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Disaster Relief through the Tax Code: Hurricane Katrina and the Gulf
Opportunity Zone

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Abstract This project investigates the impact of geographically-targeted Federal tax relief enacted in the wake of Hurricane Katrina in 2005. To facilitate administration of relief efforts and define eligibility for the temporary tax law changes, the Gulf Opportunity Zone (GO Zone) was created. We estimate the initial impacts of these tax incentives using propensity score matching (PSM) and Mahalanobis metric matching (MM) methods, combined with difference-in-difference (DD) estimation, to limit the confounding influences of observable and fixed unobservable differences between counties affected by these incentives and similarly storm-damaged counties in the region that were not included in the GO Zone. Results show that per capita personal income and net earnings increased more rapidly in GO Zone counties that experienced minimal storm damage than in similar non-GO Zone counties in the GO Zone States and neighboring States.

Introduction

The 2005 Atlantic Hurricane season will go down on record as a one of the most costly and deadly in US history.¹ Hurricanes Katrina, Rita, and Wilma together were responsible for over 2000 deaths and more than \$150 billion worth of damage (NOAA 2005; NOAA 2008). The primary victims of the hurricanes were the Gulf Coast and South Florida. In the Gulf Coast, a quarter of a million people were uprooted from their homes and communities, and nearly six years later, many have not yet returned. In the wake of the disasters, the Federal government, along with State and local governments were tasked with helping the region recover. Housing assistance was provided through the US Department of Housing and Urban Development and the Federal Emergency Management Agency (FEMA); income support following the loss of a job was provided by expanded unemployment insurance² and Disaster Unemployment Insurance (DUA); health care assistance could be obtained through Medicaid; and short-term cash assistance was available from Temporary Assistance for Needy Families (TANF) program (Winston et al. 2007). All of these are familiar programs and represent orthodox approaches to helping those who need relief, though not necessarily need arising due to natural disaster.

In what was considered to be a less orthodox means of providing disaster relief, Congress quickly enacted geographically targeted tax relief through two legislative acts: The Katrina Emergency Tax Relief Act of 2005³ (KETRA) and the Gulf Opportunity

¹The “Great Galveston Hurricane” in 1900 had a death toll of 8,000 (NOAA 2007).

² The Hurricane Katrina Unemployment Relief Act of 2005 allocated \$500 million in UI benefits from the Federal unemployment account, to be divided among LA, MS, and AL (Winston 2007).

³ H.R. 3768 was introduced on September 14, 2005, passed on September 15, signed into law on September 23, and became Public Law No:109-73.

Zone Act of 2005 (GOZA).⁴ KETRA provided tax relief primarily to taxpayers through a combination of exclusions, deductions, and credits; penalty free distributions or loans from retirement accounts or other qualified saving plans; and special look-back rules for calculating certain credits. KETRA also created an employee retention credit for employees affected by the hurricane, and classified certain individuals affected by the hurricane as a targeted group for the purposes of the work opportunity tax credit (WOTC).

GOZA provisions, on the other hand, were focused mainly on business activities in the Gulf region.⁵ GOZA was predominantly made up of incentives for capital investment, for example, accelerated expensing and depreciation provisions. GOZA created investment incentives by expanding the size and scope of tax exempt bond financing for private activities, and allocating New Markets Tax Credits (NMTCs) for qualified investment activity in the region.

To facilitate the relief, both laws created relief areas, established by geographic boundaries. In some of the Acts' provisions, businesses or individuals were merely required to meet a residency test to be eligible for the tax relief, while in other cases, a taxpayer must have shown that they had incurred a loss or displacement due to the hurricane.

The Acts were a new and relatively untested means of providing relief in the wake of a natural disaster. The Acts represented the first time the Internal Revenue Code (IRC) was used to provide broad relief after a natural disaster with so many victims, spread over

⁴ H.R. 4440 was introduced on December 6, 2005, signed into law on December 22, and became Public Law No. 109-135.

⁵ Although GO Zone included most of the same individual relief and property transaction relief, it did so primarily in order to codify and extend them to the newly created Rita and Wilma Zones.

hundreds of miles, many of whom having been displaced from their homes. After the September 11, 2001, terrorist attacks, the US Congress passed a set of tax relief packages targeted at the victims and their families, but they were more limited in scope, and the victims and regional economic circumstances differed in important ways (Joint Committee on Taxation 2005b).⁶ Further, the cost of the tax laws was not trivial. It was estimated that KETRA would cost \$3.3 billion in the first year, TY 2006 (Joint Committee on Taxation 2005a). The cost of the tax expenditures in GOZA was estimated to be \$3.95 billion in the first year, tax year 2006, and \$8.67 billion over ten years (Joint Committee on Taxation 2005c).

After six years, it remains to be seen whether the Acts had an effect on the recovery of the region. In part, this is because it is quite difficult to disentangle the effects of each provision of the Acts, because rather than a single policy “lever,” many rule changes were made, covering individuals and businesses. Further, provisions in the Act were effective for different lengths of time or by actions taken during specific dates after the storm, and many provisions were extended beyond their sunset date, with some still in effect today.⁷ Therefore, the objective of this research is to evaluate the impact of the totality of the law changes on measures of economic well-being of those covered by Acts. The hurricane offers a unique natural experiment, and the tax Acts are well suited as policy shocks because they were enacted quickly in the wake of Hurricane Katrina, thus taxpayers (individuals and businesses) did not have time to change their behavior prior to the passage of the laws in anticipation of new rules.

⁶ Congress passed two Acts following the 9/11 attacks: The Victims of Terrorism Tax Relief Act of 2001 and the Job Creation, and the Worker Assistance Act of 2002.

⁷ As of April 22, 2011.

While the storm did not respect jurisdictional boundaries, the law’s boundaries were clearly drawn and demarcated by county and state; as a result, some counties were not included in the law but nonetheless incurred damage due to the storm, particularly counties with low amounts of damage. Using the boundaries of the GO Zone and storm damage data generated from FEMA risk analysis software, we create matched “treatment” and “control” groups, covering counties in Mississippi, Louisiana, and Alabama, Tennessee, Arkansas. The treatment group consists of counties within the GO Zone, and the control group consists of like-damaged counties—as measured by a loss ratio—outside of the GO Zone that were otherwise similar in their socioeconomic and demographic characteristics.

Because we match counties by level of storm damage (as well as other factors), this inherently means that we are only able to investigate economic impacts of GO Zone designation on counties that suffered small impacts of the hurricanes—since all moderately and heavily damaged counties are included in the GO Zone. And since many of the provisions of the KETRA and GO Zone Acts were targeted to assist households or businesses who suffered actual losses from the hurricanes, it is less likely our approach will reflect the impact of those types of provisions. Our approach is more likely to reflect the impact of provisions intended to promote investment and economic development in the entire GO Zone region, regardless of whether the beneficiaries had been damaged by hurricanes. Our analysis focuses on comparing aggregate economic outcomes between two groups. As such, we use a matching estimator to generate difference-in-differences estimates of the effect of the Acts on the rate of change in per-capita income and its

major components (net earnings, receipt of interest, rents and dividends, and transfer payments), employment per capita, and population.

Background

On the morning of August 29, 2005, Hurricane Katrina made landfall in southern Plaquemines Parish Louisiana as a Category 3 hurricane. Maximum winds were estimated to be 125 mph to the east of the center of the hurricane. After landfall, the Hurricane followed a path north through the center of Mississippi. As the storm moved inland, winds diminished, but peak wind gusts still exceeded 100 mph in much of Mississippi and counties along Alabama's western border.

Katrina took a large human toll, both in terms of deaths and through the uprooting of lives. The estimated death toll was greater than 1,880, and the displacement, especially of residents of New Orleans, was estimated at 250,000. The hurricane was also very destructive in terms of economic losses. In August 2006, insurance industry estimates put the losses at approximately \$60 billion (including flood damage), though some have estimated the storm could cost the Gulf Coast states as much as \$125 billion (NOAA 2005).

Although Katrina received the bulk of the press—and for good reason—two other hurricanes, Rita and Wilma, would also make landfall in the southern United States. Hurricane Rita, a storm with a similar origin and track as Katrina was next to hit the Gulf Coast—though sparing South Florida by passing south through the Florida Keys. On September 22nd, Rita was a category 5 hurricane, and was making an ominous turn to the north toward the coast of Louisiana. As President Bush was signing the Katrina

Emergency Tax Relief Act of 2005 (HR 3768), Hurricane Rita was churning in the Gulf of Mexico as a category 3, slightly more than 125 miles from the coast, and would make landfall at the Texas/Louisiana border, early the following day, before heading north through Eastern Texas and Northwestern Louisiana as a tropical depression. It is estimated that 35 people died due to Rita, and it produced damages estimated at \$16 billion (NOAA 2008).

Disaster Relief Efforts⁸

Following the Hurricane, tax relief to victims of the 2005 Hurricane came primarily from two laws.⁹ On September 23rd, 2005, the Katrina Emergency Tax Relief Act of 2005 (KETRA) was signed by the President. Later that year in December, Congress enacted more tax relief with the Gulf Opportunity Zone Act of 2005 (GOZA), which repealed and replaced several provisions in KETRA, but added many more, most of which were business-related. Features of KETRA and GOZA disaster relief were similar, and in many cases identical, to those enacted after the terrorist attacks in New York. Like the Liberty Zone in New York, they created geographic boundaries that were used to establish eligibility for the tax provisions (Figure 1).

[INSERT FIGURE 1 HERE]

The Hurricane Katrina Disaster Area covers all areas that were declared a major disaster by the President because of Hurricane Katrina. The Gulf Opportunity Zone (GO Zone), also known as the Core Disaster Area, is a subset of the Katrina Disaster Area,

⁸ We restrict the discussion to the GO Zone and Katrina disaster area, but many of the provisions below apply to the Rita and Wilma Zones.

⁹ Some states made modifications to their tax codes to provide relief to their state's taxpayers.

and covered counties that were deemed eligible for individual only or individual and public Federal Assistance under section 401 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (IRS 2006).

Employment, Housing, and Income Support

Employment relief, as it was termed in the KETRA and codified in the IRC came in the form of credits to employers who retained workers or made it easier for workers to remain in their positions. The Employee Retention Credit was provided to businesses that were rendered inoperable by the Hurricane and that otherwise retained their employees. The provisions provided for a credit of 40% of the wages paid to an eligible retained employee living in the Katrina core disaster area, up to a max of \$6,000 in wages. Originally, the provision in KETRA covered employers of 200 or less employees, but the limit was removed by GOZA, and the credit ended on December 31st, 2006.

The WOTC was expanded to create a new group of “targeted” employees: Katrina victims. The WOTC, like the retention credit noted above, allowed employers to take a credit worth 40% of wages paid, up to \$6,000 per qualified employee.¹⁰ The original date of expiration was August 27th, 2007; however the provision was extended several times and finally expired on August 27th, 2009. GOZA also provided an incentive for employers to provide lodging. Employees who accepted the offer of lodging were allowed to exclude up to \$600 of the value of the lodging from their gross income,¹¹ and employers were allowed a credit for 30% value of the excluded amount.

KETRA created rules allowing residents of the Katrina disaster area who sustained economic losses due to Katrina to supplement their income through the use of

¹⁰ A qualified employee is someone who lived in the GO Zone when the Hurricane struck.

¹¹ The value of employer-provided lodging still applies for purposes of calculating Social Security and Medicare taxes, as well as the unemployment tax.

their retirement accounts and other specialized tax-favored accounts, 401(k), 403(b), or governmental 457 plan.¹² The provision allowed individuals to take distributions of up to \$100,000 from a qualified plan, increasing the limit from the previous \$50,000.

Distributions could be taken without incurring a penalty that would normally accompany an “unqualified” distribution, which is generally a distribution taken before age 59½ or not due to death or disability. Further, rules allowed these distributions to be re-contributed to an eligible plan made in the subsequent three-year period following a distribution and treat the contribution as a rollover, thus not includible in gross income. In lieu of a roll-over, taxpayers could elect to include the qualified distribution in income ratably over a three year period, reducing the tax burden of such a distribution in any one year. For the purposes of this provision, victims of Hurricane Katrina were permitted to take distributions between August 25th, 2005 and January 1st, 2007.

Low income residents benefited from a special look-back rule for determining earned income. Residents of the GO Zone or residents of Katrina Disaster Area were permitted to use the previous year’s earned income when determining the earned income tax credit or refundable child tax credit for tax year 2005, if the earned income from the previous year was less than that of the taxable year that included September 23, 2005.

One of the larger (in dollar terms) provisions was the suspension of certain limits on personal casualty losses—\$2.4 billion according to the Joint Committee on Taxation (2005a). The provision allowed taxpayers in the Katrina Disaster Area to take a deduction for a loss that was not compensated by insurance even if it did not pass the \$100 loss threshold or the aggregate of losses did not exceed 10% of the taxpayer’s AGI.

¹² GO Zone expanded the provision to victims of Hurricanes Rita and Wilma, codified in IRC section 1400Q.

KETRA also provided a modification to a rule that extended the period of replacement for the non-recognition of a gain from an involuntary conversion of property, for example if a resident of the GO Zone received an insurance payment due to damage or loss from the Hurricane. Under the modification, the resident had up to five years to replace the property if it was used in the Katrina Disaster Area. If the taxpayer made the qualified investment, the gain, if there was any, did not have to be recognized at the time of the conversion. Like the suspension of limits on casualty losses, the cost of this provision was relatively large, approximately \$2.1 billion.

Tax-advantaged Financing

Under GOZA, Alabama, Louisiana, and Mississippi, and their respective political subdivisions were authorized to issue new debt to finance government functions or service outstanding government debt in the GO Zone. Early estimates of the aggregate volume of new bonds—whether private-activity bonds or advance refunding bonds—was in the range of \$23 billion (Sigo and DeSue 2006). In addition, certain qualified private activities with a public goods component such as transportation facilities, residential rental property that serves low-income residents, or privately owned utility facilities, could also be financed through tax-exempt bonds, and in this case, the state or local jurisdiction serves as a conduit between investors and private activities. The benefits of tax-exempt financing are clear: Perspective bond holders are willing to accept a lower interest rate if they can exclude from gross income the interest earned on the bonds, all else equal.

Included in the tax-advantaged financing were mortgage revenue bonds, which helped to finance home purchases, or make repairs and home improvements, through

special rules for mortgage revenue bonds, which exempts interests on State or local bonds, if the bonds were used to finance mortgages for home purchases in the GO Zone, or to make repairs to an existing home.

In addition to tax-exempt bonds, GOZA created a new category of tax credit bonds called Gulf Tax Credit Bonds (GTCBs). Unlike tax-exempt bonds, which pay interest that is excluded from gross income for tax purposes, tax credit bonds do not pay interest—rather they allow the bond holder to take a tax credit in lieu of an interest payment. The tax credit is determined by a credit rate multiplied by the bond’s face value, and the credit rate is set by the Secretary of the Treasury. The volume of tax credit bonds issued was \$350 million, much smaller than the volume of tax-exempt bonds, and the GTCBs were only issued to refund outstanding bonds or to provide loans to jurisdictions to service outstanding debt (Maguire 2008). The ten-year estimated cost to the treasury of the bond provisions was approximately \$2.4 billion (Joint Committee on Taxation 2005c).

Investment Incentives

Several provisions of the tax relief regarding business expenses, acquisition of capital, and treatment of certain losses were also given increased tax advantages, effectively lowering the owner’s cost of doing business. Certain Gulf Zone property was eligible for a first-year depreciation deduction worth 50% of the adjusted basis of the property if a business invested in tangible property in the GO Zone where “substantially all of the use of which is in the Gulf Opportunity Zone and is in the active conduct of a trade or business by the taxpayer in that Zone” (JCT 2005). Furthermore, the definition

of tangible property included certain nonresidential real property and residential rental property.

As another incentive to invest in other tangible property in the GO Zone (as opposed to real property, e.g., land or permanent structures), businesses were allowed to take an increased expensing deduction in lieu of depreciation. If a business chose to expense the investment, it was previously limited to \$100,000 by Section 179 of the IRC.

¹³ However, GOZA codified the provision to allow for up to an additional \$100,000 deduction, if the investment was made in a qualified section 179 GO Zone property, and the Treasury was granted authority to extend bonus depreciation placed-in-service dates on a case-by-case basis.

GOZA also granted a total of \$700 million in additional New Markets Tax Credits to be allocated for investments in the GO Zone from the date of the Hurricane through 2006. The New Market Tax Credit was first introduced in the Community Renewal Tax Relief of 2000, and is structured so that taxpayers who make qualified equity investments in a Community Development Entity (CDE) may claim non-refundable credits worth up to 39% of the cost of their investment (Marples 2007). To qualify for an allocation of credits, the CDE must demonstrate that it serves low-income communities either through lending, investments in other CDEs, or through financial counseling. The allocation of New Market Tax Credits was estimated to cost the Treasury \$387 million over 10 years.

Other Recovery Efforts

The responsibility to remove debris from the Hurricane and demolish damaged structure was in many cases that of private citizens. Under then-present law, the costs of debris removal generally was either capitalized into the basis of the land the property was

¹³ Indexed for inflation beginning in 2003.

attached to or expensed in the present year, depending on their nature.¹⁴ If the property was held for business or trade, or used to produce income, a provision in GOZA allowed for generous expensing of demolition and clean-up costs that would otherwise be charged to the business's capital account. The provision allowed for a deduction of 50% of the cost, with the remainder being capitalized.

Tax-advantaged expensing of environmental remediation costs to clean up hazardous waste was extended to costs related to the clean-up of qualified contaminated sites in the GO Zone to include sites contaminated with petroleum products, which under present law, are not included. In cases where taxpayers in the GO Zone had net operating losses (NOL), such taxpayers could take advantage of the extension of the NOL carryback rule to five years for amounts related to casualty losses, housing or moving expenses, depreciation of GO Zone property, and repair expenses.

The Southern United States is a major producer of domestic timber, growing a combination of hardwoods and softwoods, and millions of acres of timber were vulnerable to partial or total loss. As a result of Hurricane Katrina, high winds took a large toll on the timber industry in the Gulf Region. The USDA's Forest Service estimated 4.2 billion cubic feet (19 million board feet) of timber was lost in an area spread over 5 million acres covering Mississippi, Alabama, and Louisiana (USDA 2005). To assist with recovery of the industry, changes were made to the IRC to promote reforestation.¹⁵ Under then-present law, \$10,000 of reforestation expenditures could be expensed in a single tax year. Under GOZA, owners of timber holdings that were

¹⁴ Some costs associated with debris removal may be considered as the cost of doing normal business and are thus deductible; however, if clean-up costs also involve demolition and replacement of property, it may be appropriate to capitalize the cost.

¹⁵ Rules for expensing and the five-year net operating loss carryback covered taxpayers who held 500 acres or less of timber property.

damaged due to Katrina and were in the GO Zone were permitted to double their reforestation expense deduction. To further assist with the damaging winds, net operating losses (NOLs) associated with timber holders were allowed to be carried-back five years, as opposed to the previous two years under present law Section 172.

KETRA created and GOZA codified and expanded an allowance for a suspension of limitations on charitable gifts, for both individual and corporate donors, ostensibly promoting charitable giving to organizations providing assistance to Katrina victims, particularly those who would have been limited by the existing contribution limit. However, only in the case of corporations were the contributions required to be for relief efforts to Hurricane Katrina.

Table 1 provides a summary of the major provisions of KETRA and GOZA, as well as the covered area, additional eligibility rules, and expiration dates of the provisions.

[INSERT TABLE 1 HERE]

Econometric approach

A basic challenge in empirically assessing the impacts of a policy is that we do not observe the counterfactual situation; i.e., what would have happened to the parties affected by the policy (the “treated” group) in the absence of the policy. When random assignment is not possible, as in the present case, some method of estimating the counterfactual outcomes is necessary. Commonly used methods of *ex post* economic impact evaluation include multiple regression analysis, difference-in-difference (DD) estimation, and quasi-experimental matching methods (Ravallion 2008).

These approaches have different strengths and weaknesses. Parametric regression models provide the most efficient estimator if the parametric assumptions are correct. However, these models can give biased results if the parametric assumptions are violated or if factors associated with both the incidence of the policy (or other explanatory variables) and outcomes are excluded from the model. Matching methods avoid dependence on parametric assumptions about how the policy and other factors affect outcomes; as long as there are sufficient numbers of good matches in the unaffected group for each observation in the group affected by the policy, matching can produce valid impact estimates regardless of the true relationship between observed variables and outcomes. However, like regression methods, these methods are sensitive to omission of relevant factors jointly associated with policy incidence and outcomes. DD estimation addresses the problem of unobserved confounding factors by subtracting out initial mean differences between the participant and non-participant groups. This approach is effective if the confounding factors are fixed over time or have the same additive impact on both groups, since the effects of these factors will be subtracted out (whether or not such confounding factors are observed). However, DD estimation does not address differences that may arise if the two groups were experiencing different trends in outcome variables even before the program.

Using combinations of these methods can help to address the limitations of individual methods, resulting in more robust conclusions (Ravallion 2008). For example, combining matching with DD estimation can help to reduce biases associated with observable differences between treated and untreated populations (using matching), and the effects of observable or unobservable fixed factors or common trends (using DD).

Conditional DD estimators, some of which combine propensity score matching (PSM) with DD estimation, have been shown to reduce the bias of simple DD and matching estimators in studies using randomized groups to produce unbiased benchmark estimates of impact (Heckman, et al. 1998; Smith and Todd 2005).

For these reasons, we combine matching and DD estimation in our analysis of the economic impacts of GO Zones. We compare mean differences in outcome variables from pre- to post GO Zone policy changes between matched GO Zone counties and non-GO Zone counties. We use either PSM or Mahalanobis metric (MM) matching methods to select the comparison groups.¹⁶

Each of these matching approaches has strengths and weaknesses. A major strength of PSM is that matching on the propensity score is sufficient to estimate the average treatment effect, provided that the assumption of “unconfoundedness” holds and sufficient overlap exists between the propensity scores of the treatment and control groups (Rosenbaum and Rubin 1983).¹⁷ There is no theorem comparable to that of Rosenbaum and Rubin (1983) providing a theoretical justification for the MM method, and MM often is more biased (due to differences in mean values of X_T and X_C in matched samples) than PSM, especially when a large number of covariates are involved (Gu and Rosenbaum 1993; Zhao 2004).

¹⁶ PSM matches treatment and control observations using the propensity score as the measure of distance between observations. The propensity score is the probability of being in the treatment group conditional upon observed covariates ($p(X)$). MM matches treatment and control observations by minimizing the distance function $d_{TC} = (X_T - X_C)' \Sigma^{-1} (X_T - X_C)$, where X_T and X_C are vectors of matching variables for the treatment and potential control observations (considering all possible controls, and not only matched ones), and Σ is the variance-covariance matrix of X_C .

¹⁷ The “unconfoundedness” assumption is the assumption that the counterfactual outcome that would have occurred without the treatment is independent of treatment status, conditional upon the observed covariates (X). The overlap assumption is the assumption that $0 < p(X) < 1$, which ensures that there are members of the comparison group for both treated and untreated units of observation. Rosenbaum and Rubin (1983) proved that under these assumptions, comparing groups that match in terms of $p(X)$ is sufficient to ensure that they match in terms of individual covariates X , and that the comparison yields the average treatment effect.

Nevertheless, the MM estimator often has lower standard errors than the PSM estimator and in many cases lower mean squared error, despite being more biased (Zhao 2004). Another advantage of the MM estimators is that the estimated standard errors for MM are asymptotically consistent, provided that the bias resulting from imperfect matching on covariates is corrected (Abadie and Imbens 2006).¹⁸ To address the bias, we use the MM version of the matching estimator developed by Abadie, et al. (2004), which corrects the bias using auxiliary least squares regressions of the outcome on the covariates for the matched control observations.¹⁹

For PSM, the estimated standard errors are not valid, both because of imperfect matching and because the estimated standard errors do not account for the fact that the propensity scores are estimated in a first stage estimation. We use bootstrapping to estimate the standard errors for the PSM estimator.

We use nearest neighbor PSM without replacement, which yielded better matches than PSM with replacement.²⁰ The comparison non-GO zone counties were selected from the three GO Zone States – AL, LA and MS – and from three neighboring states – AR, TN, and GA. We restricted the set of possible comparison counties to counties from GO Zone and neighboring states in order to limit the potential confounding influence of

¹⁸ Abadie and Imbens (2006) proved the consistency and asymptotic normality of a class of bias-corrected covariate matching estimators that includes the Mahalanobis metric as a special case (Ibid., footnote 4, p. 239).

¹⁹ Formally, Abadie, et al. (2004) estimate the counterfactual outcome for each treated observation i (Y_{oi}) as:

$Y_{oi} = (1/\#m(i)) \sum_{k \in m(i)} \{Y_{ok} + \mu_o(X_i) - \mu_o(X_k)\}$, where $m(i)$ is the set of matched control observations to treated observation i , $\#m(i)$ is the number of matched observations in this set, Y_{ok} is the outcome of matched control observation k (within $m(i)$), and $\mu_o(X)$ is the estimated linear regression function of the outcome on the covariates within the matched control group. The terms $\mu_o(X_i) - \mu_o(X_k)$ correct the estimated counterfactual outcome for differences resulting from differences in the values of the covariates between the treated (X_i) and matched control observations (X_k).

²⁰ We also investigated use of kernel PSM, but this resulted in even fewer treated observations that satisfied the common support requirement. We do not report those results, although they were qualitatively similar to the results reported here. Results available from the authors upon request.

differing historical, demographic, socioeconomic and policy contexts. Although the contexts are similar in these neighboring states, differences across states still may confound our results. Hence, in one variant of the PSM model, we include state level fixed effects and restrict the model to the three GO Zone states. This resulted in substantially fewer non-GO Zone counties in the analysis – reducing the number from 444 to 116 non-GO Zone counties – and poorer matches and larger standard errors. Nevertheless, we include this analysis to investigate the robustness of our findings to such variation, and helping to rule out unobserved differences across states in confounding factors as a possible explanation for our results. We also investigate robustness to the matching method, using nearest neighbor MM, with replacement.²¹ The MM estimator resulted in larger biases than PSM, which were corrected using auxiliary regressions as noted previously.

Our matching procedures impose the “common support” requirement, which drops treated observations with estimated propensity scores above the maximum propensity score in the control group, to avoid comparing observations that were poorly matched. This requirement resulted in dropping 52 GO Zone counties from the analysis, leaving 43 GO Zone counties in the matched samples.²² The most significant difference between the GO Zone counties that were dropped and those retained was the estimated loss ratio due to Hurricane Katrina: the mean loss ratio among the retained GO Zone counties was 0.04% and the maximum was 0.23%, compared to a mean loss ratio of 1.6% in the dropped GO Zone counties. The common support requirement eliminated high

²¹ Matching with replacement is the only option available with the bias corrected MM estimator provided by Abadie, et al. (2004).

²² In the model using state fixed effects and limiting the analysis to the three GO Zone states, the common support requirement dropped 57 GO Zone counties, keeping 38 GO zone counties in the analysis.

loss counties because there are no non-GO Zone counties with high enough losses to serve as suitable counterfactuals. Hence, our estimates are not representative of all GO Zone counties, but only of GO Zone counties that suffered relatively small losses, and for which suitable matching non-GO Zone counties could be identified.

To test whether our results are biased by unobserved confounding factors, we use a test suggested by Imbens and Wooldridge (2009), which is a test for significant differences in outcomes using pre-program data. If there are significant differences in pre-program trends in outcome variables between the matched groups, it contradicts the assumption that the differences in trends observed during the program period are due to the program.

Variables and data

All variables were measured at the county level. The outcome variables that we investigate include changes in per capita personal income and its major components (net earnings; dividends, interest and rent; and transfer payments), per capita employment, and population. We investigate changes from 2004 – the year prior to Hurricanes Katrina, Rita and Wilma – to 2008 (the latest year for which data were available when the analysis was conducted). The source of data for these variables is the U.S. Department of Commerce Bureau of Economic Analysis (BEA) Regional Economic Information System.

The covariates used in the matching procedures include the value of estimated losses due to Hurricane Katrina as a percentage of the value of property (loss ratio); whether the county was a metro county; the mean per capita personal income, population

and poverty rate in the county in 2000; the share of adults employed in major industries (agriculture, forestry, fishing, and hunting; construction; manufacturing; retail trade); Federal economic development grants per capita to the county in 2000 and 2001; the population density of the county in 1990; the rural and farm shares of the population in 2000; the shares of the population that are Black, children and elderly; the share of the adult population with greater than a high school education; and the shares of men and of women who worked full time all year in 1999. Except for the loss ratio, all of these variables were used in a recent analysis of the economic impacts of the Delta Regional Authority, a regional economic development program operating in the Mississippi Delta region (Pender and Reeder 2011), and many have been used in previous analyses of economic impacts of development programs or other interventions (e.g., Isserman and Rephann 1995; Stenberg, et al. 2009). These variables represent socio-economic and demographic factors hypothesized to vary between GO Zone and non-GO Zone counties and that can affect the outcome variables.

The source of data on loss ratios is the Hazus model developed by the Federal Emergency Management Agency (FEMA) (<http://www.fema.gov/plan/prevent/hazus/>). Hazus is a risk assessment tool for analyzing losses from floods, hurricane winds, and earthquakes. The software can be used to estimate physical damage to homes, businesses, public buildings, and infrastructure. It can also be used to estimate other losses, such as the loss of employment, and other economic losses. We used county level estimates of losses resulting from Hurricane Katrina provided by FEMA, estimated as the sum of the capital stock losses (i.e., building + contents + inventory losses) multiplied by 100 and divided by the sum of the building replacement values.

The sources of the other covariates are discussed in detail in Pender and Reeder (2011), and include the 2000 Population Census (for almost all of the covariates) and the Consolidated Federal Funds Report (for Federal Economic Development grants), and analysis by the Economic Research Service of 1990 Population Census data (for population density).

Results

Performance of the matching estimators

The matched set of GO Zone and non-GO Zone counties, using the PSM model and all counties in six States (AL, LA, MS, AR, GA, TN) are shown in Figure 2. The mean characteristics of the unmatched and matched set of counties using this model are reported in Table 2. The unmatched GO Zone counties are statistically significantly different from other counties in these States in many respects: on average they suffered higher losses from Hurricane Katrina; had lower personal income per capita and a higher poverty rate in 2000; had a smaller share of adults employed in manufacturing, a smaller farm share of the population, a larger Black share of the population, a larger child share of the population, a smaller elderly share of the population, and a larger share of adults with more than a high school education in 2000; and smaller shares of men and women who worked full time all year in 1999. Except for having more educated adults and fewer elderly, most of these differences reflect factors associated with lower incomes and greater poverty in the GO Zone counties than other counties in these States.

[INSERT FIGURE 2 AND TABLE 2 HERE]

By contrast, there are no statistically significant differences between the covariate means of the matched samples for any covariates, and the magnitude of the differences are in most cases fairly small, using the PSM model for counties in all six States. The largest remaining differences in the matched samples (measured by the absolute value of the percentage difference in means greater than 10%) are in the loss ratio; the population level in 2000; the share of adults employed in agriculture, forestry, fishing and hunting; population density. A global balance test of this PSM model, which tests the fit and significance of a probit model for the matched sample, indicates that the pseudo R^2 for the matched sample is low (0.111) and the significance level of the set of covariates in that model is high (0.827), both of which indicate good performance of the matching procedure (Table 3).²³

[INSERT TABLE 3 HERE]

In the three State PSM model with State fixed effects, the matching does not perform as well, but still achieves a reasonably good balance for most covariates. The only statistically significant difference between the covariate means for the matched groups is for the loss ratio, which is 0.044 for the matched GO Zone counties and 0.016 for the matched non-GO Zone counties, a somewhat larger difference than occurs with the six State PSM model, and statistically significant at the 0.053 level. The global test also indicates poorer matching performance of this restricted model, with a larger pseudo R^2 (0.226) and smaller significance level (0.303) for the joint significance test of the covariates in the matched sample. Still, the restricted model achieves reasonably good balance according to this global test.

²³ If the model achieved perfect matching, the pseudo R^2 would equal 0 and the significance level of the covariates would equal 1.0 for the probit model on the matched sample.

The MM model (used with the six State sample) performs the worst in achieving good matches. There are statistically significant differences between the mean values of several covariates for the matched samples in this case, including differences in the Black share, the child share, and the elderly share of the population (all significant at the 5% level or less). The global balance test also indicates poorer matching, with a higher pseudo R^2 and joint statistical significance of the covariates in the probit model on the matched sample (Table 3). Given the poorer matching performance of the MM estimator, it is especially important to correct for bias with this estimator, as we do using the estimator of Abadie et al. (2004).

Differences in outcomes

The mean differences in the outcome variables between the matched set of GO Zone and non-GO Zone counties are reported in Table 4 for each of the matching models. All three models find that the mean growth in per capita personal income from 2004 to 2008 was statistically significantly greater in the matched GO Zone counties than in the matched non-GO Zone counties (significance at the 10% level in the two PSM models and at the 5% level in the MM model). The mean difference in growth was about \$1,000 per capita in the two PSM models and more than \$1,200 per capita in the MM model.

[INSERT TABLE 4 HERE]

We investigated the timing of the impact on growth in per capita incomes by investigating the differences in growth from 2004 to 2005, 2006 and 2007. We find statistically insignificant differences in all cases, although the results from all models suggest greater growth began to be achieved by 2006, although the impact was not measurable with statistical confidence until 2008. Given the statistical insignificance of

the differences in personal income per capita in prior years, we did not investigate the similar time pattern of other outcome variables, for which impacts through 2008 were less statistically significant or insignificant.

We find weakly statistically significant difference in growth in net earnings per capita (at the 10 percent level) using two of the matching models (PSM and MM with the six State sample). The difference is somewhat smaller and with a larger standard error in the restricted PSM model, so is statistically insignificant. Nevertheless, in all three models, the estimated impact is positive and in the range of about \$750 to \$900 of additional growth in net earnings per capita in GO Zone counties.

We also find some evidence of more rapid growth in dividends, interest and rent in GO Zone counties. Across the three models, the estimated impact is in the range of \$250 to \$500 of additional growth in property income, although the estimated impact is statistically significant only in the MM model. Similarly, we find some evidence of more rapid growth in employment per capita in GO Zone counties, though again the estimate is statistically significant only in the MM model. And finally, we find statistically insignificant differences between GO Zone counties and matched non-GO Zone counties in changes in transfer payments per capita and in population, using all three models.

As noted previously, we investigated whether there were differences in growth rates of these outcome variables between the matched sets of counties prior to 2005, and these results are also reported in Table 4. In almost all cases, the differences in prior growth of the outcome variables were statistically insignificant. The change in per capita dividends, interest and rent from 2000 to 2004 was significantly less in the GO Zone counties according to two of the models (PSM and MM using all six states), which is in

the opposite direction of the changes from 2004 to 2008. Hence, we have no evidence that a continuation of prior differences in growth trends would explain any of the results for changes from 2004 to 2008.

Conclusion

Personal income per capita grew about \$1,000 faster from 2004 to 2008 in GO Zone counties than in matched non-GO zone counties having similar losses from Hurricane Katrina and similar socioeconomic and demographic characteristics. This finding was robust whether we included all counties in the GO Zone States and three neighboring States in the analysis, or limited the analysis to only counties in the GO Zone States. It was also robust to the method used for matching, with an even larger impact estimated using the MM estimator with bias correction. Differences in income growth prior to 2005 indicate that these results were not due to a continuation of differences in prior trends.

The main sources of increased growth in personal income in GO Zone counties appear to be more rapid growth in net earnings and property income. These results are less robust than the impacts on total personal income per capita, however, because the impacts are smaller and hence more difficult to measure. Consistent with the growth in earnings, we find some evidence of increased employment per capita in GO Zone counties, although this is not robust across estimators. We find no statistically significant difference between GO Zone counties and matched non-GO zone counties in changes in transfer payments or population.

Several of the provisions of GOZA may have accounted for the difference in the growth rate of per-capita income and one of its component, earnings, particularly the provisions that were wage subsidies. The WOTC—the credit offered to employers who hire employees living in the GO Zone—was effective through August 27, 2009, though the employee retention credit lasted through 2005 only. The GO Zone WOTC provision did not require the taxpayer to have suffered an economic loss, but rather eligibility was only contingent on residing in the covered area. Limited past research on the WOTC (and Welfare-to-Work) suggests that certification as a WOTC/WtW worker could result in greater earnings. Hamersma (2008) found the incidence of the credit at least partly accrued to WOTC-certified workers. It was reported they had an increase in their quarterly earnings of \$105, which is about close to a 9% premium, over similar workers who were not certified, though earnings gains were short-lived. Hence it is plausible that this provision could have influenced earnings and income in GO Zone counties that suffered small losses from Katrina.

Other provisions, such as tax-exempt bond financing and increased cost-recovery incentives may have contributed to the earnings growth through spurred investment in the GO Zone, but the mechanism is not clear. In fact, economic theory suggests lowering the cost of capital would result in substitution away from labor, which is consistent with our finding of limited effect on employment growth. To date, studies of similar programs, particularly “enterprise zones,” have provided mixed results to support the stylized hypothesis that tax advantages for capital investment induce employment growth (Peters and Fisher 2002). Enterprise zones, whether Federal or State, are geographically-targeted economic development zone that largely rely on tax incentives to promote employment

growth, community investment, and improve the economic circumstances of zone residents. A recent and notably robust study by Neumark and Kolko (2010) estimate the impact of California's enterprise zone program on the employment, and they fail to find an effect on employment within the zones relative to control groups.

Such provisions may have affected property income, such as rental income, by affecting property values. Hanson (2008) and Krupka and Noonan (2009) suggest geographically-targeted tax incentives might be capitalized into property values. Our finding (though statistically significant using only one estimator) that growth in property income was greater in GO Zone counties than matched non-GO Zone counties is consistent with this. Further research using data on property values is needed to more definitively test this possible mechanism of impact, however.

Because KETRA and GOZA incorporated many moving pieces of law, it is not possible to isolate the impacts of their specific provisions on the outcomes that we investigate. This study is only able to identify differences in income and employment growth between counties in the GO Zone and similar counties outside of that zone, and rule out a few alternative hypotheses for these results, such as the effects of State-specific policies or contexts, or the effects of the matching method. Although we have suggested some plausible hypotheses about mechanisms through which these policies may have led to these impacts, investigation of these hypotheses is beyond the scope of this study, and further research on this topic is needed and warranted.

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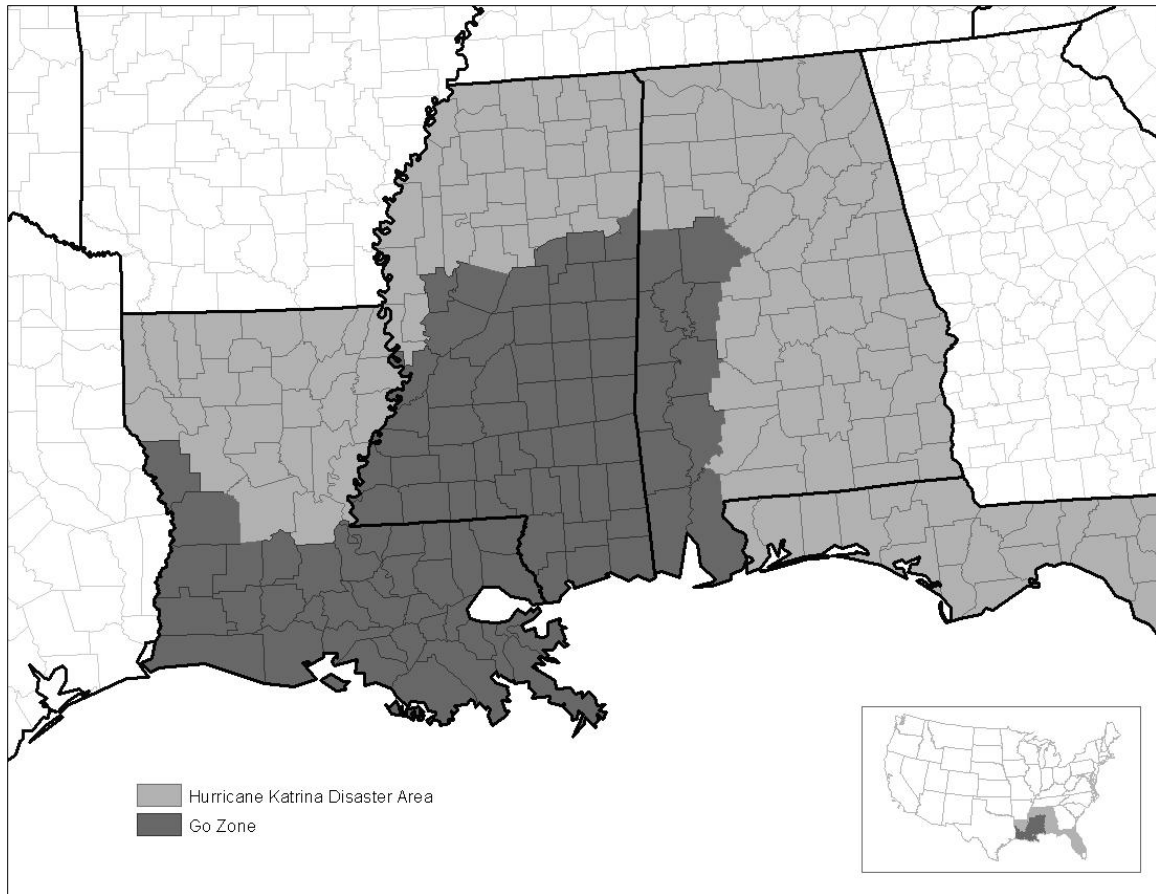


Figure 1. The Hurricane Katrina Disaster Area and the Gulf Opportunity Zone (GO Zone)
Source: IRS designations (IRS 2006).

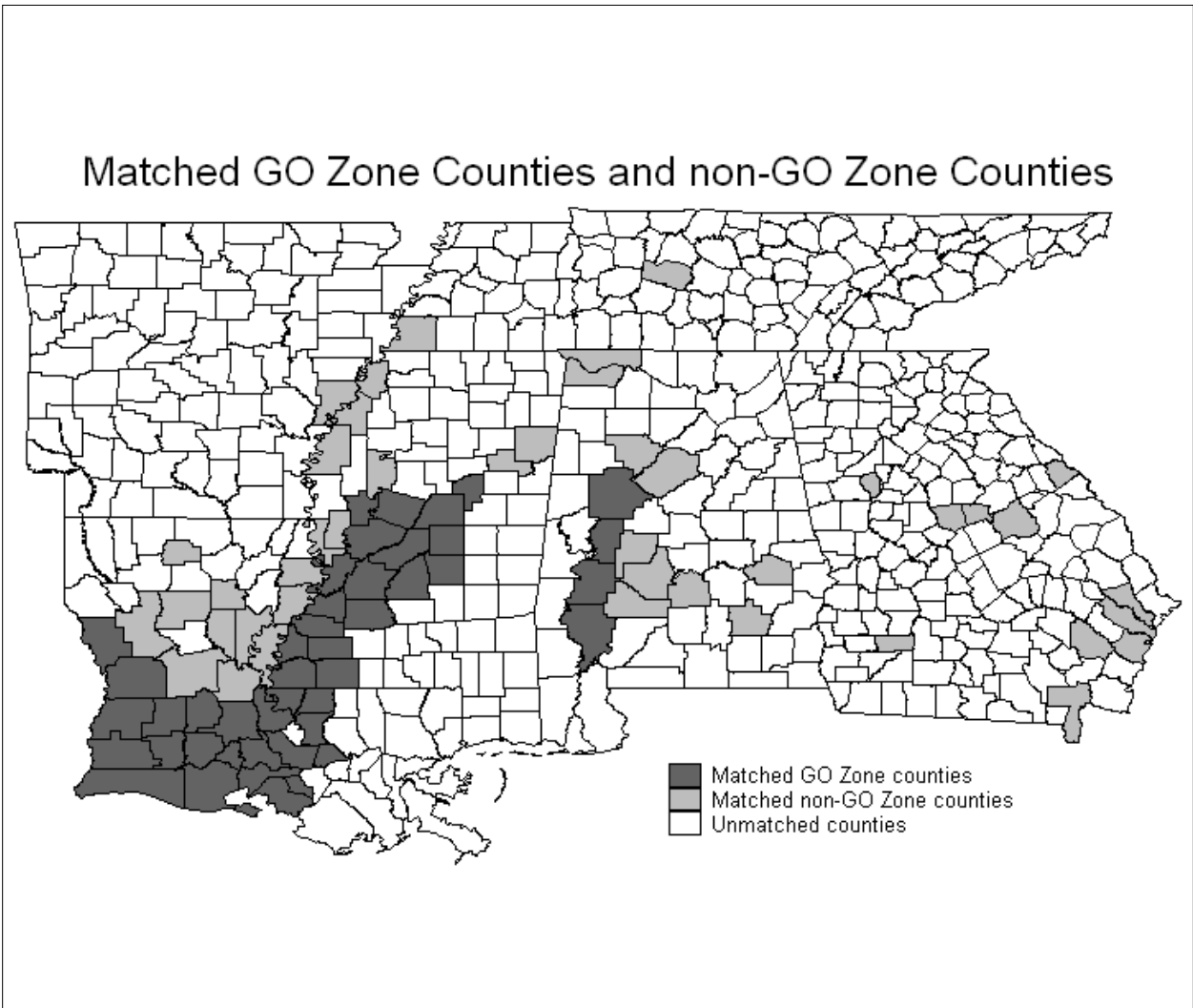


Figure 2. Matched GO Zone and non-GO Zone Counties
Source: Propensity score matching (PSM) analysis by the authors

Table 1. Major provisions of KETRA and GOZA

Provision	Law Establishing Provision	Covered Area	Additional Eligibility Rules	Sunset
<i>Employment, Housing, Income Support</i>				
Employee Retention Credit	KETRA	GO Zone	Inoperable business due to Katrina	12/31/06
Work Opportunity Tax Credit	KETRA	GO Zone	Employee resided and was hired in the GO Zone, or was displaced from the GO Zone ^a	8/27/09
Tax-favored withdrawals from retirement plans	KETRA	Katrina Disaster Area	Sustained economic loss due to Katrina	1/1/07
Look-back rule for EITC/Child Tax Credit	KETRA	GO Zone or Katrina Disaster Area	Resided in GO Zone or displace from Katrina Disaster Area	Tax Year 2005
Suspension of certain limits on casualty losses	KETRA	Katrina Disaster Area	Casualty loss due to Katrina	n.a.
Extended period of replacement for non-recognition of gain	KETRA	Katrina Disaster Area	Compulsory or involuntary conversion due to Katrina	n.a.
<i>Tax-advantaged Financing</i>				
Tax-exempt private activity bond financing	GOZA	GO Zone	Eligible projects must meet various rules regarding “public purpose” test	12/31/11
Mortgage revenue bonds	KETRA	Katrina Disaster Area	Residences located in covered zone ^b	12/31/10
<i>Investment Incentives</i>				
Increased expensing of GO Zone property	GOZA	GO Zone	Placed in service in the GO Zone on or after 8/28/05	12/31/08
Additional first-year depreciation	GOZA	GO Zone	Placed in service in the GO Zone on or after 8/28/05	12/31/08

Increase in New Markets Tax Credit for development of GO Zone	GOZA	GO Zone	Investments must be made in GO Zone	12/31/07
<i>Other Recovery Efforts</i>				
Increased expensing of certain demolition and clean-up costs	GOZA	GO Zone	Economic loss due to Katrina	12/31/07
Extension of expensing of environmental remediation costs	GOZA	GO Zone	Economic loss due to Katrina	12/31/07
Increased expensing of timber reforestation	GOZA	GO Zone	Economic loss due to Katrina	12/31/07
Extended net operating loss carryback period (5 year) for certain amounts related to Hurricane Katrina	GOZA	GO Zone	Economic loss, depreciation, or certain repair or moving expenses due to Katrina	12/31/07

Notes:

- a. Displaced workers were only covered until 12/31/05.
- b. Financed home improvements must improve residence's basic livability or energy efficiency.

Table 2. Mean Characteristics of GO Zone and Non-GO Zone Counties, using 6 State PSM model

Variable	Sample ^a	GO Zone counties	Non- GO Zone counties	t statistic	p> t
Metro county (share)	U	0.389	0.365	0.45	0.653
	M	0.372	0.372	0.00	1.000
Loss ratio (%)	U	0.927	0.004	9.10	0.000***
	M	0.037	0.018	1.61	0.111
Per capita personal income in 2000 (\$)	U	19955	21021	-2.40	0.017**
	M	19730	20627	-0.82	0.417
Population in 2000	U	64123	48549	1.52	0.130
	M	58728	72006	-0.48	0.631
Poverty rate in 2000 (%)	U	19.0	16.7	3.83	0.000***
	M	19.7	20.6	-0.60	0.550
Adults employed in agriculture, forestry, fisheries & hunting (share)	U	0.037	0.040	-0.76	0.445
	M	0.040	0.047	-0.85	0.396
Adults employed in construction (share)	U	0.086	0.082	1.16	0.245
	M	0.080	0.073	1.63	0.108
Adults employed in manufacturing (share)	U	0.168	0.224	-6.25	0.000***
	M	0.156	0.145	0.70	0.487
Adults employed in retail trade (share)	U	0.116	0.115	0.32	0.748
	M	0.115	0.113	0.75	0.454
Economic development grants per capita in 2000-2001 (\$)	U	331.9	319.2	0.22	0.822
	M	378.5	370.1	0.10	0.924
Population density in 1990 (persons/sq. mile)	U	114.9	88.2	1.25	0.211
	M	88.0	99.1	-0.30	0.763
Rural share of population (share)	U	0.616	0.661	-1.50	0.134
	M	0.584	0.557	0.45	0.654
Farm share of population (share)	U	0.020	0.026	-2.46	0.014**
	M	0.017	0.017	0.05	0.962
Black share of population (share)	U	0.357	0.222	6.16	0.000***
	M	0.394	0.419	-0.57	0.569
Children share of population (share)	U	0.275	0.257	6.73	0.000***
	M	0.277	0.277	0.06	0.956
Elderly share of population (share)	U	0.124	0.135	-3.26	0.001***
	M	0.122	0.121	0.11	0.915
Share of adult population with more than high school education (share)	U	0.369	0.347	2.13	0.033**
	M	0.357	0.382	-1.08	0.282
Share of men working full time all year in 1999	U	0.588	0.619	-4.12	0.000***
	M	0.575	0.575	-0.04	0.966
Share of women working full time all year in 1999	U	0.403	0.434	-6.12	0.000***
	M	0.402	0.406	-0.42	0.675

Notes: *, **, *** indicate difference is statistically significant at the 10%, 5%, and 1% levels, respectively.

a. 'U' represents unmatched sample; 'M' represents matched sample.

Table 3. Global balance test of unmatched and matched samples of counties in matching models

Sample	PSM with six State sample			PSM with three State sample and State fixed effects			MM with six State sample		
	Pseudo R ²	LR χ^2	p > χ^2	Pseudo R ²	LR χ^2	p > χ^2	Pseudo R ²	LR χ^2	p > χ^2
Unmatched	0.749	375.87	0.000***	0.711	206.37	0.000***	0.749	375.87	0.000***
Matched	0.111	13.21	0.827	0.226	23.80	0.303	0.295	35.19	0.013**

*, **, *** indicate difference is statistically significant at the 10%, 5%, and 1% levels, respectively

Table 4. Average effect of GO Zone Designation on Change in Outcome Measures, using different methods

Outcome measure	Time period	PSM – all six states	PSM – with state fixed effects (only GO zone states)	MM with bias correction
Change in per capita personal income (\$)	2004-2008	1046* (538)	1015* (619)	1260** (632)
	2004-2007	414 (541)	548 (577)	600 (541)
	2004-2006	446 (391)	384 (427)	207 (368)
	2004-2005	46 (227)	-99 (260)	-175 (225)
	2000-2004	-379 (333)	-517 (334)	-163 (269)
	2004-2008	912* (545)	746 (582)	837* (442)
Change in per capita net earnings (\$)	2001-2004	1 (280)	6 (198)	229 (208)
	2004-2008	251 (212)	390 (281)	484** (244)
Change in per capita dividends, interest and rent (\$)	2001-2004	-184* (97)	2 (99)	-440*** (109)
	2004-2008	-117 (98)	-122 (91)	-62 (64)
Change in per capita transfer payments (\$)	2001-2004	-76 (82)	-22 (81)	13 (51)
	2004-2008	-117 (98)	-122 (91)	-62 (64)
Change in per capita employment	2004-2008	0.0099 (0.0090)	0.0083 (0.0108)	0.0183** (0.0082)
	2000-2004	0.0010 (0.0117)	0.0025 (0.0157)	-0.0027 (0.0082)
Change in population	2004-2008	558 (1786)	349 (1369)	-302 (888)
	2000-2004	-176 (2019)	-229 (977)	-374 (839)

*, **, *** indicate difference is statistically significant at the 10%, 5%, and 1% levels, respectively