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**A HURRICANE'S LONG-TERM ECONOMIC
IMPACT: THE CASE HAWAII'S INIKI**

BY

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A Hurricane's Long-Term Economic Impact: the Case of Hawaii's Iniki

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Abstract

The importance of understanding the macro-economic impact of natural disasters cannot be overstated. Hurricane Iniki, that hit the Hawaiian island of Kauai on September 11th, 1992, offers an ideal case study to better understand the long-term economic impacts of a major disaster. Iniki is uniquely suited to provide insights into the long-term economic impacts of disaster because (1) there is now seventeen years of detailed post-disaster economic data and (2) a nearby island, Maui, provides an ideal control group. Hurricane Iniki was the strongest hurricane to hit the Hawaiian Islands in recorded history, and wrought an estimated 7.4 billion (2008 US\$) in initial damage. Here we show that Kauai's economy only returned to pre-Iniki levels 7-8 years after the storm; though 17 years later, it has yet to recover in terms of its population and labor force. As we document, these long-term adverse impacts of disasters are 'hidden.' They are not usually treated as 'costs' of disasters, and are ignored when cost-benefit analysis of mitigation programs is used, or when countries, states, and islands attempt to prepare, financially and otherwise, to the possibility of future events.

Keywords: natural disasters, hurricane, Iniki, Kauai, Hawaii

JEL codes: Q54, R50

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1. Introduction

Major recent catastrophic events — especially the December 2004 tsunami in the Indian Ocean — and the prospects for changes in climate patterns resulting from global warming have brought the human and the material cost of natural disasters to the public’s attention worldwide. In spite of this interest, however, we do not know enough about the long-term impacts of a large disaster on the affected community. Almost all of the research on the economic and human toll of disasters focuses on the short-run – i.e., the impact of the disaster in the first couple of years. The difficulty, of course, is to identify any long term impacts and distinguish them from other event dynamics that happen following the disaster. A decade after an event, how many of the changes that we observe can we confidently attribute to the event itself?

Hurricane Iniki, that hit the Hawaiian island of Kauai on September 11th, 1992, was the strongest hurricane to hit Hawaii in recorded history. It wrought an estimated 7.4 billion (2008 US\$) of direct damage.¹ Here, we would like to focus on Iniki’s *ex post* long-term impact on the economy of Kauai. Iniki is worth investigating for several reasons: (1) since the hurricane struck 17 years ago, one can examine very long-term effects of the disaster²; (2) the island of Maui, whose economy and population makeup are very similar to Kauai, can serve as a perfect control group, since it was not hit by hurricane Iniki (nor by any other major natural disaster in the last

¹ Very few people were killed by Iniki. We were surprised to realize at the onset of this project that no comprehensive or even cursory attempt has been made to account for the impact of hurricane Iniki, beyond the immediate damages incurred, on the economy of the island of Kauai; not even by the local and state authorities.

² Economic data for the island is available from the early 1980s.

several decades). The existence of a control group that is subjected to almost identical initial conditions and subsequent shocks, except Iniki, enables a much more precise investigation of the impact of the event; and (3) Hawaii's experience with disasters is not in any way unique, and the economy of Kauai is similar in important respects to other small island states. Thus, any conclusions about the long-term effects of the hurricane on Kauai are likely relevant to all small islands; and with some caveats to bigger economies as well. We document and further discuss these points in section 3-4.

2. The economics of natural disasters

2.1 GDP and disasters

Research on disasters' impact on the economy is arguably still in its infancy with few papers systematically examining the dynamics of the economy following disasters. Several research projects, however, have examined the economics of specific disaster events - such as the 1995 Kobe earthquake in Japan (Horwich, 2000), the 2001 earthquake in El Salvador (Halliday, 2006, and Wisner, 2001), the 1999 earthquake in Turkey (Selcuk and Yeldan, 2001) and hurricane Katrina in 2005 (Green et al., 2007, and Vigdor, 2008).

This body of research is clearly directly relevant to our work here. These analyses, however, were all written shortly after the event and thus solely report on its short-term impact. If they do project or estimate long run impacts, they are unable to separate this impact from other trends and shocks that would have occurred regardless of the disaster event. The

case of Hurricane Katrina demonstrates this problem. Vigdor (2008), in a carefully constructed investigation of Katrina's impact on New Orleans, documents significant population declines. However, as Vigdor readily acknowledges, it is impossible to separate these declines from a general declining trend in the area's population that long predates Katrina (and which Katrina clearly accelerated).

As far as we know, there are few papers that examine the economic facets of natural disasters using a multiple-events cross-country comparative framework. These are briefly discussed below, though none of them attempts the level of detail in which we examine Kauai's Iniki experience. The first recent attempt to empirically generalize about the macro-aspects of natural disasters is Albala-Bertrand (1993); a book that develops an analytical model of disaster occurrence and reaction and collects data on a set of 28 disaster events (1960-1979). Surprisingly, Albala-Bertrand finds that after these large natural disasters GDP increases, capital formation speeds up, agricultural and construction output increase, the fiscal and trade deficits increase (the trade deficit sharply), and international reserves increase.

Tol and Leek (1999) and Skidmore and Toya (2002) argue that the positive effect on GDP can readily be explained since disasters destroy the capital stock, while the GDP measure focuses on the flow of new production generated by this destruction. Noy (2009) and Noy and Nualsri (2007), on the other hand, finds an adverse short-run effect on GDP growth and describes some of the structural and institutional details that make this negative effect worse. Bennett (2008) summarizes this debate.

Several other papers investigate the institutional and structural determinants of the initial disaster costs (Anbarci et al., 2005; Kahn, 2004; and Raschky, 2008) or of the subsequent impact on the economy (Cavallo et al., 2009). Much of this research however, is probably less relevant for research that seeks to identify the long-run impact of a hurricane, and not estimate the determinants of its initial destructive power.

Two research projects have investigated the impact of hurricanes on economies in the Caribbean. Given similarities between island economies, these studies are likely to provide more insight though they are restricted by their statistical regression methodology to identify only short-run effects. Rasmussen (2006) conducts a tabulation of the data for the island members of the Eastern Caribbean Currency Union (ECCU). He finds that: “Among these...the median number of affected persons amounted to 9 percent of the country’s population and the median value of damage was equivalent to 14 percent of the country’s annual GDP” (p. 7).³

Heger et al. (2008) also focus on Caribbean islands (not limiting themselves to ECCU countries only). Their results also do not agree with the earlier largely optimistic research that concluded that disasters are typically followed by a period of higher growth. They find that as growth collapses, the fiscal and trade deficits both deteriorate and the island economies of the region find it difficult to rebound from the short-run impact of the disaster. They relate this

³ Though, as Rasmussen (2006) points out, some events can be significantly worse. “For example, in 1979 Hurricane David hit Dominica...killing 42 people, damaging 95 percent [of GDP] and completely destroying 12 percent of buildings, damaging or destroying the entire banana crop and 75 percent of the country’s forests, rendering virtually the entire population homeless, and leading to the temporary exodus of about a quarter of the population.” (p. 7)

deepening recessions to the reliance of island economies in the region on very few sectors (typically, and like Hawaii, tourism and agriculture).

Other impacts of disasters have been investigated only infrequently. Most important is a more precise accounting of their fiscal impact. On the expenditure side, the disaster reconstruction costs to the public may be very different than the original magnitude of destruction of capital that occurred (see Fengler et al., 2008 for more discussion). On the other side of the fiscal ledger, the impact of disasters on tax and other revenue sources has also seldom been quantitatively examined (see Noy and Nualsri, 2007, and Borensztein et al., 2008).

Impacts of disasters on the distribution of income, on different socio-economic classes, or on different sectors of the economy are all largely unexplored.⁴ Better estimates of the fiscal and other distributional consequences of disasters may also enable governments to directly insure against disaster losses, indirectly through the issuance of catastrophic bonds (CAT bonds), or through precautionary fiscal saving via sovereign wealth funds (see Borensztein et al., 2008).

3. A comparison of Kauai and Maui

⁴ Exceptions are Neumayer and Plümper (2007) that investigate the gender differences in disaster impact and Loayza et al. (2009) that looks at the impact of disasters on industry, agriculture, and services separately.

Kauai and Maui's economies are very similar, as both primarily depend on tourism and agriculture.⁵ Although Maui is larger than Kauai, particularly in its land area, population, and economic size, they are very similar in terms of the sectoral composition of their economies and by almost all per capita indicators. In 1991, the year before Iniki, Kauai's population was 53,400 while Maui's was 105,000. In comparison to Oahu (the main island and the location of Honolulu and the state's government), both Maui and Kauai are largely rural.⁶ Real per capita income in 1991 for Kauai was \$13.1 thousands, and \$13.4 thousands for Maui (in 1982-1984 US\$). In 1991, unemployment in Kauai was 4.1% while in Maui it was 5.4%.

Nearly 1.2 million visitors traveled to Kauai in 1991 while 2.2 million visitors went to Maui. Roughly 81% of the visitors to Kauai were from the U.S. and 9% were from Japan. This is quite similar for Maui – 80% of the visitors were from the U.S. while 11% were from Japan. Farm earnings on Kauai in 1991 were \$23 million and on Maui, \$66 million. This was roughly 2-3% of personal income for each. For both Kauai and Maui, sugar cane was once the biggest income generating sector, but had been in steep decline since the late 1970's.

Maui makes for an ideal 'control group' for Kauai not only because of their similar economic structure, but maybe more importantly because both are parts of the U.S. State of Hawaii. The islands operate with the same currency, are subject to the same institutional and legal structures (including the state's tax system), and are affected similarly by State and

⁵ Hawaii's state data is available for Kauai County and Maui County. Kauai County includes the islands of Kauai and the tiny island of Ni'ihau (pop. 150). Maui County includes the islands of Maui, Lanai, and Molokai. Lanai (pop. 4,000) and Molokai (pop. 7,500) are also much smaller than either Maui or Kauai.

⁶ In 1991, Oahu had a population of 850,500.

Federal policies. In addition, they are likely to be subject to similar external political and economic shocks.

Around the time of Iniki (Sept. 11, 1992), the islands were affected by deep recessions in both California and Japan. These are the two largest income generating export destinations – since most tourists to both islands come from these two places.⁷ Because of their similarity, we see no reason to believe that Kauai and Maui substantially differed in their ability to recover from the decline in tourism and investment dollars as a result of those external shocks. This is the crucial assumption that determines our ability to conclude anything about the unique impact of Iniki on Kauai's economy. In fact, we find that hurricane Iniki created marked differences in the economic characteristics between Kauai and Maui, differences that in some cases persist to this day.

4. Iniki (Sept. 11th, 1992)

4.1 Iniki's Initial Effects

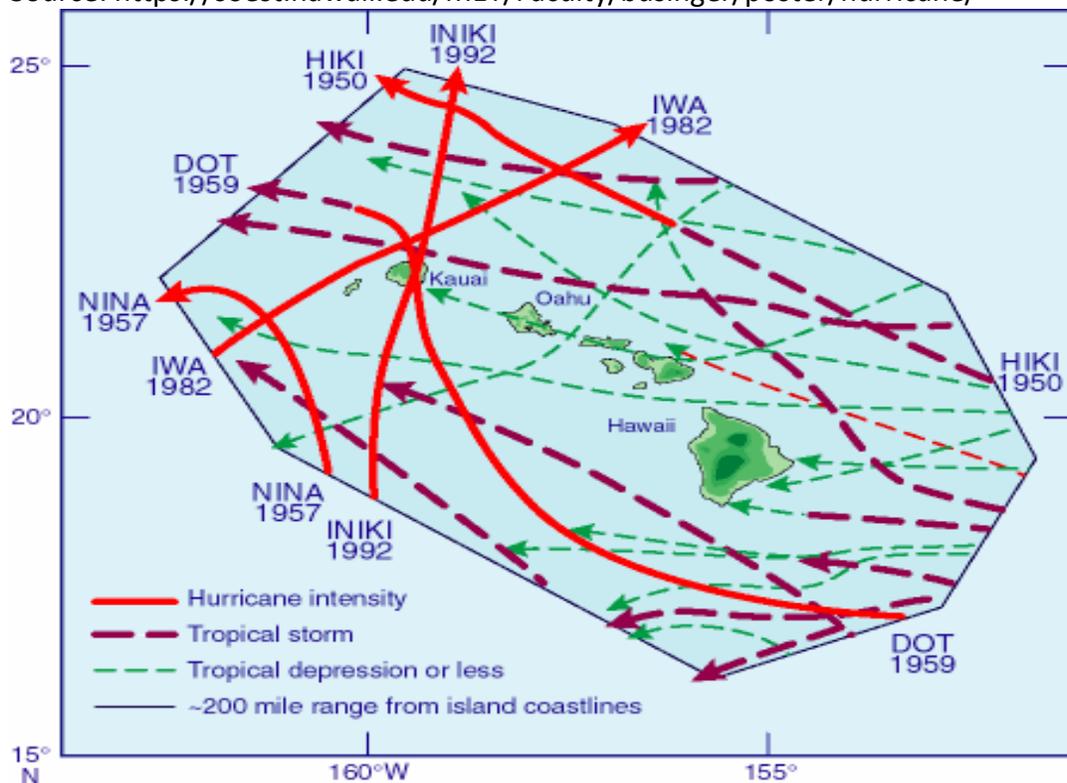
Hurricane Iniki landed on the south shore of Kauai on the afternoon hours of September 11, 1992 (for a more detailed description of Iniki's trajectory, see figure 1). CRED's EMDAT, the most comprehensive and credible international data source on natural disasters, estimates that 4 people were killed, 25,000 were affected, and there was 7.4 billion (2008 US\$) destruction of

⁷ Unlike in Japan, the recession in California was short-lived, and the economy was growing strongly by 1993.

infrastructure and property.⁸ According to NOAA, 14,350 homes were damaged or destroyed on Kauai, and electric power and telephone service were lost throughout the island and only 20 percent of power had been restored four weeks later. Crop damage was likewise extensive as sugar cane was stripped or severely set back, while tender tropical plants, such as banana and papaya, were destroyed and fruit and nut trees were broken or uprooted.

Figure 1: History of Hawaiian Hurricanes (1950-1992)

Source: <https://soest.hawaii.edu/MET/Faculty/businger/poster/hurricane/>



As can be seen in figure 1, Iniki was not the only hurricane to hit Kauai in the past 50 years; but the direct destruction that Iniki wrought was unprecedented. These direct impacts, however, do not necessarily represent the longer run indirect economic effects of the

⁸ EMDAT cites 5 billion in 1992 US\$. We converted these to 2008 US\$ using CPI data.

hurricane. In what follows, we aim to describe these long-run indirect economic effects. Kauai, like the other Hawaiian Islands, was hit at about the same time by a prolonged and painful recession in Japan, and to a lesser extent in the Continental United States. At the time, Japan was important for the Hawaii economy both because of the dominance of Japanese tourism in international arrivals, and the very large inflows of Japanese foreign investment, especially in real estate. To separate the effect of the hurricane from the effect of the Japanese recession and the aftermath of the Gulf War and the U.S. recession, the island of Maui is used as a control group.⁹ Maui was buffeted by the same shocks, except for the hurricane.

4.2 *The economic effects of Iniki*

The massive destruction of property and infrastructure resulted in a dramatic rise in unemployment as is shown in figure 2.¹⁰ Unemployment was already inching up from a low of around 3% in 1990 to 6.8% just before the hurricane as the Japanese economy was suffering from the aftermath of its real estate and stock market bubbles. However, immediately after the hurricane, unemployment on Kauai shot up to 19.1%. Maui, the control group, also experiences a rise in unemployment as a result of the Japanese recession, but on Maui unemployment

⁹ We use data for the country of Maui, which also includes the islands of Molokai and Lanai; but both are completely dominated by Maui.

¹⁰ Unless otherwise cited, all the data in the following figures was taken, with permission, from a database maintained by the University of Hawaii Economic Research Organization (UHERO). Data is available at: <http://uhero-kauai.prognos.com/>.

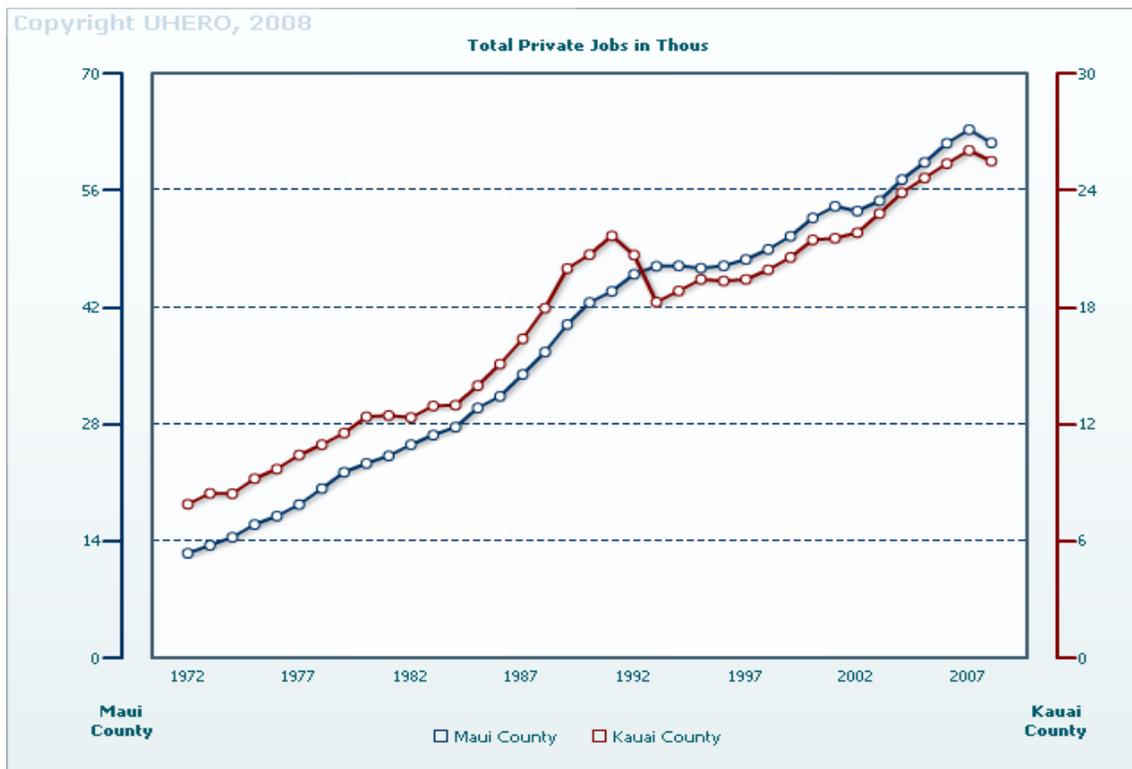
peaked at only 8.6%, up from a baseline of around 4% before the Japanese recession. Clearly, at least 10 percentage points unemployment are directly attributed to Iniki.

Figure 2: Unemployment Rate in Kauai and Maui (1990-2007)



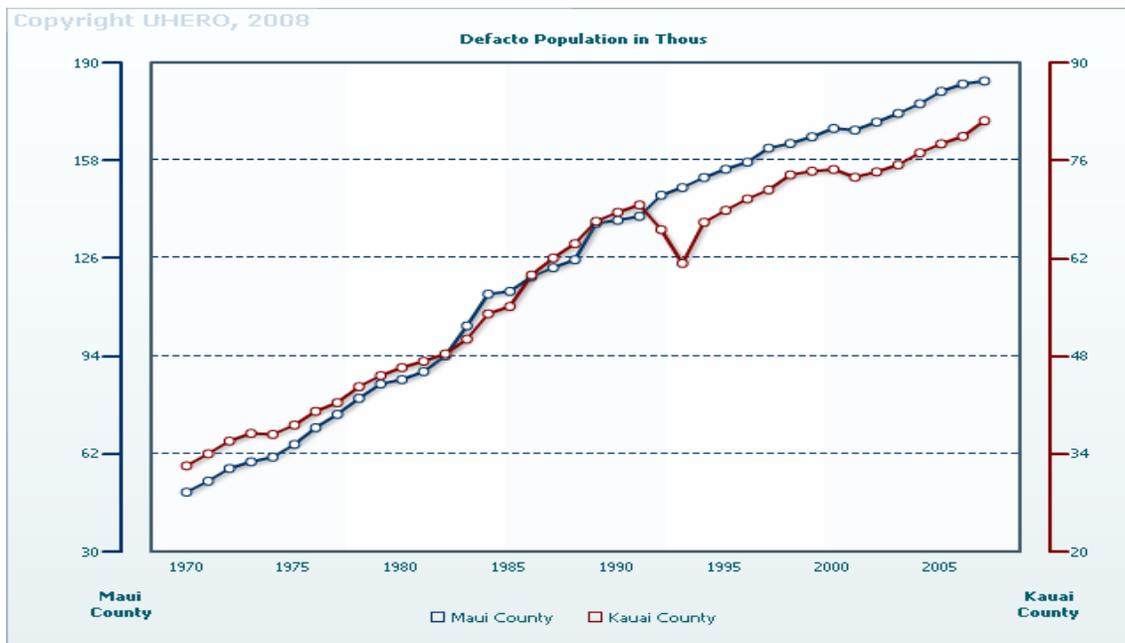
Maybe more striking is that it took Kauai 7 years (1999 Q2) for its labor market to recover to its previous pre-Iniki unemployment rate of 7% while Maui's economy was already recovering by 1995 (by 1999, Maui's unemployment was less than 5%). This pattern of an employment recovery that takes 7-8 years, while evident in several other statistics, is also misleading because there was a striking out-migration of residents (a reduction in the labor force). Figure 3 presents private jobs available for both Kauai and Maui.

Figure 3: Private job sector of Kauai and Maui (1970-2007)



Once again, it is apparent that the recovery from the disaster impact was long in coming. The number of private jobs available did not return to pre-Iniki levels until 2002, but even then, the recovery never brought Kauai back to its pre-Iniki trend. A simple calculation suggests that Kauai experienced a permanent loss of about 3000 private sector jobs (about 12% of employment on the island). This amounts to about 225 million (2008 US\$) that have disappeared from the Kauai economy every year. A similar picture can be observed when we examine the populations of both islands in figure 4.

Figure 4: Population of Kauai and Maui (1970-2007)

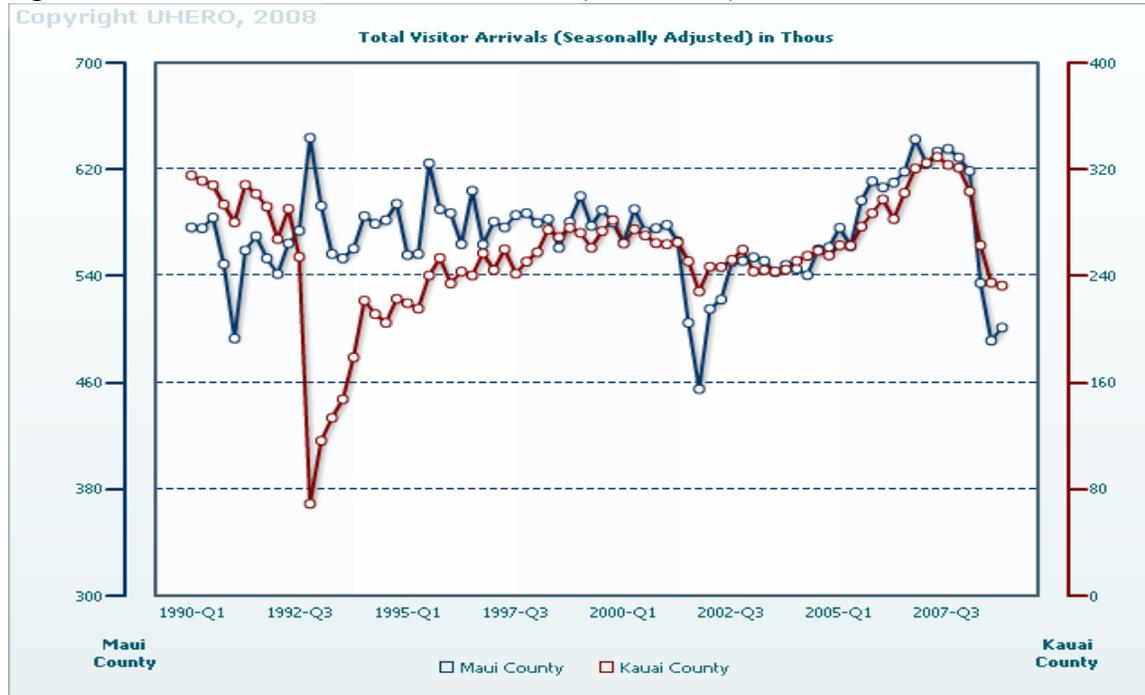


Both islands seem to follow a similar population trajectory, with both experiencing a fairly constant increase in population in the period 1970-1992.¹¹ However, Kauai's population trajectory shifts in 1992. In the two years following Iniki, Kauai's population declines, after which it begins to grow again, but increasing population at a similar pace. The growth rate of population decreases for both Kauai and Maui in the 1995-2008 period. But, Kauai never regained the population that left after the hurricane. It is evident from the empirical record that Kauai's population would have been about 10% higher had Iniki never happened. In that sense, Kauai seems to have permanently 'lost' about 10% of its population. By comparing Kauai and Maui's population trajectories, it again becomes apparent that the changes in Kauai were the result of Iniki since both were exposed to the same external economic conditions during the 1990s.

¹¹ Average population growth rates for the period 1970-1991 are 5.1% for Maui and 3.7% for Kauai.

Figure 5 examines the tourism sector, the largest sector in both employment and income on both islands, by looking at tourist arrival data for the years surrounding the hurricane.

Figure 5: Tourist arrivals for Kauai and Maui (1990-2007)



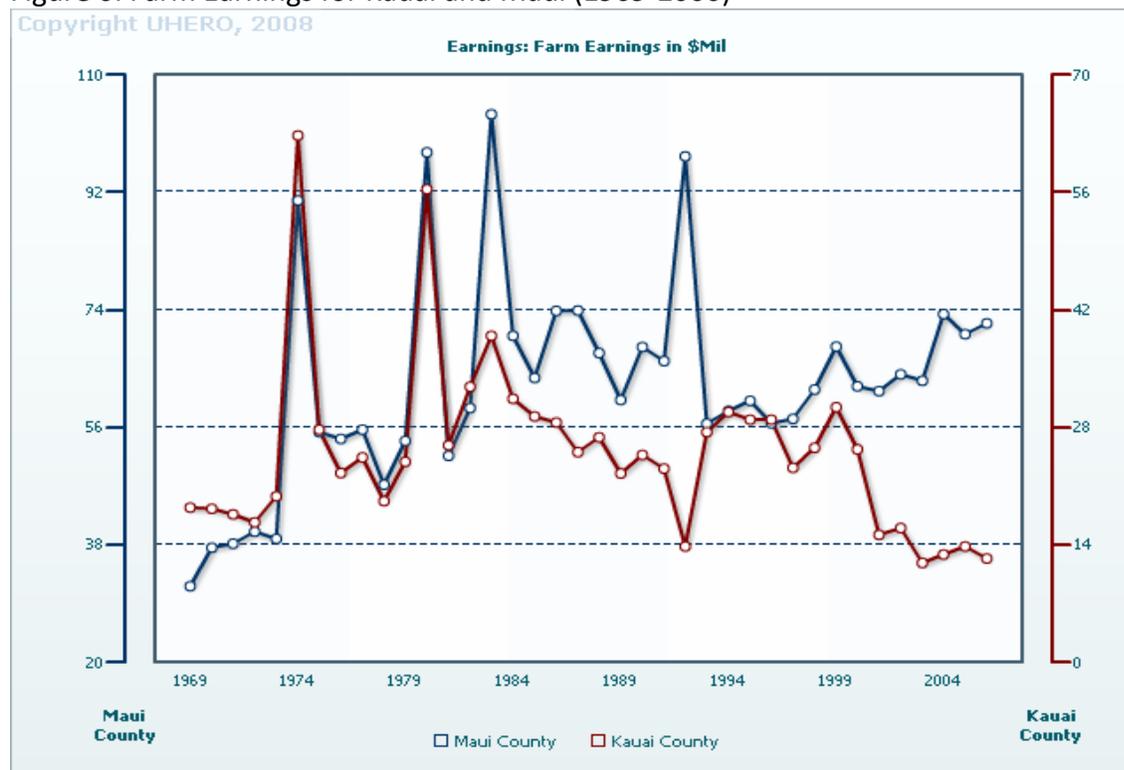
The tourism cycle seems to be highly correlated between the two islands, except for the 7-8 years following Iniki. Immediately after the hurricane, tourist arrivals to Kauai drop by 70%, with a temporary spike up in tourist arrivals in Maui when previously booked trips were re-directed to Maui facilities.¹² Kauai's tourism based economy took a long time to recover. Tourist numbers stabilized about 3 years after the hurricane, but reached 1990-1991 pre-Iniki

¹² Poipu, the main tourist area on Kauai, was heavily damaged both by winds and by the wave surges.

levels only 14 years after the hurricane.¹³

A distinct picture can be seen with the second biggest private income-generating sector on both islands, agriculture (figure 6). The agricultural economy is mainly centered on a few cash crops, and is much more volatile than tourism as a result of fluctuating world prices for the farm products produced and exported from the islands (mostly pineapple and sugar, but also macadamia nuts, coffee, and a few small specialty crops).

Figure 6: Farm Earnings for Kauai and Maui (1969-2006)



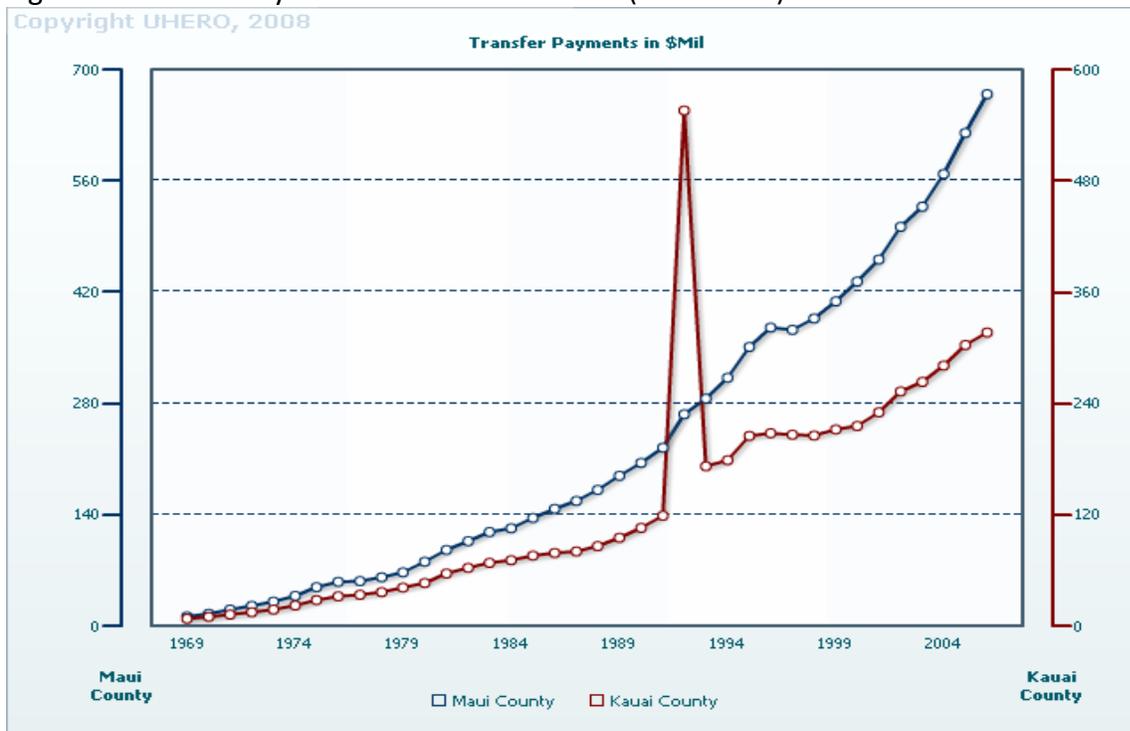
In 1992 we observe a large drop in Kauai's farm earnings' coupled with an increase in Maui's earnings. Both, however, bounce back rapidly to their pre-Iniki levels. Kauai later loses

¹³ Tourism on both islands was not much affected by the Japanese recession since Japanese tourists account for only 10-15% of the total (that number is much higher for Oahu's Waikiki where most Japanese tourists go).

much of its farming sector because of several large plantation closings; these long trends may be unrelated to Kauai's experience with Iniki, although Iniki did create an increased awareness of the future possibility of more hurricanes hitting Kauai.¹⁴

A reason why Kauai's experience with Iniki could have been much worse is evident once one examines the amount of funds Kauai received from state and federal sources (figure 7).

Figure 7: Transfer Payments for Kauai and Maui (1969-2007)



Clearly, the spike in funds associated with Iniki enabled a quicker recovery than otherwise would have been the case. However, even with this massive increase in transfers to the state government (about \$450 million; almost a five-fold increase), by most measures the economy of Kauai only recovered after nearly a decade, and by some measures it has never

¹⁴ Maui is significantly less likely to experience hurricanes given the past hurricane record (see figure 1).

fully recovered.

5. Conclusion

Seventeen years of hindsight and the existence of an ideal comparison/control makes it possible to assess the long-term economic damages of a hurricane. We analyzed the impact of 1992 Hurricane Iniki on the Hawaiian island of Kauai. We find that in spite of massive U.S. federal and Hawaii State transfers to the island (transfers that were more than 5 times as big as the island's previous budget), it still took nearly 7 years for Kauai to return to its pre-Iniki unemployment rate. This prolonged path to recovery, in spite of immediate and massive fiscal stimulus, is likely due to the fact that tourism infrastructure and tourist levels in Kauai reached their pre-Iniki levels only about 8 years after the disaster.¹⁵

However, this pattern of prolonged recovery underestimates the consequence of the hurricane, since the disaster resulted in an out-migration of Kauai residents from which the island's population has never fully recovered. The island 'permanently' lost about 10% of its population and 12% of its income. So, while 7 years after the hurricane income per capita returned to its pre-hurricane level, the economy has never fully recovered.

¹⁵ The presence of a large fiscal stimulus is important, given much recent work that predicts that disasters will more likely hit poorer countries in the future. Poor developing countries are less likely to be able to adopt counter-cyclical fiscal policies (Ilzetzki and Végh, 2008); and this will make the disaster's adverse consequences more severe.

The story of the Coco-Palms hotel demonstrates this point. The hotel was the first, the most famous, and the most luxurious resort development on the island.¹⁶ It was heavily damaged by the hurricane, and 17 years later it still lies abandoned in disrepair. In some sense, the real disaster that hit Kauai arrived after the hurricane, and it is still affecting the island today.

After Hurricane Iniki, the Hawaii State legislature created the Hawaii Hurricane Relief Fund (HHRF) to provide windstorm insurance and reinsurance coverage for hurricane force winds. Currently, in May 2009, the HHRF has about \$185 million.¹⁷ Even when considering only the \$7.4 billion that Iniki destroyed directly, the HHRF is clearly far from adequate should a major storm hit any of the main four inhabited Hawaiian Islands (Kauai, Oahu, Maui and the Island of Hawaii). Once we account for the cumulative multi-year costs of a disaster, in terms of migration, forgone income, etc., the HHRF will not cover even 5% of the projected cost should an Iniki strength storm reach one of the main Hawaiian Islands.

It is widely reported that climate change is likely to change the likelihood of future natural disasters worldwide (van Aalst, 2006). Islands are considered especially vulnerable to the effects of climate change and increased frequency of 'extreme events' (IPCC Working Group II, 2007). This assessment is based on the physical implications of climate change on island

¹⁶ It appeared in numerous movies (most famously in Elvis Presley's *Blue Hawaii*), and was also the home of the last reigning queen of the island.

¹⁷ A typical concern with these kinds of insurance policies is the generation of moral hazard; i.e., the policy's unintended consequence of generating willingness to incur more risk since this risk is insured. This tendency is especially acute if the insurance premiums are not paid by the risk-taker or if their size does not reflect the actuarial reality.

ecosystems (proportionately larger coastal areas, dependence on ocean ecosystems, and limited fresh water availability) as well as the economic conditions of islands (tourism dependence, narrow export markets, large import base, and limited agricultural production). While our research is not useful for a comparison of vulnerability of islands and continental locations, we clearly observe that as a result of a large disaster, an island economy may experiences a very long and prolonged slowdown in economic activity; an adverse outcome that can still be observed 17 years after the disaster. While we cannot conclude much about post-disaster dynamics in continental economies, our observations suggest that there is great need for planning to reduce the economic vulnerability to disasters in island economies. More specifically, the narrow focus on tourism leads to great dependency on visitor inflows and tourism infrastructure—both of which seem to suffer immensely in the aftermath of a disaster on the magnitude of Hurricane Iniki.

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