

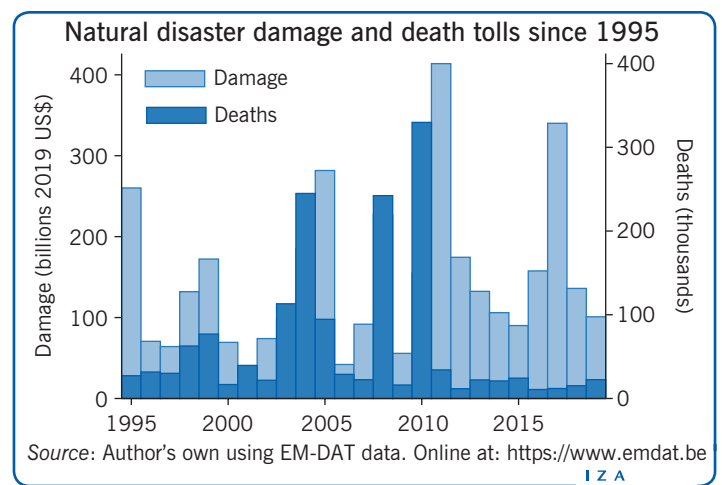
Economic effects of natural disasters

Natural disasters cause significant short-term disruptions, but longer-term economic impacts are more complex

Keywords: natural disasters, disaster aid, migration, labor market outcomes, health effects

ELEVATOR PITCH

Extreme weather events are increasing in frequency and intensity, threatening lives and livelihoods around the world. Understanding the short- and long-term effects of such events is necessary for crafting optimal policy. The short-term economic impacts of natural disasters can be severe, suggesting that policies that better insure against consumption losses during this time would be beneficial. Longer-term economic impacts are more complex and depend on the characteristics of the affected population and the affected area, changes in migration patterns, and public policy.



KEY FINDINGS

Pros

- ⊕ Out-migration following a natural disaster can serve as an important coping mechanism and reduce the number of individuals who are vulnerable to future disasters.
- ⊕ Labor market outcomes appear to be resilient to natural disasters in the long term, at least in wealthy countries.
- ⊕ Although the welfare effects of extreme weather events are surely negative, natural disasters can sometimes improve victims' outcomes along some dimensions.

Cons

- ⊖ The short-term effects of natural disasters can be severe, even in wealthy countries.
- ⊖ Large natural disasters reduce victims' income and consumption in the short term.
- ⊖ Researchers lack causal estimates of the effects of natural disaster aid.
- ⊖ More research is needed to understand the long-term effects of natural disasters on individuals, which could differ from their long-term effects on affected areas due to post-disaster migration.

AUTHOR'S MAIN MESSAGE

The economic impact of a natural disaster does not end with physical damage and loss of life. Natural disasters can also affect victims' employment, health, and migration decisions, with potentially significant long-term repercussions. Well-designed policy can limit such impacts cost-effectively, and there are many policy options available to policymakers, including protective infrastructure, better land-use policy, monetary incentives to reduce risk, and ex-post relief. Understanding the magnitude of and mechanisms behind the short- and long-term effects of natural disasters is an essential first step toward crafting optimal public policy.

MOTIVATION

There is widespread agreement among experts that climate change is increasing the frequency and intensity of extreme weather events. Although such events need not always become a natural disaster—defined as an event of natural origin that results in substantial damage or loss of life—there is evidence that damage from natural disasters is on the rise as well. Obtaining accurate damage and casualty estimates is notoriously difficult, but the most comprehensive disaster database (Emergency Events Database or EM-DAT) indicates that, between 1995 and 2019, natural disasters caused \$3.7 trillion in physical damage (in 2019 US dollars), killed over 1.5 million people, and made over 90 million people homeless. Physical damage from natural disasters has been growing faster than GDP, driven by greater wealth and larger populations living in disaster-prone areas (Illustration on p. 1). While better warning and forecasting systems as well as sturdier infrastructure have likely reduced the death toll from extreme weather events, large-scale disasters such as the 2004 Indian Ocean tsunami, the 2008 Cyclone Nargis, and the 2010 Haiti earthquake demonstrate that natural disasters continue to pose a substantial threat to human life, especially in poorer countries. To minimize the economic impacts of extreme weather events, it is essential to first understand how such impacts materialize and evolve in the aftermath of a disaster.

DISCUSSION OF PROS AND CONS

Conceptual framework

The immediate effects of a natural disaster materialize through four main channels: loss of life; destruction of physical capital (e.g. housing, commercial buildings, vehicles, and infrastructure such as roads); population displacement; and disruption of economic activity. The contribution of each channel and the overall severity of the initial impact of a disaster depend on both the physical characteristics of the disaster and broader characteristics of the affected area. For example, wealthier countries experience fewer fatalities following a natural disaster, as do democracies and countries that have developed higher-quality institutions. With some exceptions, such as Hurricane Katrina, substantial loss of life following a natural disaster is more likely to afflict poorer countries. By contrast, wealthier economies account for much of the value of destroyed physical capital.

Population displacement following a natural disaster reflects some combination of anticipatory responses and the impact of the event. The extent and duration of population displacement depend on the degree to which a disaster renders an area uninhabitable—which depends on damage to housing and infrastructure—as well as on disruption of economic activity, which can take many forms. For example, physical damage to operating locations or damage to public infrastructure (e.g. destruction of roads and electricity outages) may force businesses to close. Workers who rely on continuous employment may then find it necessary to leave an area in search of income, even if their dwellings remain habitable.

Loss of life, physical destruction, population displacement, and disruption of activities can translate into both short-term and long-term economic effects. While the welfare effects of natural disasters are surely negative, the economic consequences are more complex. There are no clear theoretical predictions regarding the sign or magnitude of the effects of a natural

disaster on population or wages, in either the short or long term. At one extreme, some have posited that disasters can have positive effects on income and growth through so-called “creative destruction,” and some empirical support for such a mechanism exists. The idea underlying this hypothesis is that natural disasters destroy suboptimal infrastructure “for free,” nudging economies to adopt newer, superior technology (including better organization of urban areas during the rebuilding phase) more quickly than they otherwise would. Another potential consequence of physical destruction is higher housing prices and rents, even absent quality improvements. Such a counterintuitive effect could materialize in areas with declining populations because housing is costly to demolish. Absent an external shock, the growing ratio of housing to population therefore drives prices down. In such cases, the destruction of housing stock by a natural disaster can increase housing prices and rents permanently, holding all else equal, by shifting an economy to a new equilibrium with reduced housing inventory and higher prices.

In addition to causing short-term population displacement, a natural disaster can lead to longer-term changes in migration patterns. Emigration can be either permanent or temporary, for example if individuals relocate to earn remittances to help family members who remain in an affected area. The migration response to a natural disaster may be more pronounced among some population subgroups, which can have implications for post-disaster recovery. If natural disasters cause the most educated or wealthiest individuals to leave a particular area, for example, the area can suffer. Natural disasters can also decrease migration if the destruction of assets prevents some individuals who would have otherwise migrated from leaving. More generally, natural disasters can cause people who are credit constrained to inefficiently remain in the disaster-affected area.

Interpreting the post-disaster migration response can be difficult. In a world without moving frictions, an individual’s current location is the optimal one and any moves caused by a natural disaster cannot lead to a welfare gain on net. In poorer countries, however, there is evidence that rural–urban migration is too low in non-disaster times due to credit constraints. In the presence of such frictions, forced post-disaster moves can improve welfare in theory.

A natural disaster can also change the local labor market equilibrium. The effect of a disaster on labor supply and demand—and therefore on wages—is ambiguous. A natural disaster can reduce the labor supply if it kills prime-age individuals or causes mass out-migration from an affected area. It is also possible, though, for a natural disaster to increase the labor supply through the so-called income effect: individuals whose assets are destroyed may decide to supply more labor—that is, work longer hours or multiple jobs—to replace the assets. The demand for rebuilding could both attract new workers to an area and raise wages. Labor demand can weaken, though, if a disaster causes a net reduction in demand for goods and services, which then translates into reduced demand for the labor needed to create those goods and services. For example, if tourism to a disaster-affected area falls, demand for labor in the hospitality sector is likely to fall as well. Labor demand in some sectors, though, such as construction, is likely to increase.

Natural disasters can also affect a broad range of health outcomes, in both the short and long terms. Apart from suffering physical injuries caused directly by a disaster, victims can experience physical and psychological health effects because of stress, disruption of routines, and subpar living conditions that sometimes prevail in a post-disaster environment. Individuals with chronic conditions may find it more difficult to access

necessary care or medications, potentially harming their health. Post-disaster changes in health can, in turn, affect other outcomes, including income and employment.

Disasters can also influence health indirectly. Individuals who find themselves unemployed because of a disaster can respond by forgoing beneficial care, worsening their health. It is also possible for disasters to be indirectly beneficial to health if, for example, they induce individuals to relocate to areas where conditions are more conducive to better health outcomes.

Empirical considerations

When a disaster affects migration patterns, it becomes important to distinguish between its effects on the place it strikes and its effects on victims. While local wages may drop, some victims may experience wage gains if they respond to a disaster by moving to a higher-wage area. Studying the effects of natural disasters on victims, as opposed to their effects on geographical areas, requires longitudinal individual-level data. Obtaining such data following natural disasters can be challenging, especially in poor countries. Asking disaster victims about pre-disaster outcomes after a disaster has occurred could be problematic because the experience of a disaster can affect the ability to recall events. Moreover, recruiting a representative sample of disaster victims and tracking them over time with minimal attrition is logistically difficult. Administrative data sets represent the most promising way of studying the effects of natural disasters on individual victims, especially over the long term, but few such studies have been conducted or are underway.

The geographic scale at which the economic effects of a disaster are considered can change both the estimated effects and interpretation of the results. For example, the migration response could be strong in a disaster-affected area but negligible at the country level if the disaster does not make it more or less likely that individuals leave or enter a particular country. Similarly, incomes may fall locally but this effect may be statistically undetectable when larger geographies are considered. Thus, studies utilizing contrasting levels of geographic aggregation are not directly comparable but rather help paint a fuller picture of a disaster's impact.

The effects of a natural disaster can also depend on a country's income levels because of differences in sectoral composition across economies (i.e. whether informal or formal labor, agriculture or services are strong sectors), the quality and quantity of infrastructure, the presence of insurance and government aid, and many other factors. Thus, it is important not to assume that findings based on studies of a wealthier country will generalize to a poorer one. Unfortunately, most individual-level studies, especially those encompassing both the short and long term, have been carried out in wealthy-country settings, likely reflecting variation in the availability of data.

Finally, natural disasters almost always generate at least some aid response from governments, non-governmental organizations, and individuals. Such disaster aid can play an important role in the disaster-recovery process, as can private insurance. Because such responses are complex functions of disaster severity, it is essentially impossible to control for such aid administered in the aftermath of a disaster. Thus, the appropriate way to interpret the estimated impacts of a disaster assumes that they represent net impacts, including the effects of any policy response. Unfortunately, there are no reliable estimates of the causal effects of disaster aid on victims' outcomes. Thus, while aid is certainly helpful, its exact effectiveness is currently unknown.

Effects of natural disasters on income and employment

Nearly every sub-national empirical study of natural disasters finds short-term declines in either income or employment. A study of major hurricane strikes in US coastal counties finds that hurricanes cause county-level personal income growth to fall by 0.45 percentage points in the year of the impact, which represents over 25% of the mean growth rate [1]. Much of this effect is due to a compositional change in the population, as richer individuals respond to the shock by moving out and poorer individuals move in. At the state level, the economic effects of a hurricane net out to zero over a given year, and past hurricanes have no significant effects on current growth. Another county-level study of US hurricanes detects no drop in per capita wage/salary levels but does find temporary decreases in the employment rate beginning a few years after a hurricane [2]. The study also finds that transfers through standing social safety net programs increase to a greater extent than transfers through dedicated disaster aid programs, potentially offsetting some negative employment and income effects that would have materialized otherwise. Thus, it is not just disaster-specific policy that can matter for recovery but other, more general, safety nets as well.

A global study of 53 major floods, each of which displaced at least 100,000 people and affected primarily poor countries, finds that the floods reduced contemporaneous economic activity in cities, as proxied by satellite-detected night light intensity [3]. Yet economic activity was disrupted only briefly, returning to normal levels quickly. Low-elevation urban areas—which also experience denser economic activity—flood more frequently but recover just as quickly as higher-elevation areas. The study concludes that, except for recently populated areas, these devastating floods appear not to have caused permanent shifts in economic activity.

Interpreting these findings requires some care. It is possible that low-elevation urban areas are inherently more productive and that, despite the presence of shocks, maintaining capital in its place pays off. If natural disasters do not convey any new risk information and there are no inefficiencies in how capital and people are distributed spatially, long-term economic activity need not change in response to disasters [3]. It is also possible, however, that some rebuilding is inefficient and reflects misdirected disaster aid, coordination failures, or other frictions and perverse incentives that prevent or discourage economic activity from relocating. As climate change threatens to increase the incidence of flooding, it is important for policymakers to consider whether, for each specific area, it is better to protect populations where they are or design incentives to relocate them to safer areas.

Another comprehensive study of natural disasters uses 90 years of US disaster data to estimate the effects of disasters on local income, housing prices, and net migration [4]. Over the decade in which a county is affected by a severe disaster, personal incomes and housing prices fall, while the local poverty rate rises. The study finds no evidence that natural disasters improve efficiency by forcing reallocation of resources and destroying outdated physical capital, as the effects of a disaster appear stronger, rather than weaker, in faster-growing areas.

The evidence mentioned above comes from place-based measures of economic activity and may not correspond to the effects of disasters on individual victims if a given disaster causes migration patterns to change. For example, local incomes can fall not only because natural disasters cause a decline in victims' incomes but also because of selective out-

migration of wealthier households and/or selective in-migration of poorer households. Studies of individual victims generally also, it should be noted, find a short-term reduction in incomes. A study of Typhoon Ketsana, which in 2009 inundated parts of Vietnam, found that the average household in flood-affected areas—as measured by satellite images—experienced a 10% income decline in the months following the typhoon, due mostly to losses in crop income [5]. The most severely affected households suffered income declines of 50%. However, consumption losses were substantially smaller in magnitude—adding up to only about 15% of the income losses—indicating that the affected households were at least partially insured against the shock. As discussed later, migration and remittances appear to be the mechanisms through which these households reduced their consumption losses. Unfortunately, the study is not able to track outcomes over a longer period.

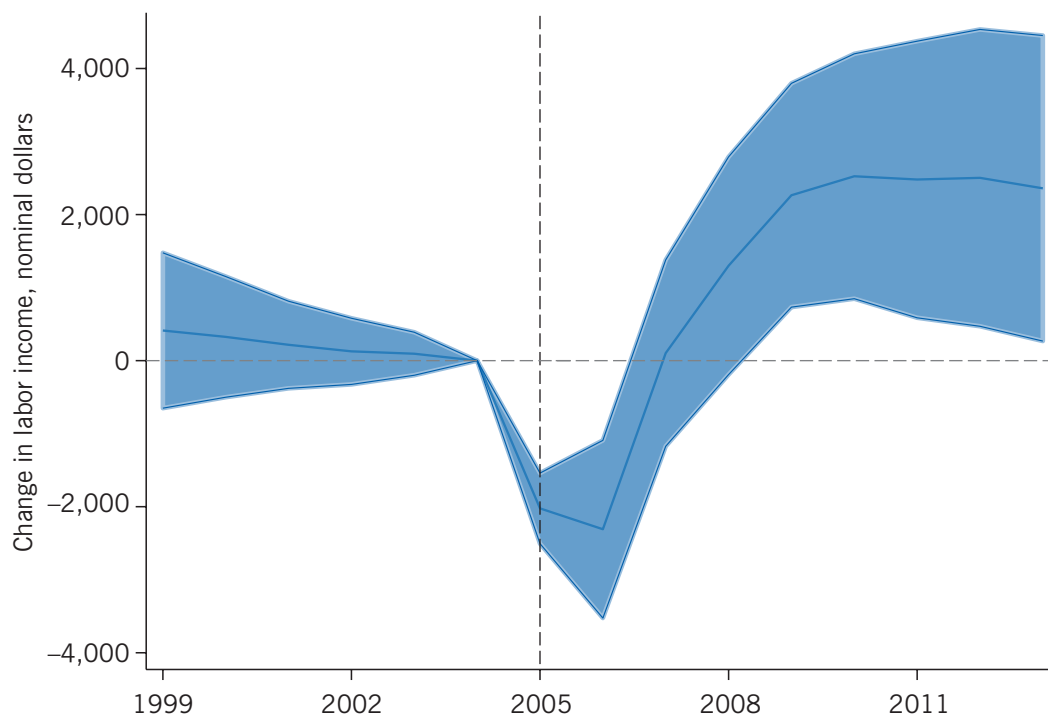
Hurricane Katrina, which struck the US Gulf Coast in 2005, is one of the most extensively studied natural disasters, likely as a result of both its extreme impacts and the ready availability of relevant data. The immediate impact of the storm killed nearly 2,000 people and displaced more than one million. Two concurrent studies find that victims who at the time of the hurricane were living in New Orleans—which was particularly hard-hit—experienced substantial short-term income losses and became significantly less likely to be employed [6], [7]. Within a few years, however, victims' incomes and employment probabilities had recovered and subsequently surpassed that of a control group (Figure 1). Four to eight years after the hurricane, the average household income was over \$2,000 higher among Hurricane Katrina victims than among control households.

These counterintuitive findings can be explained by a combination of migration to higher-wage areas and an increase in New Orleans wages. Housing prices also increased, though, so some of the wage-rate increases in New Orleans were nominal rather than real. While the estimated earnings trajectory may have been specific to Hurricane Katrina, the victims' experience illustrates the potential for natural disasters to produce counterintuitive effects along some dimensions. These findings also underscore the importance of distinguishing between the long-term effects of a disaster on a particular area and its effects on the area's victims, who may relocate elsewhere.

Migration

Many studies that consider incomes and employment also consider migration rates, often finding them to be affected by a disaster. For example, nearly a one-third greater proportion of the population left New Orleans in the year following Hurricane Katrina than in normal years, although more than half of those who left later returned [6]. The study, which spans nearly a century of US disasters, finds that, over the decade in which a county is affected by a severe disaster, the county's net out-migration rate increases by 1.5 percentage points [4]. This evidence is consistent with weaker labor demand that results from falling local productivity, which encourages out-migration. In more recent US history, hurricanes have been shown to increase both out-migration and in-migration at the county level [1] but result in no net population changes [1], [2]. One study is able to measure migration by income level, estimating that wealthier individuals are more likely to move away following a hurricane strike [1]. The study concludes that more than one-quarter of the estimated income decline can be explained by selective out-migration of higher-income individuals.

Figure 1. Changes in labor earnings of Hurricane Katrina victims over time



Note: The shaded area corresponds to 95% confidence intervals. The vertical dashed line indicates the year of Hurricane Katrina.

Source: Deryugina, T., L. Kawano, and S. Levitt. "The economic impact of hurricane Katrina on its victims: Evidence from individual tax returns." *American Economic Journal: Applied Economics* 10:2 (2018): 202–233 [6].

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In poor countries, it appears that some households use temporary migration as a coping strategy in the face of an economic shock. The study of Typhoon Ketsana victims finds that long-distance internal migration was an important channel through which households were able to offset some of the income declines [5]. Net remittances per capita from such migrants increased substantially in response to the typhoon, offsetting about 20% of the income losses on average and about 40% of the income losses among households that contributed at least one long-distance migrant. By contrast, transfers from migrants who left for non-labor reasons, informal transfers from family and friends, and transfers from social assistance programs did not increase significantly in the study's setting. The study also finds that households reacted to the typhoon by creating long-distance migrants; the typhoon increased the probability that at least one long-distance migrant would leave any given household by 17%. These so-called "ex-post" migrants earned 25–35% lower incomes than those who had migrated before the typhoon, however, despite similarities in other observable characteristics. This difference is likely due to a combination of worse job-worker matches and shorter job tenures among ex-post migrants.

Health outcomes

There is no doubt that natural disasters are harmful to short-term health, at least among the most vulnerable subgroups such as the elderly with chronic conditions. Optimal

policy design requires understanding not just the presence of a health impact but also its magnitude. Accurately estimating the (non-lethal) health effects of natural disasters is among the most elusive tasks because relatively few data sets include well-measured health outcomes and collecting data from a representative sample of disaster victims is difficult.

While many studies use post-disaster surveys to document both physical and psychological impairments among disaster victims, the often non-random nature of the samples and the lack of observations of pre-disaster health make drawing quantitative conclusions from such research difficult. The most systematic recent evidence pertaining to health impacts comes again from studies of Hurricane Katrina. A study using American Community Survey data shows that the disability rate among New Orleans victims of Hurricane Katrina increased by 4 percentage points in the year after the hurricane (an almost 20% increase), driven mainly by an increase in mental impairments [8]. A survey of low-income New Orleans parents who experienced Hurricane Katrina, most of whom were black and female, showed that, although the mental health impacts of the hurricane diminished over time, symptoms consistent with post-traumatic stress afflicted one in six respondents 12 years later. Similarly, the rate of non-specific psychological distress was higher throughout the follow-up period than prior to the hurricane [9].

Such findings do not, however, apply to all victims or all health conditions. Another study using administrative data from an insurance program covering nearly all of US elderly and long-term disabled (Medicare) estimates that Hurricane Katrina was followed by a long-term mortality decline among victims who lived in New Orleans when the hurricane struck [10]. This estimate accounts for the fact that Hurricane Katrina initially increased this group's mortality substantially and therefore cannot be explained by simple mortality displacement. Instead, the mortality declines can be explained largely by the displacement of victims to areas that are more conducive to survival than New Orleans was prior to the hurricane.

LIMITATIONS AND GAPS

To date, no studies of the economic effects of natural disasters have successfully separated the effects of natural disasters from the countervailing effects of natural disaster aid and other transfers to disaster victims. As a result, the extent to which such aid is helpful in staving off the adverse health or economic effects of disasters is unknown. This shortcoming is significant because it means that researchers cannot calculate the benefits of increasing aid to victims.

Relatedly, little is known about the returns from ex-ante mitigation spending. While not all impacts of natural disasters can be avoided, sea walls, natural flood management, zoning and building regulations, and other policies aimed at reducing the impact of an extreme event could be cost-effective ways of reducing the negative consequences of natural disasters. Yet not all mitigation measures are likely to be cost-effective, and their cost-effectiveness may depend on the characteristics of a given protected area (consider the contrast between protecting New York City and a sparsely populated rural area). More research along these dimensions would be welcome.

Furthermore, evidence pertaining to the long-term effects of natural disasters on individual victims remains limited to a handful of studies of specific disasters in the US. Long-term impacts could be quite different in poor countries because of lower incomes, less robust

social safety nets, and other differences. Similarly, more evidence is needed to understand the health impacts of natural disasters, especially when it comes to long-term outcomes and poor countries. Expanding and improving longitudinal data collection (including administrative data) and facilitating researcher access to such data are essential for filling in these gaps.

SUMMARY AND POLICY ADVICE

Natural disasters occur with increasing frequency, and this trend will continue. The short- and long-term impacts of an extreme event depend not just on its physical characteristics but also on myriad characteristics of the area it strikes, including the socioeconomic characteristics of the population, the type and spatial distribution of physical infrastructure (including protective infrastructure), and the sectoral composition of business activity. These factors can, in turn, be shaped by policy. Post-disaster aid responses and social safety nets can also play important roles in post-disaster recovery.

Researchers' understanding of the short-term impacts of natural disasters has improved significantly over the past 15 years. Studies have found consistently that disasters cause short-term income and employment losses. Combined with empirically low insurance-penetration rates, this suggests that short-term incomes and assets could be better insured. When examining how to enhance insurance coverage of various post-disaster outcomes, it is important to consider whether such insurance can be provided by the private sector or whether direct government involvement is necessary. Some additional insurance against adverse labor market outcomes could be provided through expanded social safety nets.

Although the long-term impacts of natural disasters remain unclear, several recent studies using microdata have found that, in some cases, natural disasters have positive long-term consequences for victims by inducing them to relocate or by changing the labor market equilibrium in an affected area. These findings underscore the importance of considering not just a disaster itself but also the context in which it occurs.

While it may be tempting for policymakers to try to design policy that eliminates as many natural disaster impacts as possible, such measures are unlikely to be cost-effective. Optimal policy should weigh the benefits of any intervention against its costs. Additionally, care must be taken not to unnecessarily encourage people to remain in disaster-prone areas with the expectation that they will be bailed out with free aid. Ideally, such post-disaster transfers would be funded by actuarially fair premiums paid for by the at-risk households themselves.

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Competing interests

The IZA World of Labor project is committed to the IZA Code of Conduct. The author declares to have observed the principles outlined in the code.

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