Table 12: Isocodes

Country	**Isocode**	**Country**	**Isocode**
Bahamas	BHS	Malaysia	MYS
Bangladesh	BGD	Mauritius	MUS
Barbados	BRB	Mexico	MEX
Bermuda	BMU	Myanmar	MMR
China	CHN	New Caledonia	NCL
Colombia	COL	New Zealand	NZL
Comoros	COM	Nicaragua	NIC
Costa Rica	CRI	Oman	OMN
Cuba	CUB	Pakistan	PAK
Dominican Republic	DOM	Philippines	PHL
El Salvador	SLV	Portugal	PRT
Fiji	FJI	Republic of Korea	KOR
France	FRA	Russia	RUS
Guatemala	GTM	Saint Kitts and Nevis	KNA
Haiti	HTI	Saudi Arabia	SAU
Honduras	HND	Spain	ESP
Hong Kong	HKG	Sri Lanka	LKA
Iceland	ISL	Thailand	THA
India	IND	Trinidad and Tobago	TTO
Indonesia	IDN	United Kingdom	GBR
Ireland	IRL	Venezuela	VEN
Jamaica	JAM	Vietnam	VNM
Madagascar	MDG	Zimbabwe	ZWE

Table 13: Share of manufacturing exports in total exports and of manufacture production in GDP, by country over the period 1980-2000.

	Manufacturing exports over total exports				**Manufacturing over GDP**			
Country	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
All 46 countries	48.94	28.35	0.69	98.42	17.28	7.53	0.4	40.5
Bahamas	53.5	27.2	8.5	80.4	*NA*	*NA*	*NA*	*NA*
Bangladesh	76.2	12.8	57.8	91.8	14.4	1.0	12.8	16.2
Barbados	63.8	12.1	45.1	84.7	10.0	1.5	6.4	12.7
Bermuda	67.9	25.2	29.8	98.4	*NA*	*NA*	*NA*	*NA*
China	73.3	17.4	48.6	92.3	34.5	2.2	31.6	40.5
Colombia	23.3	5.8	12.9	30.8	19.6	3.1	14.8	23.9
Comoros	22.5	20.5	8.7	81.5	4.0	1.0	0.4	6.0
Costa Rica	33.8	12.5	17.3	61.7	23.5	1.8	21.1	29
Cuba	15.4	5.0	2.7	25.8	37.1	1.1	35.6	38.7
Dominican Republic	63.6	20.8	32.4	90.4	16.6	2.3	12.1	18.9
El Salvador	40.5	22.7	9.2	81.5	23.3	0.9	22.1	24.7
Fiji	21.0	15.1	4.8	47.8	12.4	2.0	9.2	15.1
France	82.0	2.3	77.9	86.7	16.1	0.1	16	16.1
Guatemala	27.7	13.9	5.5	49.6	14.9	1.0	13.2	16.6
Haiti	79.1	7.1	63.3	89.2	12.8	3.8	9.0	20
Honduras	32.7	23.8	9.9	75.1	16.5	1.8	14.3	19.6
Hong Kong	93.5	3.5	81.2	95.4	14.8	6.9	5.3	23.4
India	68.2	10.1	49.8	80.2	16.4	0.7	14.8	17.9
Indonesia	35.8	20.8	4.9	61.8	19.9	5.2	11.9	27.7
Iceland	23.2	3.4	17.3	31.2	15.0	1.2	14.0	16.4
Ireland	71.7	8.3	57.8	87.8	31.8	2.2	29.0	34.3
Jamaica	39.1	9.3	14.9	52.7	15.3	1.4	13.7	17.2
Madagascar	19.3	13.7	5.7	46.3	10.8	1.3	7.9	12.9
Mexico	59.2	20.8	24.3	83.6	21.7	1.8	18.7	26.4
Myanmar	19.0	12.5	7	55	7.9	1.3	6.2	9.9
Mauritius	57.7	15.7	25.1	74.8	21.9	3.4	15.7	25.5
Malaysia	61.9	18.9	37.4	86.8	24.2	4.2	19.1	32.6
New Caledonia	66.8	4.4	58.6	74.1	4.5	0.3	4.0	4.8
New Zealand	28.2	3.8	23	34.6	18.7	1.5	16.6	22.1
Nicaragua	15.3	15.9	0.7	44.8	17.8	0.9	16.4	18.9
Oman	8.9	6.3	2.2	24	3.4	1.2	0.6	5.4
Pakistan	71.5	12.1	49.6	86	16.1	0.7	14.7	17.4
Philippines	70.3	14.8	43.7	91.6	24.1	1.3	21.6	25.7
Portugal	83.5	4.2	75.3	89.2	18.4	0.7	17.1	19.2
Republic of Korea	91.5	1.4	87.8	93.2	27.4	1.6	24.4	30.7
Russia	30.4	9.2	15.5	46.8	*NA*	*NA*	*NA*	*NA*
Saint Kitts and Nevis	40.5	12.9	23.1	65.4	12.4	1.9	9.9	15.4
Saudi Arabia	6.6	3.8	0.8	13.9	8.4	1.9	4.1	10.6
Spain	77.8	2.9	73.6	81.9	18.6	-	18.6	18.6
Sri Lanka	61.5	22.4	19.7	84.3	15.6	0.9	14	17.7
Thailand	57.6	16.5	32.4	78.1	26.8	3.9	21.3	33.6
Trinidad and Tobago	31.5	18.1	4.6	60	9.6	1.9	7.3	14.0
United Kingdom	78.1	6.6	65.8	85	22.7	2.4	17.9	26.5
Venezuela	13.7	6.1	4.8	23.6	17.2	2.5	13.6	23.2
Vietnam	28.7	19.1	7.3	55.5	16.9	3.0	12.3	22.4
Zimbabwe	63.8	5.3	49.3	73.3	21.5	3.4	15.8	29.5

Note: Source: World Bank Development Indicators 2009 and NBER United Nations trade data. For manufacturing over GDP, the summary statistics are computed over available years for the period 1980-2000. Missing means no data were available.

Table 14: Summary statistics of comparative advantage measures, by country over the period 1980-2000.

	Log Balassa				Hanson et al.				
Country	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
All	3.3	1.7	-5.9	12.1	1.2	1.7	-5.5	15.0	105,183
Bahamas	6.9	2.3	-1.7	10.3	-0.4	1.5	-4.8	2.6	105
Bangladesh	7	2.6	1.6	11.9	1	1.4	-1.5	5.2	210
Barbados	7.8	1.4	5.2	10.5	-0.7	0.9	-2.7	1.4	63
Bermuda	7.3	1.1	4.5	9.4	-1.3	0.8	-2.8	0.4	63
China	3.3	1.7	-4.9	7.7	2.3	1.8	-3.2	8.5	6153
Colombia	4.6	1.5	-3	9.1	0.3	1.2	-3.5	4.8	1911
Comoros	10.9	0.6	9.7	11.6	-0.3	0.6	-1.4	0.7	21
Costa Rica	5.3	1.7	-0.5	10.2	-0.5	1	-3.4	4.1	462
Cuba	7.6	2.5	4.2	12.1	0.3	1.3	-2.5	3.5	84
Dominican Republic	4.9	2.1	-3.2	9.6	-0.5	1.4	-3.7	4.5	672
El Salvador	6.3	1.3	3.6	8.2	-0.9	0.9	-2.7	1.3	147
Fiji	10.1	1	7.2	11.6	0.6	1	-1.2	3.6	42
France	3.2	0.9	-2.6	6.1	2.2	1.4	-1.7	7.3	9702
Guatemala	7	1.4	2.3	9.4	-0.7	1	-2.7	3.3	189
Haiti	5.7	1.5	0.4	9.1	-0.9	1.3	-5.5	1.5	315
Honduras	7.1	1.8	1.6	10.2	0	1.1	-2.6	3.5	252
Hong Kong	3	1.7	-5.1	7.2	1.5	1.6	-2.9	6.3	5544
Iceland	5.7	2.3	-1.3	10.9	-0.5	1.5	-5.4	4.1	252
India	3.2	1.8	-5.1	8.4	1.1	1.5	-2.2	7.2	4872
Indonesia	4	2	-5.1	9	2	1.9	-2.4	7.5	1827
Ireland	3	1.6	-3.5	7.2	-0.5	1.3	-4.9	5.5	5187
Jamaica	6.8	1.8	1.7	10.1	0	1.4	-3.7	4.1	147
Madagascar	8.4	1.4	5.5	11	1.3	1.2	-1.4	3.6	84
Malaysia	2.7	1.7	-4.6	8.5	0.9	1.7	-3.4	8.1	4263
Mauritius	6	1.2	3.5	9.5	0.1	1.1	-2.4	3.4	231
Mexico	3	1.5	-4.2	7.6	0.8	1.2	-3.2	5.8	5775
Myanmar	8.1	1.8	4.5	11.2	-0.5	1.5	-3.1	2.3	63
New Caledonia	7.1	2.9	-0.2	10.7	1.8	1.8	-1.4	5.2	84
New Zealand	3.8	1.4	-1.9	8.2	0.8	1	-2.1	4.7	3108
Nicaragua	10.9	0.4	10.1	11.6	1.2	5	-3.4	15	21
Oman	5.5	1.6	1.1	8.6	0.2	1.3	-3	3.8	84
Pakistan	4.1	2.1	-1.1	8.6	1	1.6	-3.2	6.1	1176
Philippines	3.4	1.9	-4.1	9.3	0.7	1.5	-3.9	6.4	2625
Portugal	3.3	1.5	-5.5	9	0.2	1.2	-4.1	4.8	4158
Republic of Korea	2.9	1.6	-5.9	6.9	1.8	1.6	-2.7	8.8	6930
Russia	2.9	1.8	-4.4	7.9	1.3	2	-3.3	10.9	1947
Saint Kitts and Nevis	6.3	0.9	4	8.8	-1.6	1	-4.9	0.3	105
Saudi Arabia	3.5	2.1	-3.4	8.8	-0.3	1.2	-4	5.1	861
Spain	3.2	1.1	-4.6	7	1.2	1.1	-2.1	6.4	7140
Sri Lanka	5.3	1.7	-0.6	9.2	0.9	1.2	-3.4	4.4	819
Thailand	3.8	1.5	-2.8	8.3	1.5	1.6	-2.8	7.5	3318
Trinidad and Tobago	6.3	2.2	-0.6	9.4	0.2	1.1	-3.3	2.8	189
United Kingdom	3.2	0.9	-5.5	6.3	2.4	1.4	-2.3	7.7	10059
Venezuela	3.6	2.1	-4.7	9.3	0.7	1.7	-3.4	7.3	1281
Vietnam	7.3	1.9	0.7	10	0.9	1.4	-2.4	5.1	147
Zimbabwe	5.9	2.3	-2.8	9.5	-0.4	1.5	-3.8	3.6	168

Table 15: Share of US exports in total exports, by country over the period 1980-2000.

Country	**Mean**	**Std. Dev.**	**Min.**	**Max.**
All 46 countries	27.72	24.11	0	91.98
Bahamas	50.1	18.7	25.2	86.9
Bangladesh	31.3	9.7	11.6	41
Barbados	48.1	18.1	24	86.4
Bermuda	9.1	8.2	0.9	25.6
China	17.7	5.6	6.8	27.0
Colombia	38.8	6.8	26.0	51.1
Comoros	9.2	6.9	1.7	31.9
Costa Rica	54.7	8.4	34.1	63.6
Cuba	0.0	0.0	0.0	0.2
Dominican Republic	81.4	12.2	48.9	91.3
El Salvador	60.9	14.2	30.8	84.9
Fiji	12.5	6.0	4.1	27.9
France	7.4	1.3	5.0	10.3
Guatemala	57.6	15.0	24.4	74.4
Haiti	82.6	5.8	70.1	92
Honduras	63.1	11.3	48.8	84
Hong Kong	26.9	8.7	17.9	44.6
India	20.8	4.1	15.7	34.5
Indonesia	17.9	4.4	11.1	27.9
Iceland	17.9	6.6	10.6	30.6
Ireland	9.6	3.6	4.8	20.9
Jamaica	45.7	5.8	35.6	58.8
Madagascar	14.7	4.9	5.2	23
Malaysia	17.8	3.1	13.6	23.1
Mauritius	14.5	3.8	5.6	20.1
Mexico	74.1	6.4	61.8	83.2
Myanmar	7.3	6.8	2.0	29.4
New Caledonia	8.3	1.9	5.7	13.1
New Zealand	13.5	1.7	10.4	17.4
Nicaragua	35.0	26.2	0.0	72.1
Oman	4.8	3.3	1.0	12.3
Pakistan	13.1	5.3	5.1	25.3
Philippines	35.7	3.6	27.7	42.1
Portugal	6.1	1.6	3.7	10.0
Republic of Korea	28.8	8.5	18.1	45.4
Russia	3.2	2.4	0.9	7.6
Saint Kitts and Nevis	21.8	5.7	15.7	39.5
Saudi Arabia	12.6	3.3	3.7	17.7
Spain	6.8	2.1	4.6	11.1
Sri Lanka	32.2	10.0	11.5	45.9
Thailand	20.2	3.7	12.6	24.1
Trinidad and Tobago	67.0	7.0	52.2	78.9
United Kingdom	12.8	1.8	9.5	15.4
Venezuela	50.3	8.2	32.5	58.6
Vietnam	1.5	2.5	0.0	6.5
Zimbabwe	9.5	2.7	6.5	17.2

Note: Source: NBER United Nations trade data.

Table 16: Dropping extreme values

Dependent variable	log exports$_{ict,US}$						
	All (1)	<5p (2)	<10p (3)	>90p (4)	>95p (5)	<5p, >95p (6)	<10p, >90p (7)
Hurricane$_{ct}$	-3.59^{***}	-4.08^{***}	-4.03^{***}	-4.86^{***}	-4.66^{***}	-5.66^{***}	-6.44^{***}
	(1.00)	(1.07)	(1.15)	(1.16)	(1.14)	(1.27)	(1.54)
Balassa$_{ic(t-1)}$	0.89^{***}	0.89^{***}	0.89^{***}	0.86^{***}	0.88^{***}	0.88^{***}	0.86^{***}
	(0.016)	(0.018)	(0.020)	(0.021)	(0.019)	(0.021)	(0.028)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$	0.89^{***}	0.97^{***}	0.93^{***}	1.31^{***}	1.23^{***}	1.43^{***}	1.62^{***}
	(0.22)	(0.24)	(0.25)	(0.30)	(0.27)	(0.31)	(0.38)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes			
Observations	68325	64908	61492	61493	64909	61492	54660
R^2	0.78	0.78	0.78	0.77	0.78	0.78	0.77

Notes: Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.

Table 17: Current comparative advantage

Dependent variable	log exports$_{ict,US}$			
	(1)	(2)	(3)	(4)
Hurricane$_{ct}$	0.062		0.016	-2.55^{**}
	(0.45)		(0.41)	(0.96)
Balassa$_{ic(t-1)}$		0.95^{***}	0.95^{***}	0.95^{***}
		(0.015)	(0.015)	(0.015)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$				0.67^{***}
				(0.20)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes
Observations	68325	68325	68325	68325
R^2	0.54	0.80	0.80	0.80

Notes: Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level. .

Table 18: Using quantiles instead of raw comparative advantages

Dependent variable	log exports$_{ict,US}$			
	(1)	(2)	(3)	(4)
Hurricane$_{ct}$	0.062		-0.23	-3.56***
	(0.45)		(0.39)	(0.96)
Balassa$_{ic(t-1)}$		0.046***	0.046***	0.046***
		(0.00082)	(0.00082)	(0.00082)
Balassa$_{ic(t-1)}$*Hurricane$_{ct}$				0.057***
				(0.015)
Industry, country and year dummies; Industry and country trends	yes	yes	yes	yes
Observations	68325	68325	68325	68325
R^2	0.54	0.77	0.77	0.77

Notes: Standard errors are clustered at the country level. *** denotes significance at the 1% level, ** at the 5% level, * at the 10% level.