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# The economic impact of a casino monopoly: Evidence from Atlantic City

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ABSTRACT

Place-based policies and investments are often targeted at areas in economic decline and sometimes take the form of a granted monopoly (e.g., state flagship universities, professional sports franchises, mega events). After New Jersey voters approved legalized gambling as an economic development strategy to revive the blighted seaside resort town, Atlantic City held a regional monopoly on casinos east of the Mississippi River from 1978 through 1992. Using synthetic difference-in-differences, I find that commercial casinos had an immediate impact on the Atlantic City Metropolitan Area (Atlantic County) in the first five years through an increase in employment (26 percent), wages (9 percent), personal income (5 percent), and house prices (19 percent). The casinos' positive impact on the metropolitan labor market was persistent and increasing through the early 1990s, but I find evidence that the city's 1992 monopoly expiration negatively impacted the growth of local wages and personal income through 2000.

*Everything dies, baby, that's a fact*
*But maybe everything that dies someday comes back*
*Put your makeup on, fix your hair up pretty*
*And meet me tonight in Atlantic City*
— Bruce Springsteen, *Atlantic City* (1982)

## 1. Introduction

The economic narrative of a city may rise and fall over generations and evolves through the interaction of static and dynamic forces (Rosenthal and Ross, 2015). Natural advantages, such as proximity to a natural resource, can have a persistent impact on a region's outcomes (Bleakley and Lin, 2012; Marchand and Weber, 2018), but singular government policies may permanently shift its fortune (Kline and Moretti, 2013). Federal and state governments create place-based policies to boost the economic status of specific areas that have fallen on hard times. The impacts of such policies have varied considerably based on the type of policy, place, and time (Neumark and Simpson, 2015). Many headline-grabbing economic development policies and investments have had lackluster impacts, such as professional sports stadiums (Coates and Humphreys, 2003), movie production incentives (Bradbury, 2020), or large international events (Feddersen and Maennig, 2012). However, major infrastructure investments (Kline and Moretti, 2013), superfund cleanups (Greenstone and Gallagher, 2008), and higher education institutions (Andersson et al., 2004) have had more sustained and pronounced positive economic impacts on employment, home prices, migration, and productivity. Many of these place-based investments are inherent monopolies granted either by government or private organizations. To name a few examples, few metropolitan areas can support multiple professional teams for a single sport, the Olympics are hosted in one select city at a time, and a state can contain only one flagship university.

New Jersey voters approved legalized gaming for Atlantic City in 1976 and became an early adopter of using casinos to boost economic development.[1] The Indian Gaming Regulatory Act of 1988 encouraged more prevalent commercial and tribal casinos, and as of 2021, over thirty states have casinos (American Gaming Association, 2021; Walker, 2013). Research has examined the economic impacts on host economies that opened casinos in the 1990s and 2000s (Walker, 2013) and find that casinos support economic development, but the effect is higher in lower density areas and is moderated by the presence of nearby casinos (Zhang et al., 2020; Scavette, 2022). Therefore, the empirical evidence suggests that the economic effects of casinos for host regions would be strongest outside of a major urban area in a monopoly environment (none or few nearby gambling venues). The few studies (Hicks, 2014; Walker and Jackson, 2013) that evaluate the long-term impacts of casinos on host economies focus only on personal income and find very small effects.

A not unsubstantial body of research suggests that gaming monopolies tend to produce strong economic development effects. But little of it centers on Atlantic City during the period when it held a regional monopoly on gaming during the 1980s. The 1992 opening of

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[1] The only other destination for legalized gambling in the United States was Nevada, which legalized gambling in 1931.

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Connecticut's Foxwoods Casino represented the end of Atlantic City's monopoly era after which Rose (1995) suggests the city experienced "its market being eaten away by the opening of closer casinos of convenience" (pp. 35). Although much of the literature considers the casino experiment to be a failure at reviving Atlantic City itself, casino gaming likely stimulated major economic development in the wider region (Braunlich, 1996; Rubenstein, 1984) as the city became one of the most-visited tourist destination in the United States by the early 1990s (Madhusudhan, 1995).

By learning from the Atlantic City experience, policymakers might better assess the upper bound of what casinos are able to achieve for regional economic development in a period of gaming scarcity, or when the city held a casino "monopoly" on the East Coast. Additionally, since New Jersey was such an early mover in terms of using casinos for economic development, its long-term impacts can be studied both before and after its monopoly ended. Examining the impact of Atlantic City's monopoly expiration will contribute to the literature on how the loss of regional economic development program benefits impacts their economies. Kline and Moretti (2013) study whether a lapsed development policy has persistent effects by comparing the impacts of the Tennessee Valley Authority, a regional development program consisting of major infrastructure investments, during a period when federal benefits were greatest (1930–1960) to when they were scaled down to a negligible amount (1960–2000). The authors find that while agricultural employment gains slowed during the latter period, manufacturing employment in the region continued to grow faster than comparison areas, likely due to persistent local productivity effects of the investments during the former period. Cerqua and Pellegrini (2023) study European Union regions that experienced sharp reductions in subsidies by losing convergence status and find that the policy has benefits to economic growth up to seven years after lapsing. Schweiger et al. (2022) study Soviet Russia's historical "Science Cities" place-based policy and find persistent effects on local population size, educational attainment, patenting, and salaries twenty years after state subsidies were suspended. Additionally, research (Goldin and Olivetti, 2013; Saez et al., 2021) has found that temporary labor policies can have persistent effects on employment.

My study's contributions can be summarized as follows. First, although many studies evaluate the impact of casinos on host economies, this study is one of the first to utilize modern causal inference methods (e.g., synthetic difference-in-differences, synthetic control method) and the first to examine the causal effects of casino development on Atlantic City's regional economy. Second, unlike most studies, which only estimate short-term economic impacts from casinos, this study looks at the long-term effects of casinos over multiple decades. Third, by evaluating the loss of Atlantic City's casino monopoly, this study assesses the impact of a lapsing economic development policy as explored in the literature (Kline and Moretti, 2013; Cerqua and Pellegrini, 2023; Schweiger et al., 2022).

This article assesses the impact of Atlantic City's casino monopoly on payroll employment, personal income, wages, population, and housing prices over three treatment horizons (five-, ten-, fifteen-year) during its monopoly period (1978–1992) and over one treatment horizon (nine-year) during its post-monopoly period (1992–2000). I use synthetic difference-in-differences models (Arkhangelsky et al., 2021) to compare changes in Atlantic County[2] to all other New Jersey counties. Given that Atlantic City casino development was approved by a statewide referendum, it seems plausible that voters would have approved a casino monopoly for another one of the state's blighted cities (e.g., Asbury Park, Camden, Newark, Wildwood City).[3] Due to this revealed positive voter sentiment toward casinos and the fact that Atlantic County is influenced by similar political and economic factors, I restrict my control group to New Jersey's other counties. The identifying assumption is that the state's other counties form a valid counterfactual for that of Atlantic County after conditioning on county fixed effects, year fixed effects, and differences in preexisting trends.

The estimated impacts of casinos on payroll employment are substantial and persistent over the five-, ten-, and fifteen-year treatment horizons (26, 38, and 45 percent). Estimates for payroll employment by industry reveal that much of Atlantic County's early employment growth was driven by the services (43 percent) and construction (22 percent) industries. Employment growth coincided with a positive impact on wages in the five- and ten-year treatment horizons (9 and 11 percent). Additionally, I find significant five-year impacts for personal income (5 percent) and house prices (19 percent). Additionally, there was higher net migration for younger prime working-age individuals (ages 25–40) into Atlantic County during the 1980s compared to other New Jersey counties, as numerous casinos opened and employment per capita climbed. However, I find evidence that the expiration of Atlantic City's East Coast casino monopoly in 1992 may have negatively impacted wage and personal income growth within the metro area's economy through 2000.

## 2. Background and motivation

### 2.1. Literature review

There is an extensive body of literature about the negative social and health impacts of casinos on host regions such as problem gambling (Walker, 2013), crime (Friedman et al., 1989; Albanese, 2019), and drunk driving fatalities (Cotti and Walker, 2010). Additionally, negative local economic consequences arising from casino development have been studied such as reduced household wealth (Barron et al., 2002) and housing prices (Huang et al., 2018). However, while several studies measure the positive local economic impact of both tribal and commercial casinos (Garrett, 2004; Lim and Zhang, 2017; Wenz, 2014), few utilize robust causal inference methods or event study designs for identification.

Many studies evaluating the economic impact of casinos on host regions find short-lived positive economic effects of varying degrees on employment and wages. Using panel regression methods, Cotti (2008) models U.S. counties with new casinos from 1990 through 1996 and finds an 8 percent increase in employment compared to non-casino counties, but no impact on wages. The most sizeable impacts occurred between one and three years after the casino opened. Covering a similar treatment period (1988 through 1994), Rephann et al. (1997) matches sixty-eight U.S. counties that developed casinos to non-casino control counties on pre-treatment characteristics (industrial structure, spatial position, economic growth, and demographics) and compares their growth rate differences for several economic variables. Earnings (46 percentage points), employment (28 percentage points), and per capita personal income (5 percentage points) grew faster in the casino counties than in the matched counties. In a more recent study of Canadian casino openings between 1991 and 2006, Humphreys and Marchand (2013) find that census divisions with new casinos experience substantial employment and wage growth for one to five years following their openings (doubling of employment and wages for divisions that did not have existing casinos). However, their analysis suggests that the positive labor market effects did not extend beyond five years, and multiplier effects from casino development to other industries are limited (i.e., most resulting positive employment and wage growth are limited to the hospitality industry). The few studies that examine the economic impact of casinos on host areas beyond ten years find small long-term impacts on personal income. Walker and Jackson (2013) examine twelve states between 1990 through 2010 and find that casinos granger-caused per capita income growth over

[2] Atlantic County is coterminous with the Atlantic City Metropolitan Statistical Area.

[3] Many of the state's blighted cities (except Atlantic City) were later targeted for economic development with urban enterprise zones in the 1980s–2000s (Scavette, 2023).

the period. Hicks (2014) studies county-level data in Indiana over an eighteen-year period and finds modest increases (1 percent) in personal income on host counties.

Although many studies indicate economic gains for host regions that develop casinos, there is growing evidence of an effect that reduces the marginal benefits of developing in geographic proximity to existing ones, referred to in the literature as a "saturation," "cannibalization," or "competition" effect (Walker and Nesbit, 2014; Gallagher, 2014; Geisler and Nichols, 2016). In other words, competition between casinos in the same geographic market does not produce a positive agglomeration impact. Identifying a potential channel through which the "saturation" effect occurs, Walker (2013) indicates that consumers substitute between gambling activities to a point where consumption at new gambling venues may come at the expense of nearby existing gambling operations (e.g., existing commercial casinos, horse tracks, lottery). However, both Walker and Nesbit (2014) and Gallagher (2014) suggest that Atlantic City and other densely clustered destination casino markets (e.g., Biloxi, Las Vegas) likely benefit from retail agglomeration effects such that the addition of further casinos may add to the location's appeal in attracting tourists.

Lastly, many studies find that the economic benefits from casino development tend to be higher in lower density areas (Cotti, 2008; Garrett, 2004; Wenz, 2014). Garrett (2004) suggests that casino gaming is harder to detect in more-metropolitan areas where total employment is more variable and gaming represents a smaller share of total employment.

### 2.2. Casino gaming in Atlantic City

Nicknamed "America's Playground," Atlantic City welcomed nearly sixteen million tourists every summer during its 1930s heyday (Johnson et al., 2018). The small seaside resort offered visitors a boardwalk, four miles of beach, and a flagrant disregard of the federal prohibition on alcohol sales. The city's success and issues with organized crime during the period were immortalized in Johnson (2002) and the HBO series that it inspired, *Boardwalk Empire*. Unfortunately, the city's appeal to tourists diminished in the postwar period as the rise of automobiles, highway building, and inexpensive air travel broadened recreational options (Atlantic County Department of Regional Planning and Economic Development, 2000). Thus, Atlantic City shared the fate of many older northeast American cities of population loss and economic blight (Simon, 2004). Media coverage of the city's seedy and decaying features (e.g., poor quality hotels, dirty streets, burlesque theaters) as it hosted the 1964 Democratic National Convention cemented its reputation as a failed resort (Darrow, 2014; Press, 2016).

After rejecting statewide casino gambling two years earlier (60 percent voted "No"),[4] New Jersey voters narrowly approved legalized casino gaming (56 percent voted "Yes") in a 1976 referendum that limited the casinos to Atlantic City (Commission, 2023). The resulting amendment to the state constitution clarified how Atlantic City's regional monopoly on gambling might revive its appeal as a tourist destination and benefit the local economy:

> *"Legalized casino gaming has been approved by the citizens of New Jersey as a* ***unique tool of urban redevelopment for Atlantic City****. In this regard, the introduction of a limited number of casino rooms in major hotel convention complexes … will facilitate the redevelopment of existing blighted areas … and attract new investment capital to New Jersey in general and to Atlantic City in particular."* New Jersey Casino Control Act (1977)

The resulting state legislation, the Casino Control Act, established the New Jersey Casino Control Commission (NJCCC) in 1977 as the state's gaming control board, which is responsible for licensing casinos and key casino employees. The legislation requires applicants for the latter to establish residency in the state before receiving a license.[5] Additionally, the Casino Reinvestment Development Authority (CRDA) was established in 1984 to guide the investment of some casino tax revenues into public and private projects to revitalize Atlantic City, Atlantic County, and other parts of New Jersey.[6]

The first casino opened in Atlantic City (Resorts International) in 1978, followed by twelve others between 1979 and 1990.[7] The city enjoyed a regional monopoly on casino gambling in the eastern United States until 1992, when the Mashantucket Pequot Tribal Nation opened Foxwoods Resort Casino in Connecticut. Rose (1995) characterizes how the Foxwoods opening spurred an end to the city's coastal casino monopoly:

> *"Political and economic pressure to break the Foxwoods monopoly in the Northeastern U.S. market made competition inevitable. In 1993, an Indian casino without slot machines was opened by the Oneida tribe in the middle of New York state; casino ships with slots started operating out of ports in Connecticut; an Indian tribe in Rhode Island won a court order allowing it to open a casino; and legislation for slot machines, video lottery terminals, and more casinos on riverboats and on land was introduced in state legislatures in Massachusetts, Pennsylvania, Connecticut, and nearly every other jurisdiction north of Atlantic City" (pp. 25).*

## 3. Data

I use data on five annual economic variables for New Jersey counties between 1970 and 1992. The payroll employment and wage series come from U.S. Census' County Business Patterns (CBP). The payroll employment series is "Total Mid-March Employees," and the average weekly wage series is constructed by dividing the quotient of "Total First Quarter Payroll" to "Total Mid-March Employees" by thirteen. Population and Per Capita Personal Income come from the Bureau of Economic Analysis "Personal Income by County, Metro, and Other Areas" dataset. The housing price index series is the "House Price Index for Counties (All-Transactions Index)" from the Federal Housing Finance Agency where 1990 is the base year. I deflate the average weekly wages and per capita personal income variables to 2015 dollars using the annual "Consumer Price Index: Total All Items for the

[4] According to then New Jersey State Senator Raymond Bateman, "if approved, the constitutional amendment [as proposed in the 1974 referendum] would enable any community to have a state supervised casino if local residents authorized it with their own referendum" (Waggoner, 1974).

[5] "Each applicant employed by a casino licensee shall be a resident of the State of New Jersey prior to the issuance of a casino key employee license; provided, however, that upon petition by the holder of a casino license, the commission may waive this residency requirement for any applicant whose particular position will require him to be employed outside the State; and provided further that no applicant employed by a holding or intermediary company of a casino licensee shall be required to establish residency in this State" (New Jersey Casino Control Act, 1977).

[6] The state administered two key taxes on Atlantic City casinos: The Casino Revenue Tax and the Investment Alternative Tax. The Casino Revenue Tax was set at 8 percent of gross gaming revenues and collected by the NJCCC to use in support of programs for the disabled and elderly. The Investment Alternative Tax was set at 2.5 percent of gross revenues and collected by the CRDA to invest in economic development projects (Madhusudhan, 1995). In comparison, Nevada charged casinos a 7.75 percent effective tax rate, 6.75 percent tax on gross gaming revenues, and 1 percent of taxes in fees. All Nevada tax revenues are directed into the state's general fund (UNLV, 2023).

[7] Caesar's (1979), Bally's Park Place (1979), The Brighton (1980), Harrah's (1980), Golden Nugget (1980), Claridge (1981), Playboy (1981), Tropicana (1981), Trump Plaza (1984), Trump Castle (1985), Showboat (1987), Trump Taj Mahal (1990). Source: Atlantic City Free Public Library (2022).

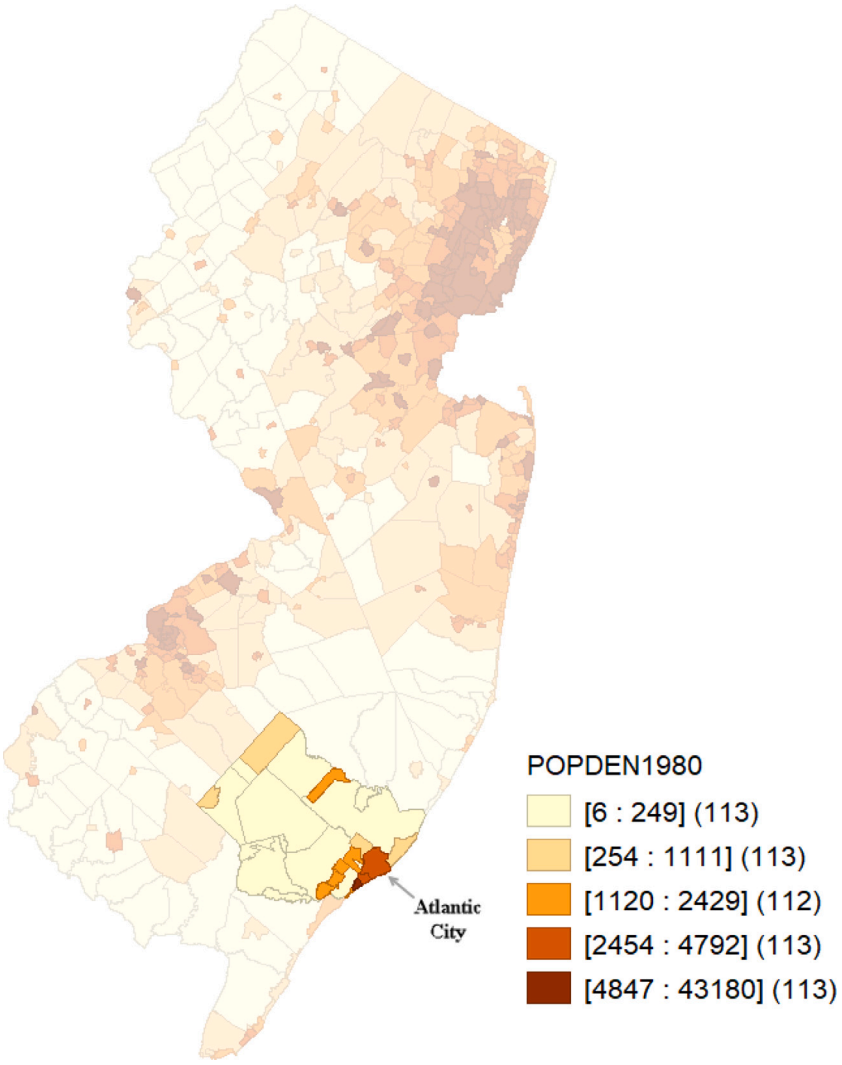


**Fig. 1.** Map of New Jersey Municipalities by 1980 Population Density Quintiles (Ranges of Persons per Square Mile in Brackets).
*Source:* U.S. Census.

United States" from the Organization for Economic Co-operation and Development.

Atlantic County's municipalities are emphasized and shaded by 1980 population density quintiles in Fig. 1. As discussed in the previous section, the literature suggests that Atlantic County's relatively low population density[8] would have allowed it to experience stronger economic development benefits from casino development than its more urban counterparts elsewhere in the state.

Before the casino referendum passed, Atlantic County was below the median levels for employment per capita, average weekly wage, and personal income per capita across New Jersey counties. Fig. 2 plots employment per capita, average weekly wage, and personal income per capita across New Jersey's counties for a pre-treatment year (1975), five years (1982), ten years (1987), and fifteen years after treatment (1992), respectively. In terms of employment per capita, Atlantic County ranked thirteenth out of the twenty-one counties before treatment, but rose to second within five years of treatment. Ranked twentieth, Atlantic County had the second to lowest average weekly wage before treatment before rising to fourteenth within five years of treatment. Lastly, the county was ranked near the median county at eleventh for per capita personal income pre-treatment but rose to seventh by 1982. Its low average weekly wage and personal income rankings prior to casino development are not surprising given that, at 12.5 percent, Atlantic County had the fourth lowest educational attainment (bachelor's degree or higher) across New Jersey counties in 1980.[9] With a below-median employment to population ratio and some of the lowest wages in the state, Atlantic County could stand to benefit from a supply of high-paying hospitality jobs to employ its largely non-college-educated population.

[8] The United States Department of Agriculture's Rural Urban Continuum Codes suggests that Atlantic County was the state's fifth most rural county in 1974 (behind Cape May, Hunterdon, Ocean, and Sussex). Source: USDA, Economic Research Service.

[9] The percentage of New Jersey's population with a bachelor's degree or higher in 1980 was 18.3 percent. Source: U.S. Census General Social and Economic Characteristics.

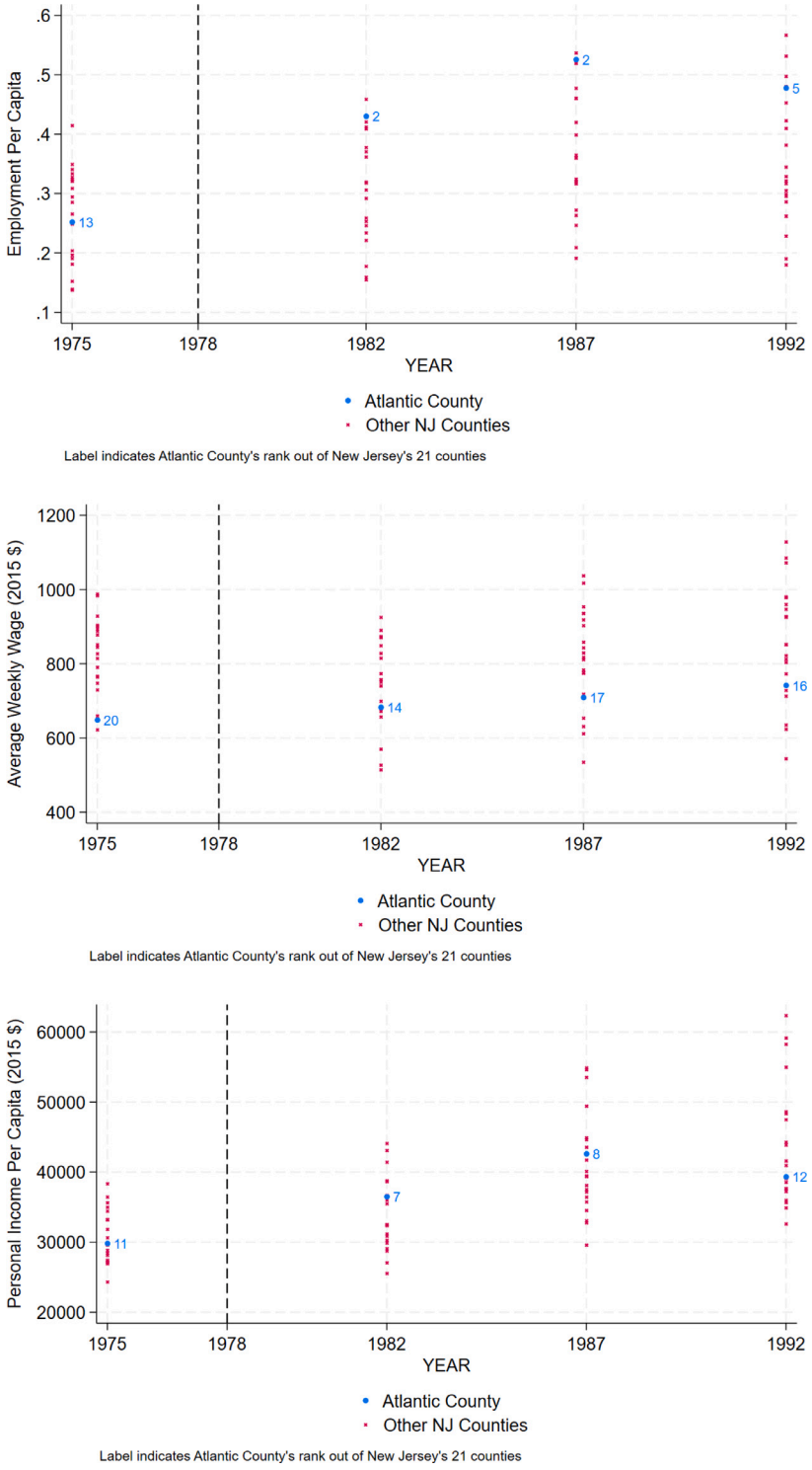


**Fig. 2.** Scatterplots for employment per capita (upper panel), average weekly wages (middle panel), and personal income per capita (lower panel).

## 4. Methods

I use four different empirical approaches in my analysis: difference-in-differences (DiD), generalized difference-in-differences (GDiD), synthetic difference-in-differences (SDiD), and the synthetic control method (SCM).

### 4.1. Difference-in-Differences (DiD)

I begin by estimating the impact of casino development on Atlantic County with DiD models where the dependent variable is the natural log of total payroll employment, average weekly wages, per capita personal income, population, or housing prices in county $i$, $i = 1, \ldots, 21$, and year $t$, in which $t = 1974, \ldots, 1992$ for average weekly wages,

$t = 1976, \ldots, 1992$ for housing price index,[10] $t = 1970, \ldots, 1992$ for payroll employment, population, and per capita personal income.[11]

$$y_{it} = \alpha_i + \delta_t + \beta D_{it} + \epsilon_{it}. \quad (1)$$

The area and time fixed effects are denoted by $\alpha_i$ and $\delta_t$, respectively, and the dummy variable $D_{it}$ equals one from 1978 onward for Atlantic County, as seen in Fig. 1, and zero otherwise. Therefore, the control group consists of all other New Jersey counties. The area effects control for time-invariant differences in local economic characteristics from unobservable factors that vary across counties, while the time effects capture common time trends that are shared across counties. I cluster standard errors at the county level.

### 4.2. Generalized Difference-in-Differences (GDiD)

In addition to estimating the average treatment effect of casino development on Atlantic County with DiD models, I estimate GDiD models in order to determine the degree to which the economic impact of casino development varied from year to year. I also use the GDiD models to evaluate whether the common trends assumption that is required for DiD identification holds across my models. In other words, the DiD strategy requires the assumption that Atlantic County's economic variables would have followed a similar path as its controls absent casino development. Significant lead coefficients in Eq. (2) would indicate a violation of the common trends assumption.

$$y_{it} = \alpha_i + \delta_t + \sum_{j=-8}^{14} (treated_i * d_j) + \epsilon_{it}. \quad (2)$$

The GDiD models also control for time and county fixed effects and cluster standard errors at the county level. The leads and lags in Eq. (2) are dummy variables set to one for Atlantic County and zero for the control counties.

### 4.3. Synthetic Difference-in-Differences (SDiD)

If the common trends assumption is found to have been violated in the GDiD models, then the average treatment effects estimated with DiD models are likely biased. Therefore, I estimate the same models in Eq. (1) with the SDiD estimator (Arkhangelsky et al., 2021), which allows the common trends assumption to be relaxed by allowing for potentially different pre-trends among the treated and control units.

$$(\hat{\tau}, \hat{\mu}, \hat{\alpha}, \hat{\beta}) = \arg \min_{\tau,\mu,\alpha,\beta} \{ \sum_{i=1}^{N} \sum_{i=1}^{T} (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \hat{\omega}_i \hat{\lambda}_t \} \quad (3)$$

I describe the estimation of the average treatment effect on the treated (ATT), or $\hat{\tau}$, from Eq. (3) as outlined by Clarke et al. (2023). The ATT, $\hat{\tau}$, is estimated by a two-way fixed effect regression of the dependent variable, $Y_{it}$, observed for each unit $i$ in each period $t$ where the binary policy variable of interest is denoted $W_{it}$. $W_{it} = 1$ indicates unit $i$ is treated at time t (i.e., Atlantic County from 1978 onward). Year fixed effects are denoted by $\beta_t$ and county fixed effects are denoted by $\alpha_i$.

The SDiD estimator effectively combines the standard DiD estimator with the synthetic control method. Firstly, using all other New Jersey counties as its donor pool, the SDiD estimator selects unit weights, $\hat{\omega}_i$, so that the control units' pre-treatment outcomes match Atlantic County's as best as possible. This ensures that pre-treatment outcomes for control units are approximately parallel, on average, to pre-treatment outcomes for the treated unit. Secondly, time weights, $\hat{\lambda}_t$, are optimally chosen to draw more weight from pre-treatment periods which are more similar to post-treatment periods such that there is a constant difference between each control unit's post treatment average and pre-treatment weighted averages across controls (Clarke et al., 2023). Thirdly, SDiD estimates the ATT by comparing the change in outcomes between the treated unit and the counterfactual both before and after the treatment is introduced such that it accounts for pre-existing differences between treatment and control. Therefore, the average post-treatment outcome for the control units will differ by a constant amount from the weighted average of the pre-treatment outcomes for the same control units (Arkhangelsky et al., 2021). Finally, standard errors for the SDiD estimates are calculated with the placebo method, which is a necessity when the number of treated units is small. This method applies the treatment to each of the control units, re-estimates $\hat{\tau}$, creates a vector of ATTs, and estimates the variance of that vector.

### 4.4. Synthetic Control Method (SCM)

I also generate estimates of the casino treatment effects using the synthetic control method (SCM), which generates a counterfactual of a treated area's dependent variable using optimally chosen weights of untreated donor areas. Unlike the SDiD method, which estimates the ATT by comparing the change in outcomes between treatment and control both before and after treatment, the SCM's estimates a treatment effect using only the post-treatment outcomes between the treated unit and its synthetic control. Therefore, unlike SDiD, the SCM does not use time-varying pre-treatment weights in its estimation procedure since only post-treatment outcomes are used to estimate a treatment effect. For this analysis, the synthetic version of Atlantic County's variables will be assembled from a donor group of New Jersey's other counties in order to match the dependent variable in Atlantic County before casino development occurred. The SCM methodology from Abadie et al. (2010) is outlined below.

$Y_{it}^N$ represents the dependent variable that would be observed for county $i$ at time t in the absence of casino development for counties $i = 1, \ldots, J+1$ counties and time periods $t = 1, \ldots, T$, where $J$ represents the number of untreated "donor" counties.

Let $T_0$ be the number of pre-treatment periods, with $1 \leq T_0 < T$. $Y_{it}^I$ represents the value that would be observed for county $i$ at time $t$ for the county exposed to casino development (i.e. Atlantic County) in period $T_0 + 1$. We assume that the treatment has no effect on the dependent variables before the implementation period, so for $t\epsilon(1, \ldots, T_0)$ and all $i\epsilon(1, \ldots, J+1)$, we have that $Y_{it}^I = Y_{it}^N$.

Let $\alpha_{it} = Y_{it}^I - Y_{it}^N$ be the effect of casino development for Atlantic County at time t, and let $D_{it}$ be an indicator that takes value one if county $i$ is exposed to the treatment at time t, and value zero otherwise. Therefore, the observed outcome for unit $i$ at time $t$ is

$$Y_{it} = Y_{it}^N + \alpha_{it} D_{it} \quad (4)$$

Only Atlantic County (county "one") is exposed to casino development treatment after period $T_0$ so we estimate $(\alpha_{1T_0+1}, \ldots, \alpha_{1T})$. For $t > T_0$,

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N \quad (5)$$

Since $Y_{1t}^I$ is observed, in order to estimate $\alpha_{1t}$ we need only $Y_{1t}^N$ which is the synthetic control, or counterfactual outcome.

The synthetic control estimator will estimate $Y_{1t}^N$ using a linear combination of donor counties $i\epsilon(2, \ldots, J+1)$ using weights $w = (w_2, \ldots, w_{J+1})$ which through constrained optimization matches Atlantic County on pre-treatment levels of the dependent variable. Since the weights are nonnegative and sum to one, the synthetic control of Atlantic County is:

$$Y_{1t}^N = \sum_{i=2}^{J+1} w_i^* Y_{i,t} \quad (6)$$

[10] Hudson and Salem Counties are excluded from the control group and donor pools for the housing price models due to extensive missing data.

[11] The above years represent the models with fifteen-year treatment horizons. The final years for all models with ten-year and five-year treatment horizons are 1987 and 1982, respectively.

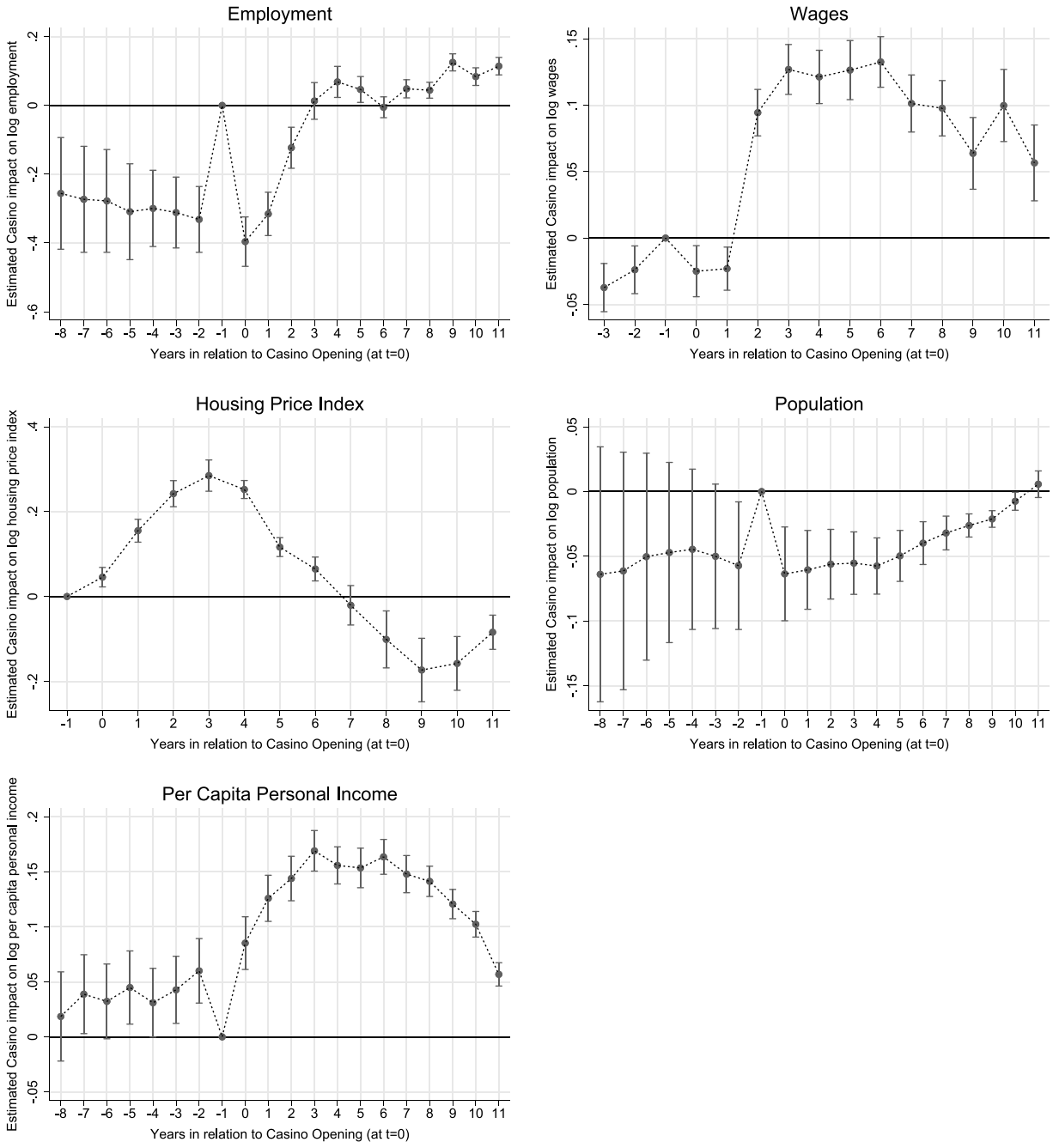


**Fig. 3.** Lead and lag effects of the Casino Monopoly on Atlantic County's employment, wages, population, personal income, and housing price index.

I estimate the significance of $\alpha_{1t}$ using a permutation method that compares the synthetic control estimates to a distribution of placebos, where the placebos are treatment effect estimates using the SCM for the $J$ donor counties.

## 5. Results

### 5.1. Main results

Fig. 3 captures lead and lag effect estimates of casino development from GDiD models. Most of these figures indicate violations of the common trends assumption via significant lead coefficients. These results are consistent with Atlantic County's economy performing relatively worse than the rest of the state when it was selected as the proposed site for casino development ahead of the 1976 referendum. However, the SDiD and SCM estimators are able to match suitable counterfactuals to each of the Atlantic County variables during pre-treatment periods (see Fig. 4.[12]). The results from the DiD, SDiD, and SCM models are presented in Fig. 5. I discuss my preferred results from the SDiD estimator here as the method deals with the likely bias arising from

[12] The left panels of Fig. 4 display the outcome trends for Atlantic County vs. the counterfactuals for each of the fifteen-year SDiD models along with time weights shaded in green and the treatment year as the red vertical dashed line while the right panels show the outcome trends for each of the fifteen-year SCM models. Fig. 13 displays scatterplots of the relative SDiD ATTs for each of the donor counties and Atlantic County (red horizontal dashed line) where the size of the points represent the relative size of the unit weights selected across each of the fifteen-year models while Fig. 14 shows equivalent figures for the SCM models.

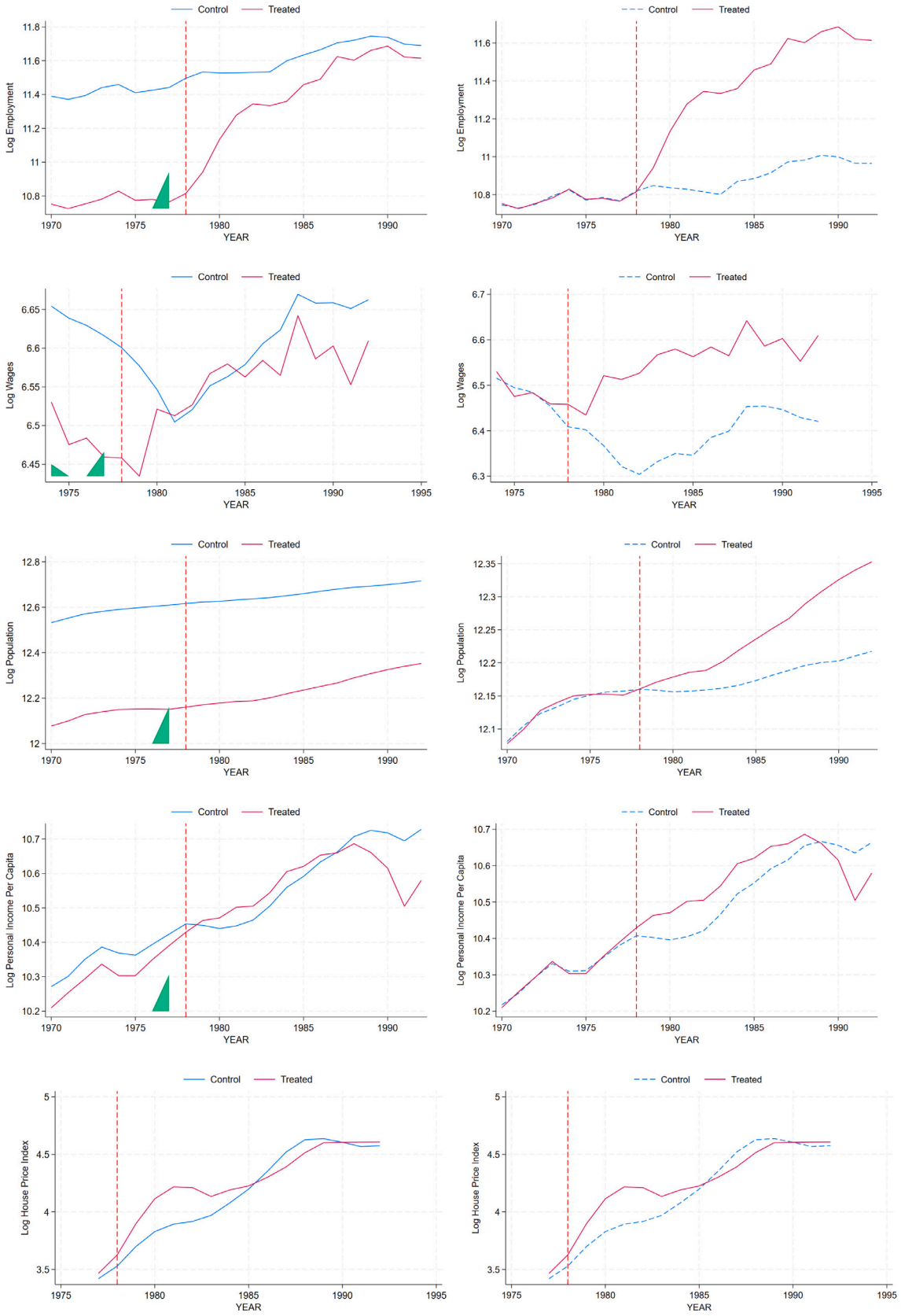


**Fig. 4.** Fifteen-Year Outcome Trends for SDiD with time weights (left) and SCM (right) for Atlantic County's employment, wages, population, personal income, and housing price index.

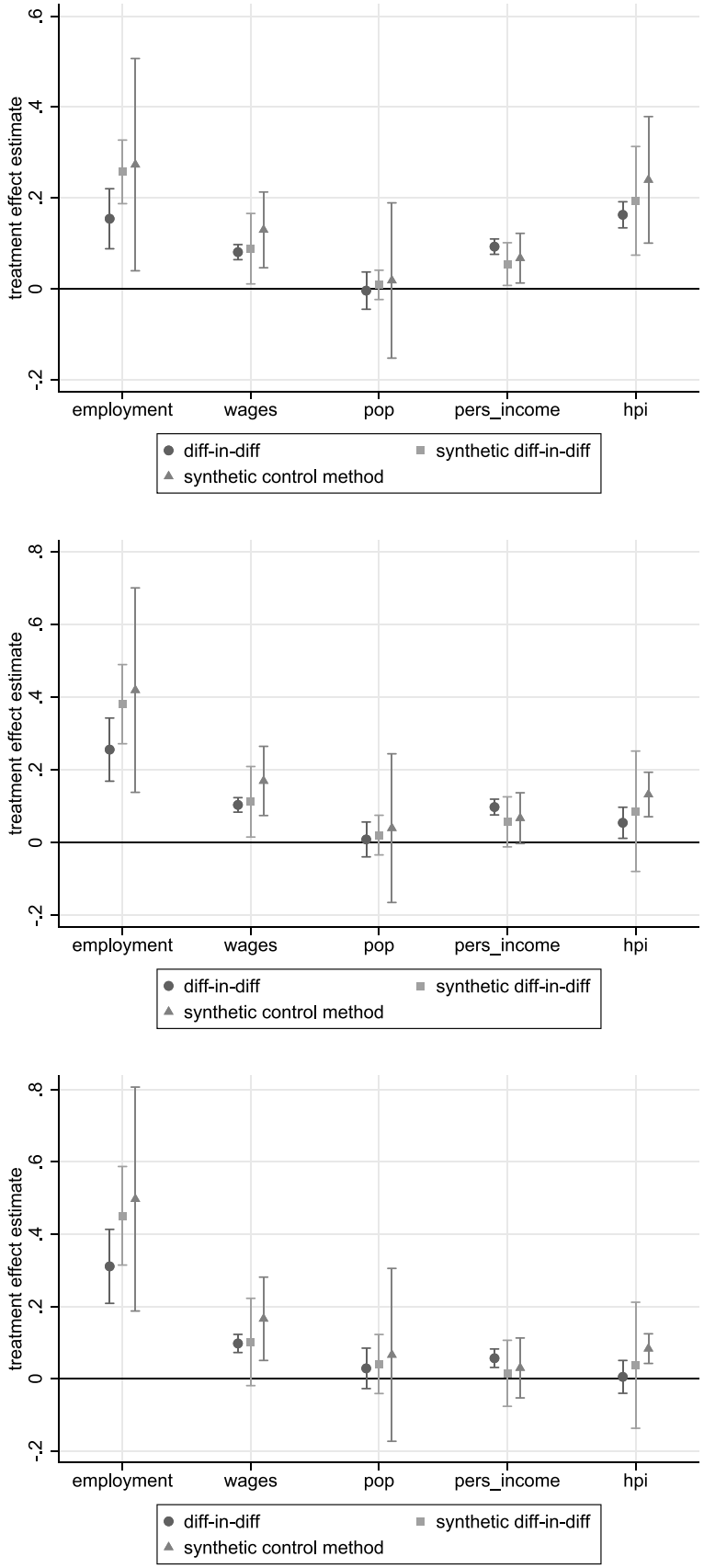


**Fig. 5.** Point estimates and 95% confidence intervals for the five-year (upper panel), ten-year (middle panel), and fifteen-year treatment horizons (lower panel).

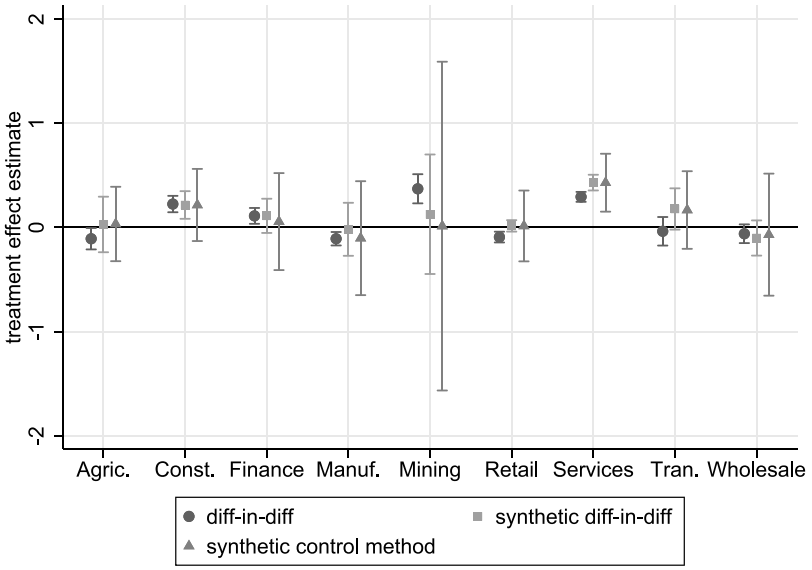


**Fig. 6.** Five-year treatment effect estimates and 95% confidence intervals for payroll employment by industry.

the violation of the common trends assumption across several of the DiD models and controls for differences in the pre-treatment periods between the treated unit and control. The top panel of Fig. 5 reports coefficient estimates for the five-year treatment horizon (ending in 1982), which suggests a positive treatment effect on Atlantic County due to casino development for employment (26 percent), wages (9 percent), personal income (5 percent), and house prices (19 percent). The middle panel reports coefficient estimates for the ten-year treatment horizon (ending in 1987), which suggests a positive treatment effect for employment (38 percent) and wages (11 percent). Lastly, the bottom panel reports coefficient estimates for the fifteen-year treatment horizon (ending in 1992), which suggests a positive treatment effect for employment (45 percent). However, the treatment effect on population is not statistically different from zero for any of the three time horizons.

The differences between the DiD and SDiD treatment effect estimates in Fig. 5 suggest that violations in the common trends assumptions resulted in bias within several of the DiD models. The results from the payroll employment models suggest that the differential pre-trends between Atlantic County and the rest of the state result in an underestimate (negative bias) of an employment treatment effect by 10 to 15 percentage points across the simple difference-in-differences models. However, the differential pre-trends result in an overestimate (positive bias) of 4 to 5 percentage points across the DiD for personal income. The DiD results for personal income would have made the treatment effect significant across all three treatment horizons instead of for the five-year model only. Additionally, the DiD models appear to underestimate the treatment effect on house prices by 3 to 4 percentage points, even though the DiD coefficient indicates a significant effect for the ten-year treatment horizon when the SDiD coefficient does not. There are no major differences between the DiD and SDiD model treatment effects for population or wages.

A comparison between the estimates from the SDiD and SCM estimators in Fig. 5 consistently indicates slightly larger treatment effects from the latter (usually between 1 and 5 percentage points). For the five-year treatment effects, the SCM estimate is 1 percentage point higher than SDiD for employment (27 vs. 26 percent), 4 percentage points higher for wages (13 vs. 9 percent), 2 percentage points higher for personal income (7 vs. 5 percent), and 5 percentage points higher for house prices (24 vs. 19 percent). However, despite much larger standard errors on some of the estimates, the SCM's significance findings agree with SDiD for every variable. For the ten-year treatment effects, the SCM estimate is 4 percentage points higher than SDiD for employment (42 vs. 38 percent) and 6 percentage points higher for wages (17 vs. 11 percent). Additionally, while the SDiD ten-year model does not find a significant impact on house prices, the SCM finds a significant positive impact of 13 percent. For the fifteen-year treatment effects the SCM estimate is 5 percentage points higher than SDiD for employment (50 vs. 45 percent). Additionally, the SCM finds significant impacts on wages (17 percent) and housing prices (8 percent) for the fifteen-year treatment horizon.

The primary takeaway from the results in Fig. 5 is that casino development had a persistent positive effect on the labor market during Atlantic City's monopoly period. While the impact on wages is somewhat stable, the treatment effects for payroll employment are monotonically increasing across the three time horizons. It is important to note that the city was consistently adding casinos over this time period such that there were nine casinos by 1982, twelve by 1987, and thirteen by 1992. The sustained and increasing job growth potentially suggests a lack of a cannibalization effect between the casinos such that the demand for Atlantic City casino services was able to match the supply during this monopoly period.

Another takeaway is that the effect of casinos on house prices is strongest and significant across all three models for only the five-year time horizon. This result is consistent with findings by Sweet (2017) that speculative development in the late 1970s and early 1980s produced an extreme market imbalance, especially for properties in close proximity to casinos. Additionally, the CRDA's use of eminent domain and condemnation of properties throughout Atlantic City further reduced its housing stock over the 1980s. The author suggests that this housing supply crunch pushed more of Atlantic City's already small population of middle-class residents into Atlantic County suburbs, leaving only the city's poorest residents. Therefore, the increase in housing prices does not necessarily reflect welfare gains for city or county residents.

### 5.2. Payroll employment by industry

Since much of the economic impact of the casinos appears to be driven by payroll employment growth, I further investigate the industrial composition of the employment treatment effect by estimating models for employment within nine major Standard Industrial Classification divisions. Each of the estimates use the DiD, SDiD, and SCM methodologies described in the methods section with eight-year pre-treatment periods running from 1970 through 1977 and five-year treatment periods from 1978 through 1982. The data on payroll employment by industry at the county level comes from the Bureau of

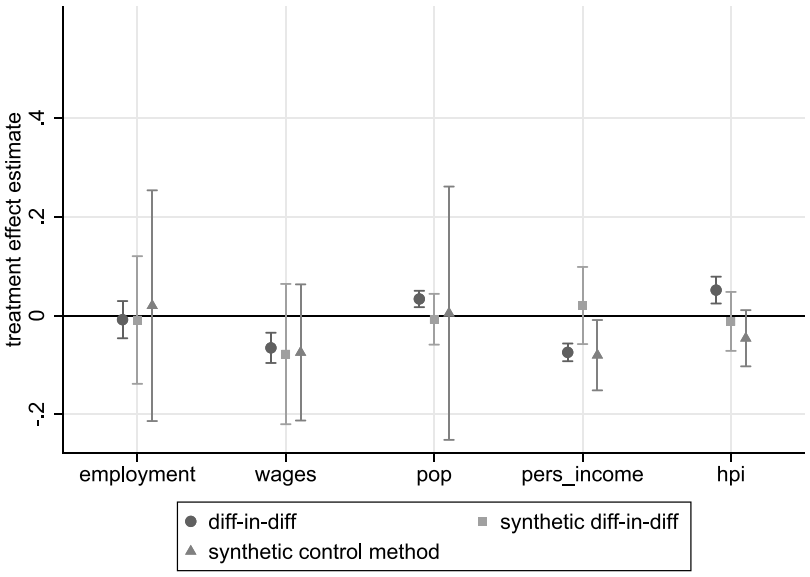


**Fig. 7.** Nine-year post-monopoly treatment effect estimates and 95% confidence intervals for Atlantic County's employment, wages, population, personal income, and housing price index.

Economic Analysis (BEA) Table "CAEMP25S: Total full-time and part-time employment by SIC industry." These divisions are Agriculture, Forestry, And Fishing (Agric.), Construction (Const.), Finance, Insurance & Real Estate (Finance), Manufacturing (Manuf.), Mining, Retail Trade (Retail), Services, Transportation & Public Utilities (Tran.), and Wholesale Trade (Wholesale).[13]

Coefficients for employment by industry are plotted in Fig. 6. According to the SDiD estimates, only two industries experience a significant five-year treatment effect on employment due to casinos: construction (22 percent) and services (43 percent). The SCM industry treatment estimates largely agree with those of the SDiD except that it finds the construction estimate insignificant. It is not surprising that the largest treatment effect is experienced by the services industry, as the effect appears driven from strong hiring from the casinos themselves.

### 5.3. Effect of monopoly ending in 1992

In order to assess the impact of Atlantic City's regional casino monopoly ending in 1992, I estimate models for employment, wages, population, personal income, and housing price index using DiD, SDiD, and SCM estimators for a post-monopoly treatment period. I use five-year pre-treatment periods running from 1987 through 1991 and nine-year treatment periods running from 1992 through 2000 for each of the models. Coefficients from each of the estimators are plotted in Fig. 7 and outcome trends are plotted in Fig. 8 (Unit weights for the SDiD and SCM models can be found in Figs. 15 and 16, respectively). The results indicate no discernible impact of the monopoly's end on employment, population, or housing prices. However, despite being insignificant for the SDiD and SCM treatment effects, all three models estimate a negative effect for wages of 7 percent. Additionally, the DiD and SCM models indicate a significant negative impact on personal income of 8 percent. Despite there being no apparent impact on payroll employment, the end of the casino monopoly may have resulted in lower demand for casino workers manifested in lower growth for both wages and personal income.

[13] Much of the county-level series experienced censoring by the BEA beginning in 1982, so I do not estimate ten- or fifteen-year treatment effects.

## 6. Migration

A concern often raised in the literature about place-based policies targeted at distressed areas is that the economic opportunities generated may attract in-migrants and dilute the economic impact for incumbent residents (Austin et al., 2018; Glaeser and Gottlieb, 2008; Abeberese et al., 2023). I use estimates from Fuguitt et al. (2010) to evaluate net migration across New Jersey counties from 1980 to 1990, when Atlantic County experienced rapid growth in casino establishments and payroll employment. Additionally, in order to assess the degree to which migration may have impacted the demographics of Atlantic County over the study period, I track the area's race and educational composition from the decennial census.

Fig. 10 plots county estimates of net migration from 1980–1990 across New Jersey counties against 1980 population using data from Fuguitt et al. (2010). Each of the points represents a NJ county, where Atlantic County and each of its adjacent counties are labeled in red. Fig. 9 indicates each of Atlantic County's six adjacent counties as Burlington, Camden, Cape May, Cumberland, Gloucester, and Ocean. Atlantic County experienced the fifth highest net migration rate across New Jersey's counties at 12 percent between 1980 and 1990, which was higher than four of its adjacent counties. Fig. 11 breaks down net migration rates by five-year age groups for Atlantic County, the median of its adjacent counties, and the median of all other New Jersey counties. The estimates indicate that net migration for Atlantic County was higher than the median of its neighbors and the rest of the state's counties for most age groups between 10 and 65 years of age. Additionally, the highest net migration rates were experienced in the age groups for 25 to 29, 30 to 34, and 35 to 39.

Table 1 provides estimates of Atlantic County and New Jersey from 1970 through 2000 for population growth, percentage of the population with 4+ years of college, and the nonwhite population. Although population growth in Atlantic County lagged the state in the 1960s (9 vs. 18 percent), it was considerably higher in the 1970s (11 vs. 3 percent) and 1980s (16 vs. 5 percent). Before casino legalization in 1970, the share of Atlantic County's population with 4+ years of college was 6 percentage points below New Jersey's (6 vs. 12 percent) and by 1990, the difference in shares increased to 11 percentage points (19 vs. 30 percent). While Atlantic County was more diverse than the state in terms of its nonwhite population in 1970 (18 vs. 11 percent), it was only slightly more diverse than the state in 1990 (23 vs. 21 percent).

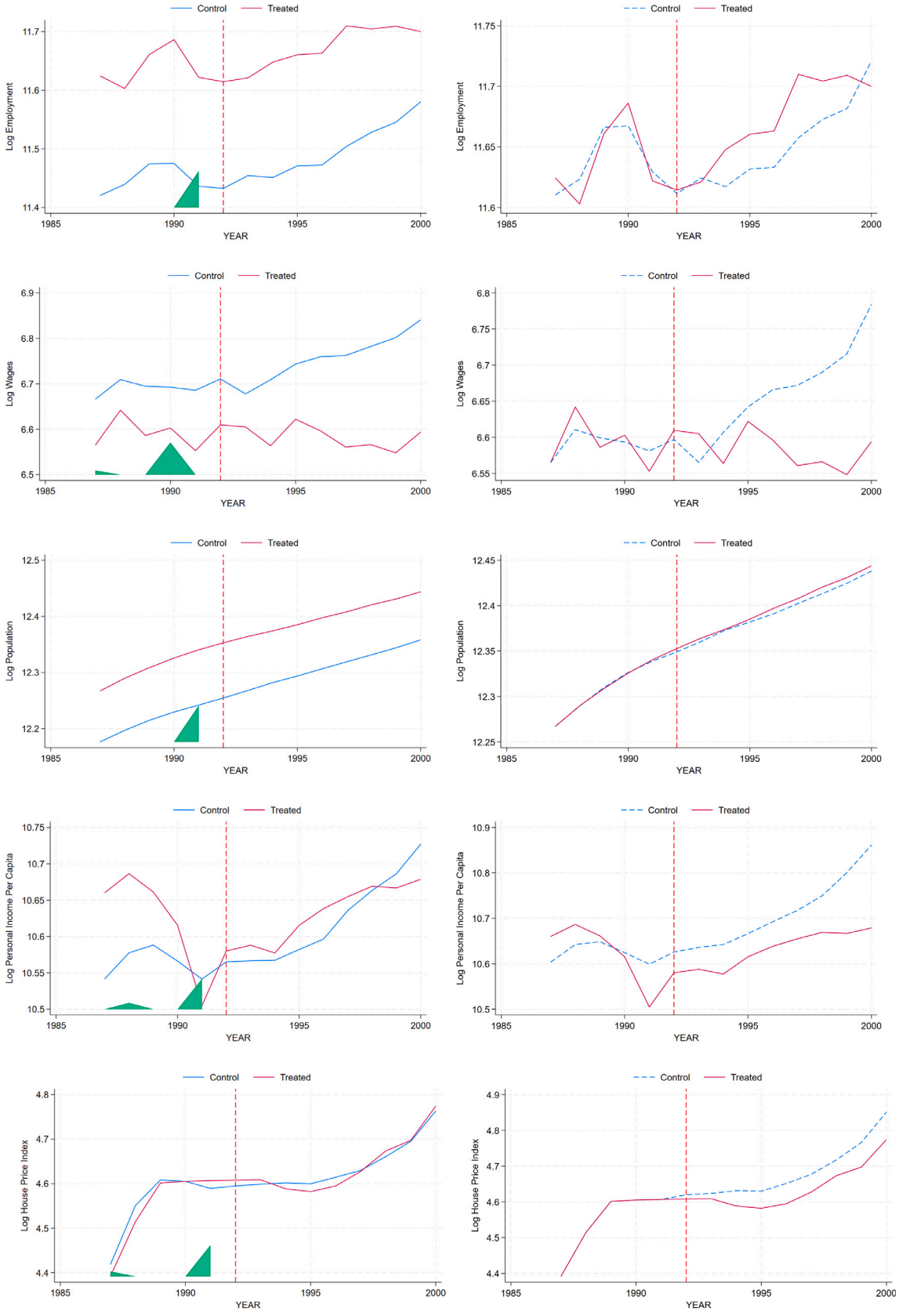


**Fig. 8.** Nine-Year Post-Monopoly Outcome Trends for SDiD with time weights (left) and SCM (right) for Atlantic County's employment, wages, population, personal income, and housing price index.

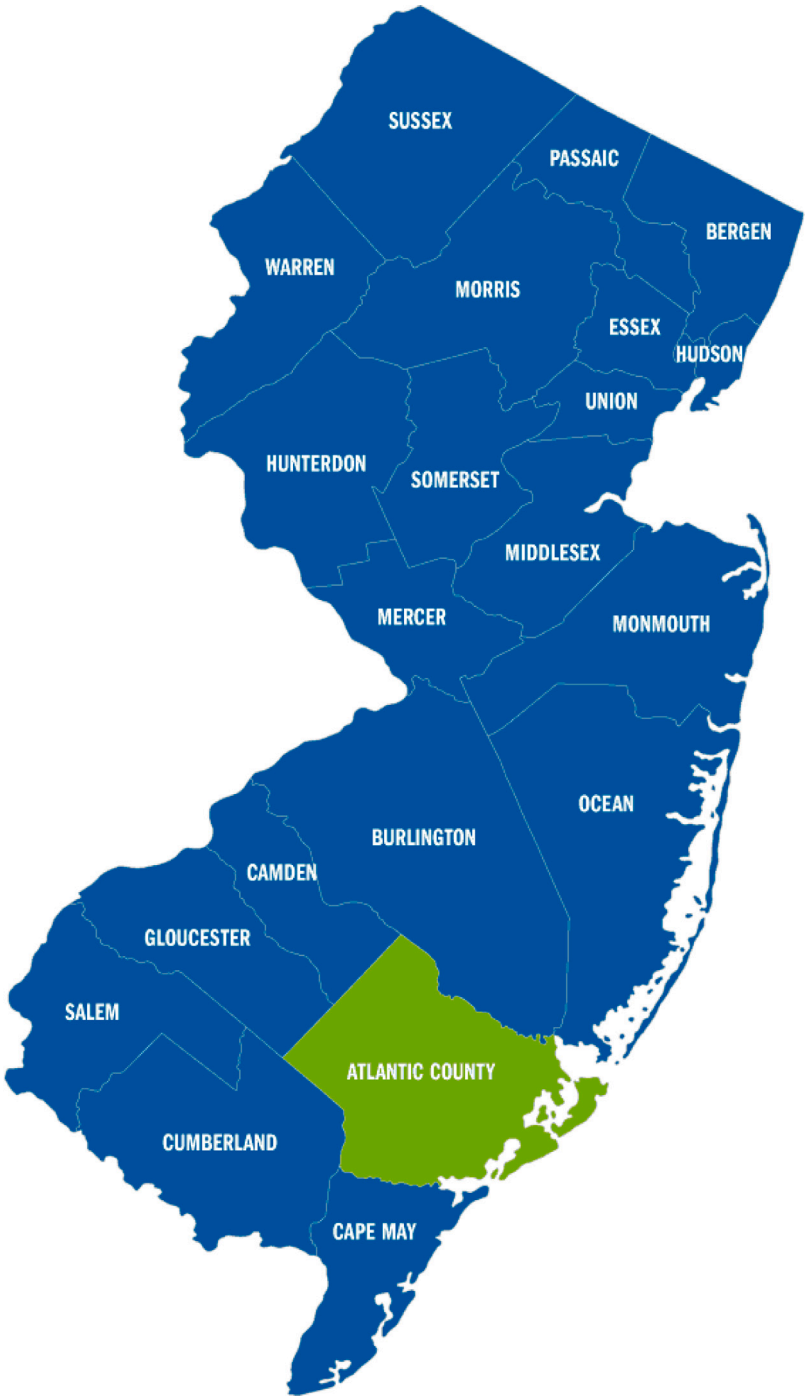


**Fig. 9.** Map of New Jersey Counties.

**Table 1**
Demographic figures for Atlantic County vs. New Jersey, 1970–2000.
*Source:* U.S. Census.

| Area | Variable | 1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|---|
| New Jersey | Population growth (%) since last census | 18 | 3 | 5 | 9 |
| | Percentage (%) of 25+ with 4+ years of college | 12 | 18 | 25 | 30 |
| | Nonwhite population (%) | 11 | 17 | 21 | 27 |
| Atlantic County | Population growth (%) since last census | 9 | 11 | 16 | 13 |
| | Percentage (%) of 25+ with 4+ Years of College | 6 | 13 | 16 | 19 |
| | Nonwhite population (%) | 18 | 20 | 23 | 32 |

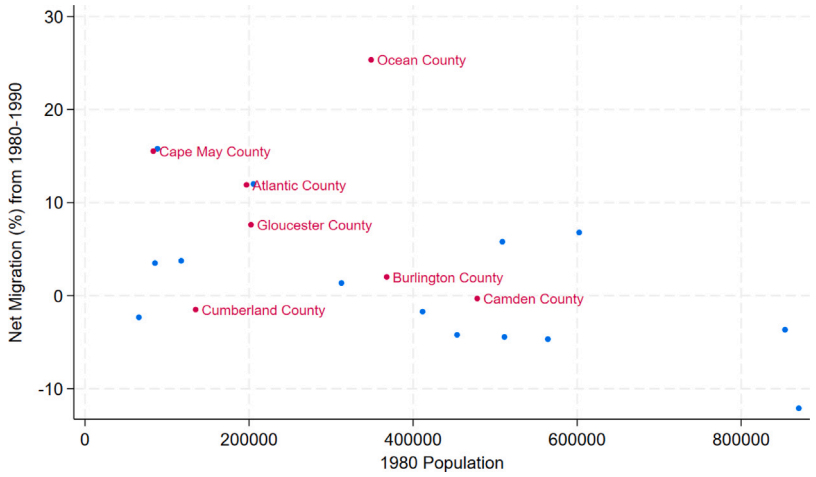


**Fig. 10.** Net Migration (%) in New Jersey Counties (1980–1990) by 1980 Population.

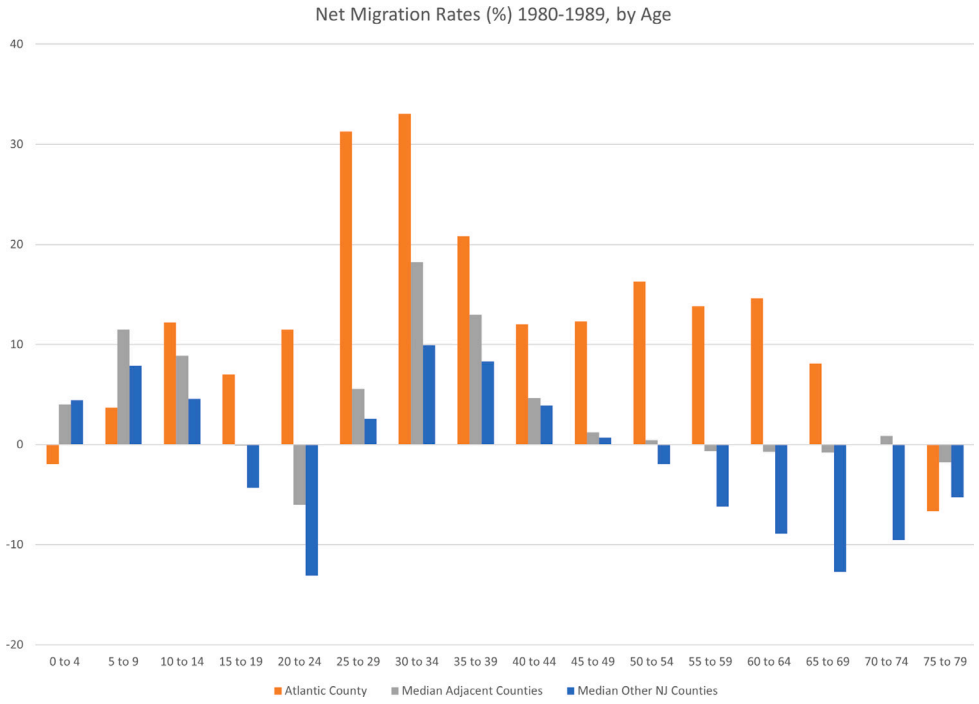


**Fig. 11.** Net Migration (%) in New Jersey Counties (1980–1990) by Age Group.

The demographic and migration data suggest that roughly 75 percent of Atlantic County's population growth during the 1980s (16 percent) was driven by net migration (12 percent). However, the demographic composition of Atlantic County in relation to the state does not appear to have been substantially impacted by net migration in terms of postsecondary education or race. Net migration for Atlantic County was strongest for prime working-age individuals toward the beginning of their careers (25 through 39), which is consistent with in-migration to establish careers at the casinos or related industries impacted by casino legalization. Therefore, it is likely that casino legalization spurred in-migration to Atlantic County from other New Jersey counties and beyond for job seeking reasons. While in-migration may have dampened the effect of casino legalization for original county residents through competition for jobs or homes, it seems unlikely that in-migration completely crowded out their labor market benefits as employment per capita and average weekly wages were increasing throughout the 1980s (see Fig. 2). Studying the role that local ties play in migration responses to policy, Zabek (2019) finds that place-based policies in economically depressed areas lead to smaller population changes than in more productive places such that they transfer income without distorting where people live.

## 7. Discussion

I provide evidence on the impact of legalized casino development on the economy of the Atlantic City Metropolitan Area (Atlantic County, NJ) by estimating treatment effects on payroll employment, average weekly wages, population, personal income per capita, and housing prices. I use public data from the U.S. Census, the Bureau of Economic Analysis, and the Federal Housing Finance Agency to construct the variables. I compare the outcomes in Atlantic County to New Jersey's twenty other counties from 1970 through 1992, estimating models for five-, ten-, and fifteen-year treatment horizons. Using a synthetic difference-in-differences approach, I find no impact on the population for the treated area. I find positive impacts on personal income per capita (5 percent) and housing prices (19 percent) for the five-year

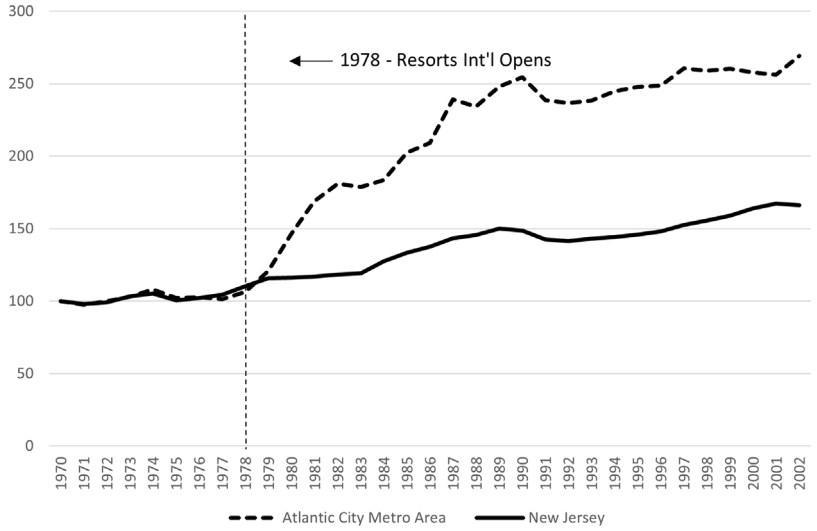


**Fig. 12.** Payroll Employment Change: Atlantic City Metropolitan Area vs. New Jersey, 1970–2002. 1970 = 100. *Source:* U.S. Census' County Business Patterns.

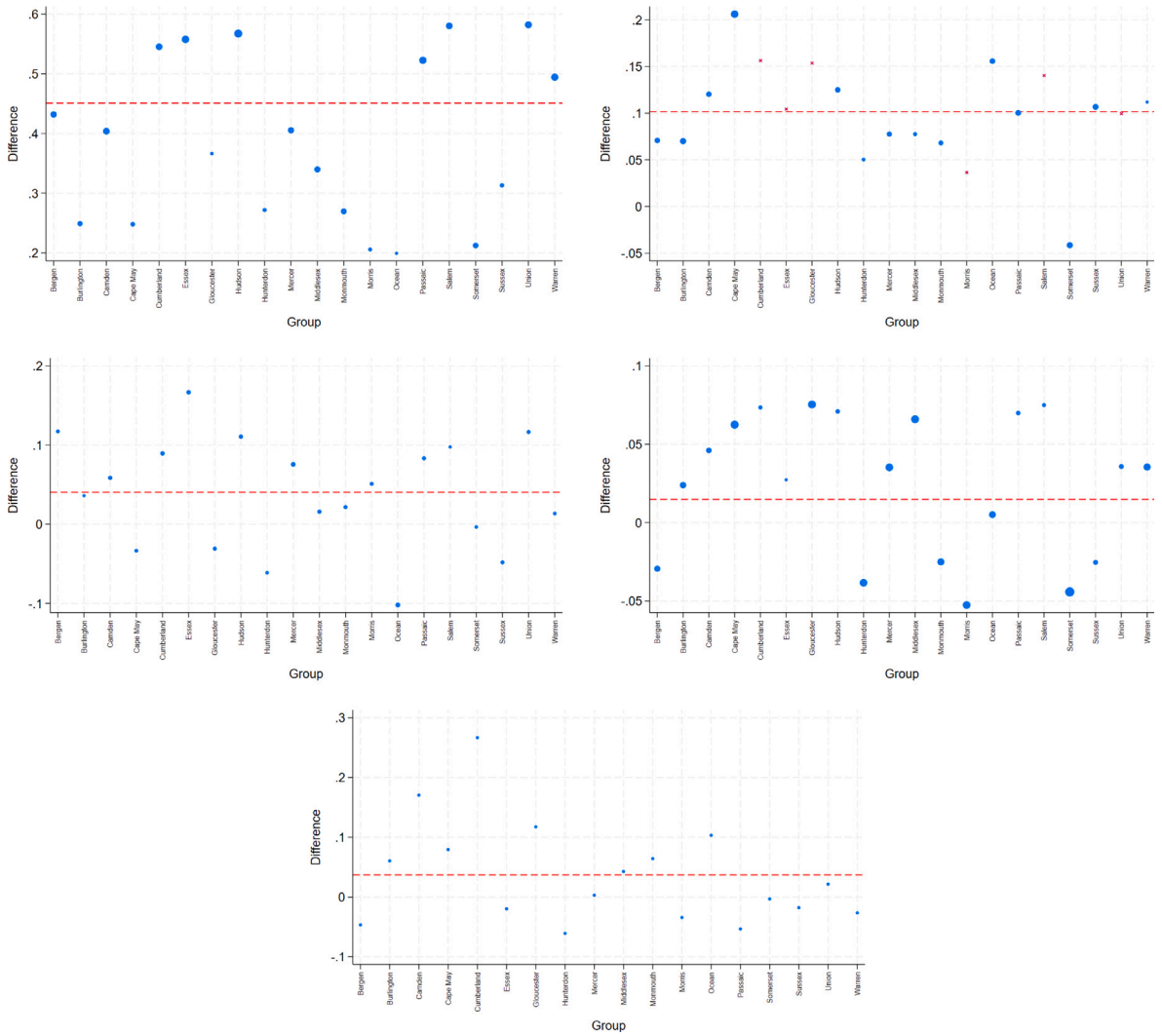


**Fig. 13.** SDiD 15-Year Model Unit weights for Atlantic County's employment (top left), wages (top right), population (middle left), personal income (middle right), and housing price index (bottom).

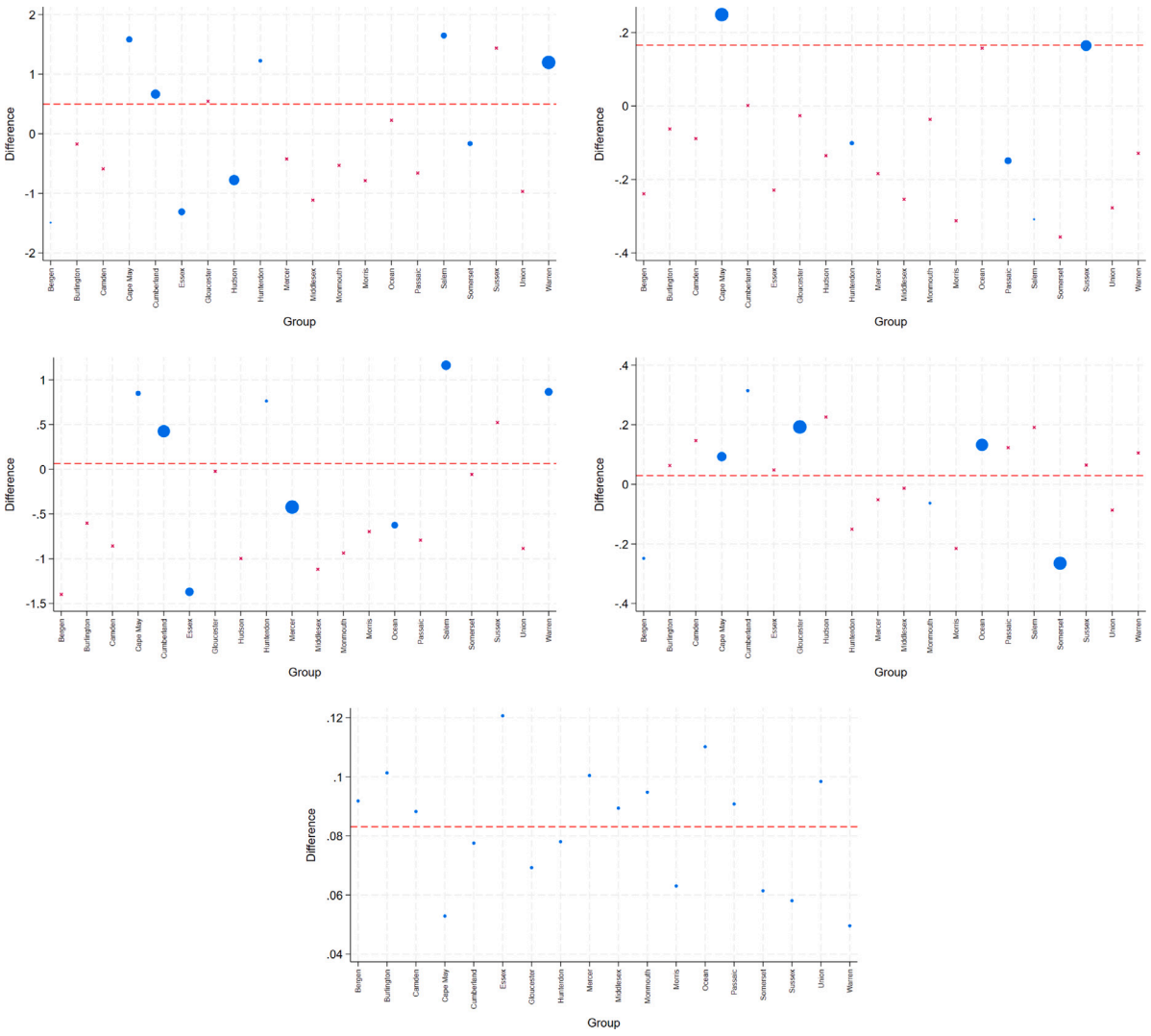


**Fig. 14.** SCM 15-Year Model Unit weights for Atlantic County's employment (top left), wages (top right), population (middle left), personal income (middle right), and housing price index (bottom).

treatment horizon (ending 1982). Furthermore, I find positive and significant impacts for wages across the five- and ten-year treatment horizons (9 and 11 percent). Finally, I observe a positive significant impact on payroll employment, which is monotonically increasing over the three time horizons (26, 38, and 45 percent).

My results suggest that casino development had a strong and persistent impact on Atlantic County's labor market (payroll employment and wages). My five-year result for payroll employment at 26 percent is much higher than the impact found in Cotti (2008) (8 percent), comparable to Rephann et al. (1997) (28 percent), but lower than Humphreys and Marchand (2013) (100 percent). It should be noted that the latter study uses Canadian census divisions rather than U.S. counties, so it may not be a good comparison.[14] However, my persistent and monotonically increasing results for Atlantic County payroll employment are inconsistent with those three studies in terms of the duration of the employment effect. All three studies find the positive labor market effects to be strongest within one to three years of casino openings and to decay quickly thereafter, which may be the result of competition effects that are not present for Atlantic City in my study period. Additionally, the five-year impact that I found on wages (8 percent) is higher than Cotti (2008) (no impact) but lower than findings by Rephann et al. (1997) (28 percent) and Humphreys and Marchand (2013) (100 percent) for similar treatment horizons.

The employment by industry estimates in Section 5.2 indicate that the services (43 percent) and construction (22 percent) industries were positively impacted by casinos in the five-year treatment period. These industry results are largely consistent with Humphreys and Marchand (2013) who find limited spillover effects beyond the local hospitality and entertainment industries. My results suggest that the primary driver of the strong labor market effects from casino development was a large supply of relatively high-paying service jobs, mostly by direct hiring from the casinos themselves. Of the 65,598 private nonfarm jobs that Atlantic County added between 1975 and 1992, 55,207 (84 percent) were in services, 4,910 (7.5 percent) were in retail, and 2,600 (4 percent) were in finance.[15] Furthermore, private nonfarm earnings increased by 3.4 billion dollars between 1975 and 1992, where 2.4 billion

[14] There are 293 census divisions across Canada's ten provinces and three territories.

[15] Source: U.S. Bureau of Economic Analysis, "CAEMP25S Total full-time and part-time employment by SIC industry 1/" (accessed Tuesday, January 10, 2023).

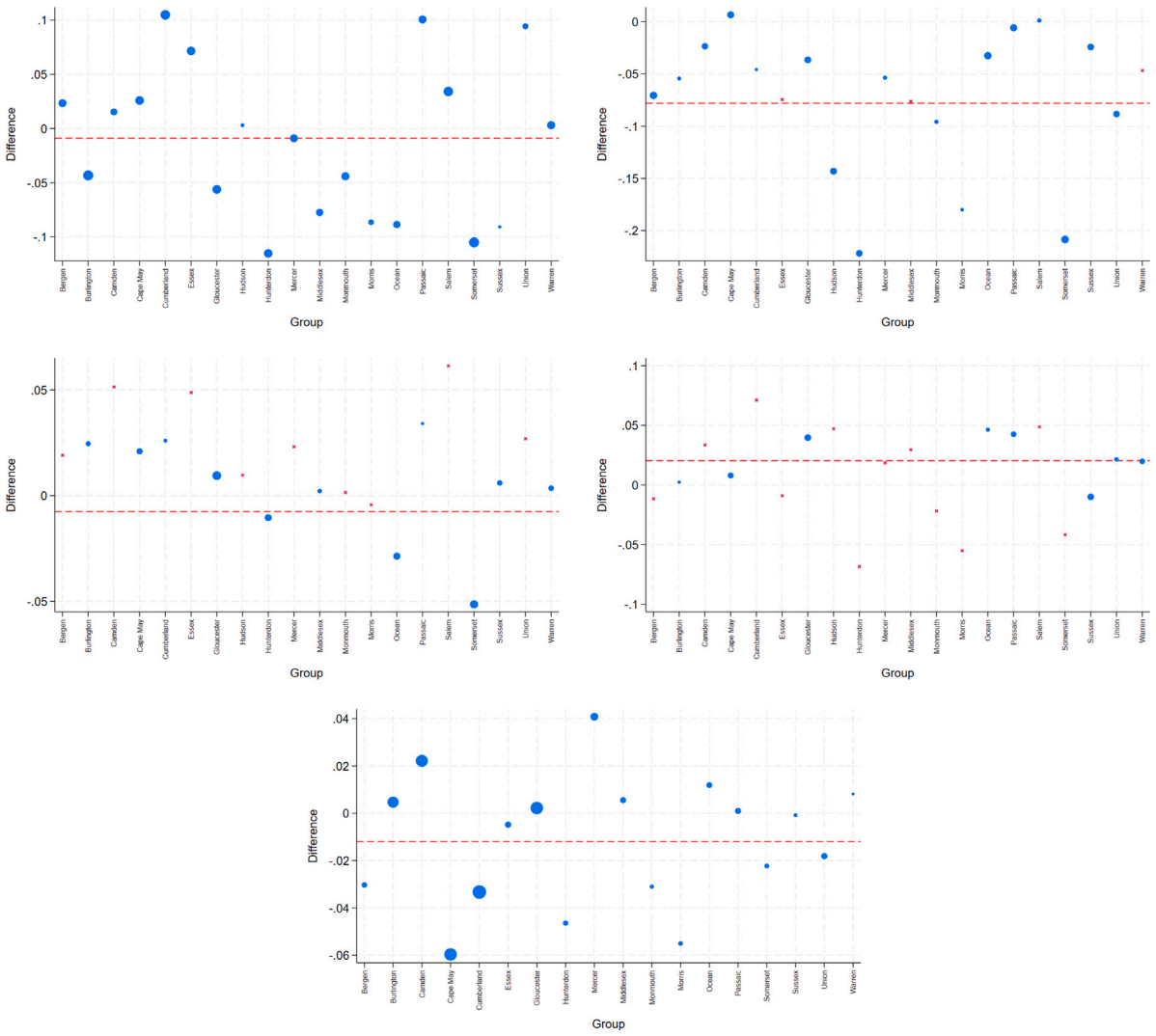


**Fig. 15.** SDiD 9-Year Model Post-Monopoly Unit weights for Atlantic County's employment (top left), wages (top right), population (middle left), personal income (middle right), and housing price index (bottom).

was due to increased earnings in the service industry (69 percent) and 1.4 billion from hotels and other lodging places alone (43 percent).[16]

Since the analysis here is for Atlantic County rather than Atlantic City, one should also consider who may have benefited from the strong job and wage growth over the study period. Table 2 displays the economic characteristics of both Atlantic City and Atlantic County residents near the beginning of the monopoly treatment period (1980) and toward the end (1990). While Atlantic City experienced an increase in the male labor force participation rate over the period (7 percentage points), it lost 6 percent of its population, while retaining its high poverty and unemployment rates. However, Atlantic County increased its population by 16 percent (largely through net migration as discussed in Section 6) and reduced its unemployment and poverty rates by 3 percentage points each. Additionally, Atlantic County experienced larger growth in real per capita income than Atlantic City (30 vs. 23 percent). These results support research (Braunlich, 1996; Rubenstein, 1984) suggesting that casino development helped the Atlantic City Metropolitan Area more than Atlantic City itself, as well as analysis by Rephann et al. (1997) who find earnings and jobs drains outside of their studied casino counties. Results from the latter indicate that casino jobs often go to residents outside of the casino's immediate area, which could be a deliberate labor recruitment strategy by casino management due to stigma associated with residents of impoverished areas (e.g., lacking education, skills, or strong work ethic). A 1985 survey found that of Atlantic City's 40,000 casino and casino hotel employees, only 20 percent lived in Atlantic City, half lived elsewhere in Atlantic County, and the remainder in nearby counties (Janson, 1986). Another survey (Heneghan, 1993) of casino employees conducted eight years later found similar results (see Table 3). Furthermore, property speculation due to casino development resulted in a low housing stock and high prices which drove population loss and further concentrated poverty in the city (Sweet, 2017). When asked about location preferences in 1985, 63 percent of casino employees stated that they would not consider living in Atlantic City, citing reasons such as crime, school quality, and the inflated cost of housing due to land speculation (Janson, 1986).

Overall, this study suggests that casino development was a rather successful economic development strategy for Atlantic County. Back in the 1970s, the county held relatively low employment, wage, and education levels. When Atlantic City regained its appeal as a top tourist destination in the 1980s, the county's fortunes blossomed. The casinos brought in a high supply of leisure and hospitality jobs which resulted in the county having the second highest employment to population ratio in the state only five years later with consistent employment

[16] Source: U.S. Bureau of Economic Analysis, "CAINC5S Personal income by major component and earnings by SIC industry 1/" (accessed Tuesday, January 10, 2023).

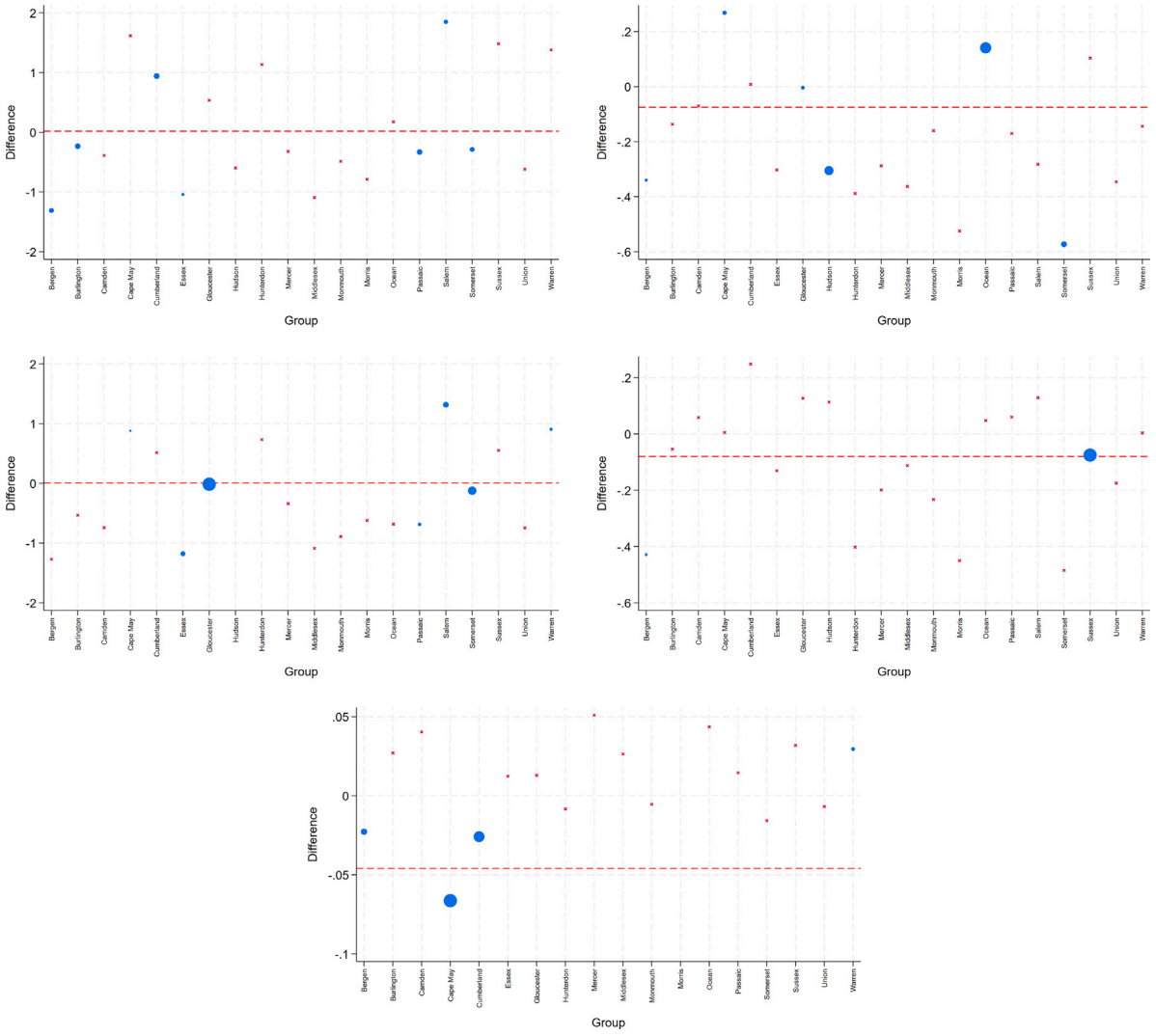


**Fig. 16.** SCM 9-Year Model Post-Monopoly Unit weights for Atlantic County's employment (top left), wages (top right), population (middle left), personal income (middle right), and housing price index (bottom).

**Table 2**
Economic characteristics of Atlantic City vs. Atlantic County.
*Source:* U.S. Census General Social and Economic Characteristics.

| Area | Variable | 1980 | 1990 |
|---|---|---|---|
| Atlantic City | Male labor force participation rate (%) | 64 | 70.7 |
| | Unemployment rate (%) | 11.2 | 9.6 |
| | Poverty rate (%) | 24.9 | 25 |
| | Population | 40,199 | 37,986 |
| | Real per capita income ($ 1984) | 7,864 | 9,696 |
| Atlantic County | Male labor force participation rate (%) | 73.4 | 77.1 |
| | Unemployment rate (%) | 8.5 | 5.5 |
| | Poverty rate (%) | 12.6 | 9.4 |
| | Population | 194,199 | 224,327 |
| | Real per capita income ($ 1984) | 9,911 | 12,922 |

and wage growth thereafter. If Atlantic County's growth were indeed driven by a retail agglomeration effect, as suggested by Walker and Nesbit (2014) and Gallagher (2014), then the end of the city's casino monopoly might not necessarily disrupt its economic advantage. My end-of-monopoly analysis finds some evidence of a negative impact on wages (−7 percent but significant for only the DiD model) and personal income in Atlantic County (−8 percent and significant for the DiD and SCM models) through 2000, potentially indicating a slowdown in local labor demand. While my post-monopoly analysis in Section 5.3 does not indicate an immediate impact of Foxwoods opening on Atlantic County's payroll employment, the event coincided with an end to the strong employment growth it had experienced in the 1980s. As seen in Fig. 12, employment growth began to stall in the early 1990s. However, the slower growth could signal industry maturation for the region rather than a competition effect due to monopoly expiration. While Atlantic County's employment grew much faster than New Jersey's during its monopoly era (122 vs. 28 percent), its growth fell below the state's in the subsequent ten-year period (14 vs. 17 percent). Additionally, steady casino building ceased, and growth in

**Table 3**
Residence of Atlantic City casino employees in 1993.
*Source:* Heneghan (1993).

| County | Number of employees | Percentage |
|---|---|---|
| Atlantic (excluding Atlantic City) | 23,408 | 55.1 |
| Atlantic City | 9,957 | 23.4 |
| Burlington | 521 | 1.2 |
| Salem | 92 | 0.2 |
| Camden | 2,270 | 5.3 |
| Cumberland | 2,123 | 5.0 |
| Gloucester | 1,222 | 2.9 |
| Monmouth | 90 | 0.2 |
| Ocean | 2,253 | 5.3 |
| Other | 560 | 1.3 |
| Total | 42,496 | |

casino revenues slowed after the monopoly's end. In 1990, Trump Taj Mahal Casino Resort (now known as Hard Rock Hotel & Casino) became Atlantic City's thirteenth and final casino to open during the monopoly era (Atlantic City Free Public Library, 2022). Another casino would not open in Atlantic City until the Borgata Casino & Spa in 2003. While Atlantic City casino revenues grew slower from 1992–2001 (34 percent) compared to 1983–1992 (82 percent), they did not decline until 2007 when nearby Harrah's Philadelphia opened (University of Nevada Las Vegas Center for Gaming Research, 2023).

Evidence from this study suggests that casinos had a substantial and sustained positive impact on Atlantic County's economy. Policymakers looking to replicate these effects might benefit from pursuing similar first-mover economic development strategies. Might Atlantic County's economic trajectory have been permanently shifted because New Jersey voters narrowly approved legal gaming before the rest of the East Coast was ready to host casinos?

## CRediT authorship contribution statement

**Adam Scavette:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing, Validation, Supervision.

## Declaration of competing interest

The author declares that he has no relevant or material financial interests that relate to the research described in this paper. He did not receive funding to work on this paper, and the data used in the paper are publicly accessible.

## Data availability

Data will be made available on request.

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## Appendix A. Unit weights for sdid and scm models

See Figs. 13–16.

## Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.regsciurbeco.2023.103952.

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