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Dinámica de los precios de la vivienda a raíz de la Ley de Empleos y Reducción de Impuestos de 2017

House Price Dynamics in the Wake of the Tax Cuts and Jobs Act of 2017

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RESUMEN

La Ley de Empleos y Reducción de Impuestos de 2017 (TCJA) cambió la política fiscal en dos aspectos importantes. Limitó las deducciones fiscales estatales y locales (SALT) a 10.000 dólares y redujo las tasas impositivas marginales en la mayoría de los tramos de ingresos. En este análisis, estimo modelos de series temporales de precios de la vivienda para 20 ciudades de EE. UU. utilizando datos de Case-Shiller y pruebo las rupturas de las series cuando se adoptó e implementó la TCJA. El propósito es probar si existe una raíz unitaria con puntos de interrupción en cada serie. De ser así, el shock de la TCJA fue permanente, no transitorio, y el proceso de series temporales no significa revertirse. Los resultados revelan rupturas significativas en 12 de los 20 índices de ciudades. Además, hay importantes puntos de ruptura en 22 de las 48 pruebas en todos los niveles de precios de las ciudades (16 ciudades con tres niveles de precios de la vivienda cada una). La fecha de interrupción modal es el mes de la aprobación de la legislación TCJA con otros 13 puntos de interrupción importantes dentro de los seis meses posteriores a la adopción de la TCJA. Los resultados indican que la TCJA se asoció con un efecto negativo inicial sobre los precios de la vivienda en muchos mercados inmobiliarios y niveles de precios. Es importante destacar que la presencia de procesos de raíz unitaria indica que la dinámica de los precios de la vivienda es más variable posteriormente.

PALABRAS CLAVE
Dinámica del precio de la vivienda; recortes de impuestos; estudio de eventos

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ABSTRACT

The Tax Cuts and Jobs Act of 2017 (TCJA) changed tax policy in two important aspects. It limited state and local tax deductions (SALT) to $10,000 and lowered marginal tax rates in most income brackets. In this analysis, I estimate house price time series models for 20 U.S. cities using Case-Shiller data and test for series breaks when TCJA was adopted and implemented. The purpose is to test whether there is a unit root with breakpoints in each series. If so, the TCJA shock was permanent, not transitory, and the time series process is not mean reverting. Results reveal significant breaks in 12 of the 20 city indices. Additionally, there are significant breakpoints in 22 of the 48 tests across city price tiers (16 cities with three house price tiers each). The modal break date is the month of TCJA legislation passage with another 13 significant breakpoints within six months of TCJA adoption. Results indicate that TCJA was associated with an initial negative effect on house prices in many housing markets and price tiers. Importantly, the presence of unit root processes indicates that house price dynamics are more variable subsequently.

KEYWORDS

House price dynamics; tax cuts; event study.

Clasificación JEL: H31; R31; C22. MSC2010: 62M10;

62P20.

1. INTRODUCTION

The Tax Cuts and Jobs Act of 2017 (TCJA) was adopted by Congress and signed by the President in December of 2017 and took effect for tax year 2018. That Act included a myriad of provisions, most notably limiting state and local tax deductions (SALT) to a maximum of $10,000 and lowering marginal tax rates in most taxable income brackets. With the SALT limitation, many itemizers faced an increase in taxable income in tax year 2018. Additionally, the user cost of owner-occupied housing was increased by this provision, especially in areas of the country with high state and local taxes (and property taxes in particular). As a result, we might expect to see house prices in these areas fall because of the passage of the TCJA of 2017. On the other hand, the reduction in marginal tax rates may have induced income effects that increased demand for houses. With two opposing effects, it is important to examine the house price time series to determine whether the TCJA had an appreciable impact.

In this analysis, I estimate house price time series models for the 20 metro areas covered in the Case-Shiller data and test for a break in the price series at the point when TCJA was adopted and became effective. The purpose of this analysis is to test whether there is a unit root with breakpoints in each of the house price series. If so, the effect of the TCJA shock is permanent, not transitory, and the statistical process is not mean reverting. If that is the case, house price dynamics are subject to greater variation going forward, giving insight on the impacts of subsequent shocks due to the pandemic and other factors.

The popular press certainly attributes a depressing effect of TCJA on house prices, as reported

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by Lucking (2019) in the Wall Street Journal. Concern over the effects of TCJA have been heightened as additional state tax complications of the federal SALT deduction limitative have become evident, as reported by Saunders (2019). Beyond popular press reports, the question of whether TCJA influenced house prices is important to answer. If TCJA altered the dynamic process of house prices in a city, subsequent shocks may have different effects than would have been expected previously.

Based on the canonical user cost of capital model we expect that the SALT deduction limitation raised the cost of capital and thereby put downward pressure on house prices for households likely affected by the limitation. Higher income households or those in states with higher state and local taxes were more likely to be affected. Additionally, the marginal tax rates and taxable income brackets were altered in ways that favored higher income households. The Case-Shiller indices are available for the top, middle and bottom thirds of the house price distributions in each of the 20 cities, so I test whether the SALT deduction limitation and tax structure changes had a greater effect at the top of the house price distribution than at the middle or bottom.

The paper proceeds as follows. After a literature review, section 2 presents a user cost of capital model in which we can examine the potential effects of the SALT deduction limitation and the tax rate changes. That model indicates the SALT deduction limitation negatively affects the cost of housing, leading to the testable hypothesis that house prices are negatively affected. The model also indicates that tax rate reductions positively affect housing prices which may at least partly dampen the SALT limitation deduction effect. Section 3 then presents the empirical approach employed in testing whether TCJA affected house prices near the time the legislation was adopted and implemented. Section 4 describes the Case-Shiller data used in the analysis. Section 5 presents the empirical estimates. Finally, section 6 gives a summary and conclusions.

1.1. Literature review

It is well known that the federal tax system provides incentives for homeownership. Chief among those incentives is the non-taxation of the implicit rental value of home ownership. In addition, the federal tax code provides deductions for mortgage interest and property taxes. Early analysis of housing markets and federal incentives for home ownership include Rosen (1979a, 1979b, 1985), Rosen and Rosen (1980), Poterba (1992), and Green and Vandell (1999). Bourassa and Grigsby (2000) summarize the various federal tax system features that encourage home ownership. In the brief review that follows, two strands of literature are summarized. First, general studies of house prices and the effects of TCJA due to both its less favorable treatment of owner-occupied housing and its income effects due to lower tax rates. Second, more specific studies that explore the time series properties of house prices are reviewed.

McClelland et al. (2022) use a variety of data sources to analyze the impact of TCJA on housing markets. Their analysis considers both the substitution effect due to loss of itemization and the income effect from lower overall tax rates. They find a small but significant effect on mortgages due to both fewer house buyers benefitting from the mortgage interest deduction and a small positive effect from increased after-tax income. Sommer and Sullivan (2020) use an equilibrium model to estimate the effects of TCJA. They also distinguish the effects of the Act on itemization behavior and after-tax income effects.

Himmelberg et al. (2005) reviewed the state of high house prices on the cusp of the 2007 bubble collapse, providing a relatively sanguine view. At the same time, Glaeser et al. (2005) asked why housing prices had gone up and provided the answer that local government regulations were a major answer to that question. Shortly thereafter, the housing bubble burst in many locations in the United States, and prices fell substantially making it clear that bubbles did exist in numerous markets. Furthermore, Damen et al (2014) provided evidence from several countries that

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mortgage interest deductions are fundamental determinants of house prices.

Rosen and Rosen (1980) conducted an early time series analysis of the effects of federal tax policy on homeownership. Their analysis indicated that approximately one-quarter of the growth in the proportion of homeowners relative to renters in the post WWII era can be attributed to favorable tax treatment of home ownership. Lai and Van Order (2017) provide the most recent analysis of house prices using panel estimation methods suitable for large N and large T (i.e. mean group and pooled mean group estimation). Their analysis of 45 metropolitan markets indicates similar results across metropolitan areas, with house prices explained by the same fundamentals. They find that the long-run rent to price ratio is approximately 5 percent plus 0.75 times the real interest rate.

Unit root tests have been used in several studies of housing price bubbles. Bourassa et al. (2019) review the various methods used in testing for bubbles, including the use of unit root tests. Taipalus (2006) investigates housing markets in five countries, including six urban areas in the United States, using unit root tests and finds evidence of bubbles in San Francisco starting in 2003 and Chicago starting in 2000. Taipalus and co-authors in Virtanen et al. (2018) later apply similar unit root tests in the context of bubbles in financial markets to identify banking crises. Yiu al. (2013) use the unit root tests developed by Phillips et al. (2011) in their study of the Hong Kong housing market. They identify ten brief bubbles periods over an 18-year span in that housing market. Finally, Escobari et al (2015) use time series test for bubbles in Case-Shiller house price índices for 15 U.S. metro áreas.

This review reveals that while many housing studies use micro-level data, there are important recent studies that employ time series methods to analyze aggregate house price series dynamics. Unit root tests have been used in studying the dynamics of house price trends. Consistent with those studies, the present study implements this approach to investigate whether the TCJA and its SALT deduction limitation had a significant effect on the time series properties of house prices in the United States.

TCJA had implications for real estate markets from both a federal and state/local perspective. Theus (2022) identifies the following key provisions of the Act with real estate impacts. At the federal tax level, TCJA implications for real estate flow from the following provisions:

- *Lower rate of corporate tax rate*: The top rate was reduced from 35 percent to a flat 21 percent for tax years 2018 and following. This provision of the Act was favorable to real estate entities as the corporate tax rate is combined with the qualified dividends, lowering the rate for distributions to shareholders to 36.8 percent, approximately the same as the Act's reduced individual rate of 37 percent.
- *Section 199A qualified business income deduction* (pass-through deduction): The Act provides a 20 percent deduction on qualified income for certain non-corporate taxpayers and captive REIT dividend income. Taxpayers in the top tax bracket who qualify have an effective federal tax rate of 29.6 percent.
- *Section 1031 Like-kind exchanges*: The Act removed the use of like-kind exchanges for some industries (e.g. rental cars and sports contracts) making the use of such exchanges relatively more important for investors and developers in the real estate sector.
- *Depreciation*: The Act provided for 100 percent bonus depreciation on qualified property acquired and put in service after September 27, 2017, through the end of calendar year 2022. After that, full depreciation phased down 20 percent each year for real property put in service in years 2023 through 2026. Additionally, Section 179 provisions were expanded to cover investments up to $1 million.
- *Business interest expense*: The section 163(j) interest expense deduction limitation may, in

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some ways, provide relative advantages for real estate.

- *Net operation losses and excessive business losses*: The Act modified NOL rules, disallowing losses to be carried back to previous years, but carry forwards are indefinite without expiration.

At the state/local level TCJA implications for real estate come from the following provisions:

- *SALT cap $10,000*: Limits state and local tax deduction.
- *Pass-through entities (PTETs)*: To offset the SALT limitation many states began to allow elective pass-through entity taxes (PTETs). Pass-through entities can take advantage of entity-level state elections to work around the $10,000 limitation.
- Mortgage interest deduction: The Act continues to permit mortgage interest deductions (MID), although limited to the first $750,000 in principle value, reduced from $1 million.

In his retrospective on the real estate impacts of the TCJA, Theus (2022) indicates that the intended purpose of the Act was to, "...give investors and developers a let up to do long-term business in the real estate market, an advantage single-family homeowners can only dream of receiving." He maintains that the intention was to, "...uplift the real estate business, not the individual homeowner, something that TCJA delivers." Hence, the implications of the Act for the real estate industry in general are more generous than those for homeowners. Yet, the SALT deduction limitation and the lower marginal tax rates may have had important effects deserving of analysis to determine whether they changed the dynamic trajectory of house prices

2. THEORETICAL MOTIVATION

The two major TCJA components that have a first-order effect on housing are the SALT limitation and the reduction in marginal tax rates. To address the implications of those features of the Act, a theoretical model is presented motivating the anticipated effects. The approach in Anderson et al. (2007) is used, which is ultimately based on the asset market approach first described and employed in analysis by Poterba (1984). The basic model below follows the approach in Poterba (1992).

We can begin with the benchmark case where the full value of the real economic return to homeownership is taxed. In that case, the net-of-tax income from homeownership with house price P_H and imputed rental value R, for a homeowner with a federal marginal income tax rate of τ, is given by the expression:

$$(1-\tau)\left[R-(i+\tau_p+m-\pi)P_H\right]$$

where i is the interest rate, τ_p is the property tax rate, m is the maintenance and depreciation cost rate, and π is the expected rate of house price inflation. The term in parentheses on the right-hand-side is the homeowner's forgone equity cost minus her capital gain. The equity cost is composed of both the foregone interest earned on the housing asset and the property taxes and maintenance/depreciate cost, each as a proportion of the house price. The expected capital gain is the rate of inflation π applied to the house price.

Assuming a competitive housing market, the net economic income earned from home-ownership is zero so the above expression can be set equal to zero and solved for the imputed rental value R in terms of the house price P_H:

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$$R = [i + \tau_p + m - \pi]P_H$$

This cost of housing expression represents the competitive equilibrium rent if the federal tax system fully taxes the net housing income as it does the interest income from other assets.

Taking the ratio of the rental value R to the house price P_H yields the term in brackets which is the user cost of home ownership:

$$\frac{R}{P_H} = \left[i + \tau_p + m - \pi\right].$$

This expression indicates that the user cost of ownership depends on the interest rate, property tax rate, maintenance and depreciation rate, and the expected rate of house price inflation.

For an itemizer, however, the user cost of housing is reduced by the deductibility of mortgage interest and property taxes. The foregone interest on housing equity is given by the after-tax interest rate $(1-\tau)i$ and the interest rate paid by the homeowner on the debt portion of the asset is the same after-tax interest rate that is due to the mortgage interest deduction. Hence, the rental price of housing for an itemizer, denoted R_I, can be expressed as:

$$R_I = \left[(1-\tau)\left(i + \tau_p\right) + m - \pi\right]P_H,$$

or,

$$R_I = \left[(1-\tau)i + m - \pi\right]P_H + (1-\tau)\tau_p P_H$$

where the second expression separates the property tax deductibility effect. Equivalently, in terms of comparison with the rental price for a non-itemizer, we have:

$$R_I = R - \tau(i + \tau_p)P_H$$

The rental price reduction due to the federal tax code is captured in the term $-\tau\left(i + \tau_p\right)P_H$, which represents the value of deductibility of mortgage interest and property taxes. The homeowner subsidy is directly related to the taxpayer's marginal tax rate, the interest rate, the property tax rate, and the house price. The subsidy is more valuable for high-income homeowners in areas where home prices and property tax rates are high.

The TCJA limits the deduction for state and local taxes, however, which results in higher user cost and therefore a lower house price. Given that property tax paid is $\tau_p P_H$, the full amount of property tax paid is deductible if $\tau_p P_H \leq T^{cap}$, but it is only partially deductible if $\tau_p P_H > T^{cap}$. The deduction for property tax is limited to the capped amount T^{cap}. Hence, the expression for the rental price of housing for an itemizer subject to the SALT cap, denoted $\tilde{R}_I$, is:

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$$\bar{R}_I = \left[i(1-\tau) + m - \pi\right]P_H + (1-\tau)T^{cap}$$

The difference between this rental price and the unconstrained rental price is the amount by which the homeowner's property tax exceeds the capped amount under TCJA. For itemizers subject to the deduction limitation, the rental price increases by an amount equal to the taxpayer's marginal tax rate times the difference between her property tax bill and the capped deduction allowed: $\tau(\tau_p P_H - T^{cap})$. The greater the share of the taxpayer's property tax payment that exceeds the cap, the lower the rental price of housing and the house price. The more binding the limitation the greater the negative impact.

Consequently, the effect of the TCJA is to reduce aggregate measures of house prices and do so in proportion to the prevalence of itemizers subject to the SALT deduction limitation the Act imposes. In a real estate market with few itemizers subject to the cap, there should be little price impact, but in a market dominated by itemizers subject to the cap the price reduction may be substantial. Clearly, for itemizers subject to the limitation, the rental price of housing is increased. As the rental price of houses for itemizers increases in the housing market, we expect that house prices will decline.

The second major effect of TCJA is to lower the marginal tax rate τ. Prior to the Act, marginal tax rates for individuals ranged from 10 percent to 39.6 percent. Most of the marginal tax rates were reduced by the Act and adjustments were made to the brackets. The exceptions were the 10 percent and 35 percent tax rates which were unchanged. Note however, for the 35 precent bracket the income threshold and top amount were changed.

The tax brackets and rates both before and after TCJA implementation are given in Table 1 of Appendix B. In general, the marginal tax rates fell by one to four percentage points depending on the taxable income bracket.

This component of the Act has the effect of increasing the rental price of housing. That implication is established by taking the partial derivative of *R* with respect to which yields an expression that is strictly negative:

$$\frac{\partial R}{\partial \tau} = -(iP_H + T^{cap}) < 0$$

Hence, a reduction in the marginal tax rate has the effect of increasing the rental value of housing. Of course, the size of that effect depends on the interest rate, the capped SALT deduction, and the price of housing.

There may be concern that interest rate changes confounded house price trends during the period under consideration. Thirty-year fixed rate mortgage data recorded in FRED indicate that in late 2017, the month prior to TCJA implementation, rates rose modestly from 3.90% on November 30 to 3.99% on December 28. The first rate recorded on January 4, 2018 was 3.95%, revealing no sudden change at the effective date of TCJA implementation. Rates rose thorough 2018, peaking in November at 4.94%. By the end of 2018 (December 27) the rate was down to 4.55%. Given this pattern, there does not appear to be a sudden change in mortgage rates that would occur at the time of TCJA implementation. Source: 30-Year Fixed Rate Mortgage Average in the United States (MORTGAGE30US) | FRED | St. Louis Fed (stlouisfed.org)

Based on this analysis, we have two opposing effects of TCJA on the rental value of housing: the

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SALT limitation reduces house prices whereas the reduction in the marginal tax rates increases house prices. As a result, the overall impact on prices is ambiguous depending on the strengths of the two effects.

3. EMPIRICAL APPROACH

The empirical approach employed in this study is time series analysis—unit root tests with a breakpoint. Typical research on house prices uses the Ordinary Least Squares (OLS) regression method to discover factors associated with prices. That method is based on an underlying assumption that the means and variances of the variables involved are constant over time. If those variables have means and variance that change over time, they are said to be non-stationary or have unit roots. A time series that with a unit root is a nonstationary process. A unit root process can be viewed as having a level shift at each point in time, whereas a stationary process has infrequent level shifts with some of those being persistent and others only temporary. Consequently, it is important for housing researchers to know whether housing price time series data have unit roots as they conduct their empirical analysis. Furthermore, it is important to know whether there are structural breaks at points in time, whether at known or unknown dates. Reviews of unit root tests with structural breaks are provided in Glynn et al. (2007) and Haldrup et al. (2012). Enders (2004) and Kim and Perron (2009) provide rationales for testing unit roots in the presence of a structural change.

Why do we care about whether house price series have unit roots with breakpoints? We are interested in the time series properties of the C-S series to understand what effect the TCJA had on the dynamic properties of aggregate house price series. We are not primarily concerned with the question of TCJA impacts on prices, but rather whether the Act fundamentally altered the dynamic properties of house price series. For context, a shock to a trend-stationary process eventually reverts to trend. The stochastic part of the process is stationary, and the effect of a shock is transitory. Hence, the process is mean reverting. With a unit root process, however, that is not the case. The effects of a shock are permanent, and the process is not mean reverting. In this study we are interested in the question of whether the TCJA shock had a permanent effect on house prices, not a mean reverting effect.

If we denote the house price index in period *t* as $p_t$and the break period as T_b the innovational outlier (IO) model can be expressed as,

$$p_t = p_{t-1} + \beta + \psi(L)[\theta D_t(T_b) + \gamma DU_t(T_b) + \varepsilon_t]$$

where $\psi(L)$ is a lag polynomial that represents the dynamics of the ARMA error process, ε_t represents the i.i.d. innovations, $D_t(T_b)$ represents a one-time break dummy variable, and $DU_t(T_b)$ represents an intercept break variable. This equation follows the approach in EViews (2019), equation (41.30). The IO model is estimated for each city and price tier, including three potential breaks: (1) an intercept break variable that takes on the value zero for all time periods prior to the break, and the value one thereafter, (2) a trend break variable that takes on the value one for all time periods prior to the break, and is a break date re-based trend for subsequent time periods, and (3) a one-time break dummy variable that takes on the value one on the break date, and zero otherwise.

The Augmented Dickey-Fuller (ADF) model, due to Dickey and Fuller (1979), is estimated, with the null hypothesis that the house price series has a unit root. Break selection is determined by minimizing the Dickey-Fuller *t*-statistic. Lag lengths are chosen using the Schwarz information criterion (SIC).

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4. DATA

Data used in this analysis are from the Case-Shiller (C-S) home price indices for 20 cities. The series employed provided monthly data, seasonally adjusted. For 16 cities, the indices are available by house price tiers. In those cases, we have prices for low, medium, and high price tiers where each tier includes one-third of the houses. Data source: FRED: https://fred.stlouisfed.org/series/SPCS20RSA

Figure 1 illustrates the S&P Case-Shiller 20-City Composite Home Price Index over the period January 2017 through December 2018. There is no obvious break in the series at December 2017 when TCJA was passed by Congress and signed by the President, or in January 2018 when the Act went into effect. A flattening of the series appears to have occurred, however, in March of 2018 as indicated by the vertical line. Whether that apparent break in the aggregate 20-city series reflects the experience in individual city housing markets, however, is a question that can be addressed empirically. We may be interested to see whether there is a more pronounced break in the house price series in markets where there are likely to be more itemizers subject to the SALT deduction limitation or more high tax rate households.

Figure 2 illustrates the S&P Case-Shiller 20-City Composite Home Price Index over the extended period January 2017 through June 2023. This figure indicates that after TCJA house prices in these cities rose especially rapidly following the recession of early 2020. The economic shock of the COVID-19 pandemic appears to have accelerated the rate of increase in house prices starting in June 2020. The Case-Shiller National Index had a local trough in January 2020 when the index registered 214.41, then rose to a peak in June 2022 of 308.32. Subsequently, the index fell to a local trough of 292.71 in January 2023 thereafter rising to a peak of 308.25 in June 2023. With this experience we have an indication that the pandemic economic shock to house prices was indeed not mean reverting.

Initial ADF tests on the Case-Shiller home price series in levels indicate that all the series, whether aggregate or by price tiers within each city, have a unit root. Hence, these house price series are not mean reverting when subjected to a shock. With first differencing, however, all but one of the series are stationary. The sole exception is the Chicago medium price tier series, which is stationary in second differences. Given these ADF test results, we know that the house price series are not mean reverting. Shocks to the series have permanent effects.

The next question is whether the individual city series exhibit evidence of breaks at or near the time of the TCJA passing or implementation. The analysis that follows uses the C-S house price series available for the 20 cities of the composite index as well as the price tier series available for 16 cities.

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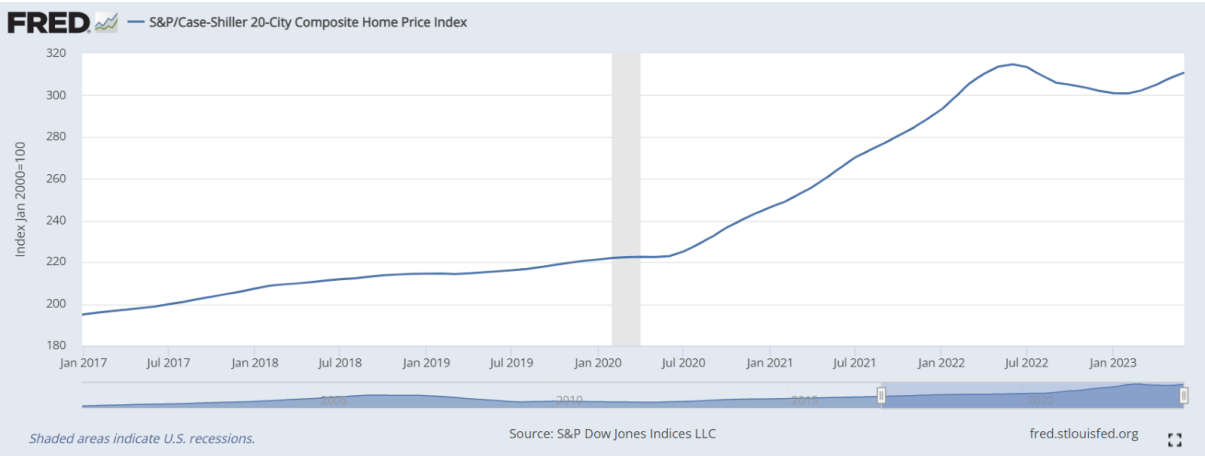
Figure 1: Case-Shiller 20-City Composite Home Price Index, 2017-2018.

Source: https://fred.stlouisfed.org/series/SPCS20RSA

Figure 2: Case-Shiller 20-City Composite Home Price Index, 2017-2023.



Source: S&P/Case-Shiller 20-City Composite Home Price Index (SPCS20RSA) | FRED | St. Louis Fed (stlouisfed.org)

5. CONCLUSION AND POLICY IMPLICATIONS

Empirical estimates are computed using time series tests for unit roots with breaks in the C-S price indices. Monthly data is used for the 12 months prior to TCJA adoption and the 12 months following its adoption. These are short data windows purposely chosen to isolate the potential effects of TCJA and avoid other confounding events. While previous studies using unit root tests to identify housing bubbles typically use longer data sets, there are studies using shorter series. See, for example, the Yiu et al. (2013) study of the Hong Kong housing market which reports that

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they used a minimum of eleven (11) observations in each regression. In each case the ADF t-statistic for the unit root test is computed, along with Vogelsang's asymptotic p-values (Vogelsang and Perron, 1998). Computed p-values are used to test the null hypothesis of a unit root. The alternative hypothesis is that the series is stationary. Small p-values, less than 0.10, are evidence that we can reject the null hypothesis of a unit root in the house price series. Furthermore, we can test for breaks in the series identifying the dates at which those breaks occur. The break test employed is based on a minimized Dickey-Fuller t-test for the most likely break date.

Table 1 reports estimates for the twenty Case-Shiller MSAs. The first column reports the unit root break tests for the house price series allowing for both intercept and trend breaks. Of the twenty MSAs, 12 have statistically significant breaks. Three MSA price series have breaks in the twelfth month of 2017. The modal break date is the following month, i.e. the first month of 2018 when the eight MSA series break. A total of 14 of the 20 MSAs have break dates within the first six months of 2018. These results indicate that the TCJA of 2017 may have had a significant impact on house prices in these MSAs at the time the Act was passed or shortly thereafter. The second column reports unit root break tests allowing for trend breaks only. The tests indicate similar results with eleven statistically significant breaks although the dates of the breaks occur generally later than in the first column of test results.

The third and fourth columns of Table 1 report unit root break test results for first differences of the house price series. Unit root break tests in column (3) permit both intercept and trend breaks. Those test results reveal thirteen significant breaks clustered from 2017.M12 through 2018.M4. The trend-only break tests reported in column four reveal nine significant breaks although the break dates are widely variable. The test results in columns (1) and (3), where break tests allow for both intercept and trend breaks, are quite similar indicating nearly identical breaks in both the price levels and first differences.

Table 2 reports estimates for the MSAs by home price tiers. Of the 48 tests conducted (for 16 MSAs each with three price tiers), 22 results have statistically significant results with p-values less than 0.10. Those 22 cases are shown in Table 2. Five of the significant results are for high price tier homes, where we would especially expect such results. Note, however, that 11 of the significant results are for low price tier homes. For each of the cities and price tiers reported in Table 2, the appendix provides graphical illustrations of Dickey-Fuller t-statistics showing the significant break points.

Table 3 orders the results by estimated break dates. It is notable that the modal break date among the significant results is December 2017, with six estimated breaks in that month and another 13 of the significant break dates falling within the first six months of 2018. Hence, most of the observed effects occur just prior or subsequent to TCJA adoption and implementation.

Table 4 reports the estimated break coefficients. Three potential break effects are estimated. First, consider the break dummy coefficients recalling that this variable takes on the value one in the break period and one otherwise. For 21 of the 22 estimates in the table the estimated coefficient is negative indicating that the house price index fell in the break period. In 18 of those cases the negative coefficient is statistically significant. The sole exception is the case of high price homes in Miami where the estimated coefficient is positive and significant. Next consider the intercept break coefficient estimates. Since the intercept break variable takes on the value zero for time periods prior to the break and one thereafter, a positive estimated coefficient indicates that the intercept increases at the break. That is the case for 21 of the 22 estimated intercept break coefficients. In all but five of those cases the positive coefficient is statistically significant. Again, the sole exception is the case of high price homes in Miami where the intercept break coefficient is negative and significant. Finally, consider the trend break coefficients which indicate the re-based trend starting on the break date. The estimated coefficients are generally

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negative and significant (negative in 17 of the 22 cases, and negative and significant in 14 cases) indicating flatter trends starting on the break date.

6. SUMMARY AND CONCLUSIONS

This study uses Case-Shiller house price indices to test for the potential effects of the TCJA on house price dynamics in 20 U.S. cities. The empirical method employed is to test for unit root breaks in the house price time series, both price levels and first differences. Tests are conducted for the 20 U.S. cities in the Case-Shiller 20-city house price index as well as for the three price tiers available for 16 of those cities (48 series). In each case three potential types of breaks in the series are estimated: a break dummy, an intercept break, and a trend break.

The estimated results indicate that not only were there significant breaks in the house price indices around the time of the TCJA passage and implementation, but also that those breaks affected the intercepts and/or trends of the series. The TCJA provisions are possible explanations for these results. The TCJA limited the SALT deduction and generally lowered taxes for most taxpayers. The SALT deduction limitation would have the effect of reducing house prices especially in high tax areas. However, the tax rate reductions would have the effect of raising after-tax income which could be expected to increase the demand for housing and raise prices. Whether mean house prices were affected is one question, but the focus of this analysis is on the question of whether the Act altered the statistical properties of house price series. The subsequent COVID-19 pandemic and its economic shock put upward pressure on house prices due to its impacts on new construction, supply chains, and inflation pressures. House prices have risen across the country, as indicated by the C-S 20 City index, but importantly, the evidence given here is that in many cities house price dynamics are characterized by unit root processes with the implication that shocks cause permanent, not transitory, effects. Hence, the processes are not mean-reverting and house price dynamics are subject to greater variation.

The implications of the breaks identified, and their direction, are important to consider. Evidence that the SALT deduction limitation reduced house prices following the series breaks means that homeowner wealth was reduced. Hence there is a negative welfare implication. While the tax cuts provided in the TCJA increased after-tax income for many taxpayers, which was welfare improving, that effect was apparently dominated by the negative effect of the SALT deduction limitation for many taxpayers, especially those with high incomes and high-priced homes.

There are several limitations of this study that point to future research possibilities. First, the identification of structural change can be sensitive to the particular unit root test used. ADF tests are used here, but alternative tests are available, and their use may result in somewhat different findings. Unfortunately, the literature on unit root tests is not conclusive in pointing to a single superior test. Herranz (2017) provides a good overview of alternative tests, but concludes that, "There is no single URT [unit root test] that is optimal under every scenario." Second, the time frame used in this study is short. That has been done to isolate the potential breaks surrounding a narrow policy implementation window. Longer time series can be used, however, confounding effects related to the ensuing pandemic and other factors arise in late 2019 and early 2020 that may make it difficult to isolate the impact of JCTA implementation which took effect in calendar year 2018. Finally, the models estimated here are univariate, analyzing a single variable—house prices, as measured by the Case-Shiller indices. More comprehensive models of house prices can be implemented within which to potentially isolate the impact of the TCJA.

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Table 1: Break Dates for Case-Shiller 20 MSAs.

MSA	Break Date in Trend and Intercept of Price Series (1)	Break Date in Trend of Price Series (2)	Break Date in Trend and Intercept of First Difference of Price Series (3)	Break Date in Trend of First Difference of Price Series (4)
Atlanta (ATXRSA)	2017.M12***	2017.M09**	2018.M01	2018.M02
Boston (BOXRSA)	2018.M1*	2018.M10**	2017.M12*	2018.M05**
Charlotte (CRXNSRA)	2018.M01***	2018.M03	2018.M02***	2017.M09***
Chicago (CHXRSA)	2018.M01***	2018.M11**	2017.M10	2017.M05
Cleveland (CEXRSA)	2018.M01	2017.M05	2018.M02***	2018.M09***
Dallas (DAXRNSA)	2018.M01***	2018.M03***	2018.M02**	2018.M08
Denver (DNXRSA)	2018.M05	2018.M08	2018.M02*	2018.M01
Detroit (DEXRSA)	2018.M01	2018.M05	2018.M04***	2017.M04
Las Vegas (LVXRSA)	2017.M04	2018.M11	2018.M05	2018.M09
Los Angeles (LXXRSA)	2018.M01	2018.M04	2018.M04***	2018.M1
Miami (MIXRNSA)	2017.M12	2017.M04	2017.M12***	2018.M06***
Minneapolis (MNXRSA)	2018.M02**	2018.M05	2018.M03***	2017.M06***
New York (NYXRSA)	2018.M02***	2018.M04***	2018.M03**	2018.M07
Phoenix (PHXRNSA)	2017.M09**	2017.M12**	2018.M02	2018.M11
Portland (POXRSA)	2017.M12*	2018.M3*	2017.M09	2018.M02
San Diego (SDXRSA)	2018.M06	2018.M07*	2018.M02***	2018.M03***
San Francisco (SFXRSA)	2018.M05	2018.M08	2018.M04	2017.M12
Seattle (SEXRNSA)	2018.M04***	2018.M06***	2018.M05*	2018.M06**
Tampa (TPXRSA)	2018.M09***	2018.M10***	2018.M02***	2017.M12***
Washington DC (WDXRSA)	2018.M01***	2018.M04*	2018.M03	2017.M05**

Note: Superscripts *, **, and *** indicate *p*-values less than 0.1, 0.05, and 0.01, respectively.

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Table 2: Break Dates for Case-Shiller MSAs, by House Price Tier.

MSA	House Price Tier	Break Date in Trend and Intercept of Price Series (1)	Break Date in Trend and Intercept of First Difference of Price Series (2)
Atlanta	High	2017.M12***	2018.M01**
Atlanta	Low	2017.M12***	2017.M12*
Boston	High	2018.M03***	2018.M04***
Chicago	Medium	2017.M12***	
Chicago	Low	2018.M02*	2018.M03***
Denver	Low	2018.M12*	2018.M02**
Los Angeles	Low	2018.M01**	2018.M04***
Miami	High	2017.M09***	2018.M04*
Miami	Low	2017.M05***	2018.M03*
Minneapolis	High	2018.M02*	2018.M03***
Minneapolis	Low	2018.M02***	2018.M02**
New York	Medium	2018.M01***	2018.M03***
Phoenix	Medium	2018.M01**	2017.M12***
Phoenix	Low	2017.M12**	2017.M12***
Portland	Low	2018.M02*	2018.M02***
San Diego	Medium	2018.M06**	2018.M02***
Seattle	High	2018.M04**	
Seattle	Medium	2018.M04**	2018.M01***
Seattle	Low	2018.M09**	2018.M02*
Tampa	Low	2018.M04***	2018.M11*
Washington DC	Medium	2018.M02***	
Washington DC	Low	2017.M12**	2018.M02*

Notes: Only statistically significant break date results are shown. Superscripts *, **, and *** indicate *p*-values less than 0.1, 0.05, and 0.01, respectively.

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Table 3: Break Dates for MSAs, by House Price Tier, Ordered by Break Date.

MSA	House Price Tier	Break Date in Trend and Intercept of Price Series
Miami	Low	2017.M05***
Miami	High	2017.M09***
Atlanta	High	2017.M12*
Atlanta	Low	2017.M12**
Chicago	Medium	2017.M12***
Phoenix	Low	2017.M12**
Washington DC	Low	2017.M12**
Los Angeles	Low	2018.M01**
New York	Medium	2018.M01***
Phoenix	Medium	2018.M01**
Chicago	Low	2018.M02*
Minneapolis	High	2018.M02*
Minneapolis	Low	2018.M02***
Portland	Low	2018.M02*
Washington DC	Medium	2018.M02***
Boston	High	2018.M03***
Seattle	High	2018.M04**
Seattle	Medium	2018.M04**
Tampa	Low	2018.M04***
San Diego	Medium	2018.M06**
Seattle	Low	2018.M09**
Denver	Low	2018.M12*

Notes: Only statistically significant break date results are shown. Superscripts *, **, and *** indicate *p*-values less than 0.1, 0.05, and 0.01, respectively.

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Table 4: Intercept and Trend Break Coefficient Estimates.

MSA	House Price Tier	Break Date	Intercept Break Coefficient	Trend Break Coefficient	Break Dummy Coefficient
Atlanta	High	2017.M12***	0.776**	-0.018	-0.832*
			(0.321)	(0.040)	(0.453)
Atlanta	Low	2017.M12***	0.405	0.496***	-1.042**
			(0.421)	(0.096)	(0.378)
Boston	High	2018.M03***	4.293***	-0.417***	-3.567***
			(0.724)	(0.071)	(0.711)
Chicago	Medium	2017.M12***	1.610***	-0.154***	-1.408***
			(0.414)	(0.050)	(0.474)
Chicago	Low	2018.M02*	4.593***	-0.767***	-3.073*
			(1.442)	(0.206)	(1.526)
Denver	Low	2018.M12*	4.453***	-0.753***	-2.463***
			(1.108)	(0.145)	(0.914)
Los Angeles	Low	2018.M01**	5.425***	-1.160***	-4.088***
			(1.104)	(0.149)	(0.904)
Miami	High	2017.M09***	-1.733***	0.176***	2.018***
			(0.342)	(0.061)	(0.407)
Miami	Low	2017.M05***	3.362***	-0.845*	-3.005**
			(0.132)	(0.413)	(1.088)
Minneapolis	High	2018.M02*	3.666***	-0.224*	-2.696**
			(0.993)	(0.111)	(1.157)
Minneapolis	Low	2018.M02***	0.725	0.117	-2.141***
			(0.615)	(0.089)	(0.689)
New York	Medium	2018.M01***	3.361***	-0.641***	-3.765***
			(0.840)	(0.125)	(0.948)
Phoenix	Medium	2018.M01**	1.174***	0.242***	-0.781**
			(0.296)	(0.067)	(0.354)

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Phoenix	Low	2017.M12**	1.264*** (0.268)	0.073 (0.044)	-0.902*** (0.332)
Portland	Low	2018.M02*	0.069 (1.038)	-1.101*** (0.309)	-2.677* (1.475)
San Diego	Medium	2018.M06**	1.444* (0.769)	-1.880*** (0.369)	-0.739 (0.707)
Seattle	High	2018.M04**	4.752*** (1.261)	-1.786*** (0.328)	-3.155*** (0.984)
Seattle	Medium	2018.M04**	8.270*** (2.296)	-2.358*** (0.496)	-4.015** (1.791)
Seattle	Low	2018.M09**	12.446*** (3.655)	-3.191*** (0.789)	-4.678** (1.945)
Tampa	Low	2018.M04***	0.500 (0.826)	-1.057*** (0.208)	-2.910** (1.057)
Washington DC	Medium	2018.M02***	1.936*** (0.520)	-0.091 (0.054)	-0.850 (0.566)
Washington DC	Low	2017.M12**	0.550 (0.954)	-0.141 (0.118)	-1.553 (1.111)

Notes: Only statistically significant break date results are shown. Superscripts *, **, and *** indicate p-values less than 0.1, 0.05, and 0.01, respectively.

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Appendix A:

Atlanta-High Price Tier

Denver-Low Price Tier

Minneapolis-Low Price Tier

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Atlanta-Low Price Tier

Los Angeles-Low Price Tier

New York-Medium Price Tier

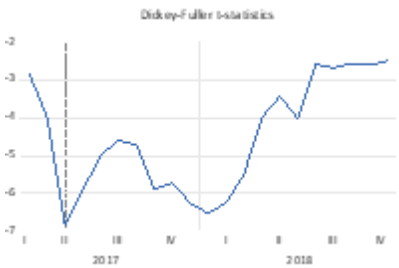
Boston-High Price Tier

Miami-High Price Tier

Phoenix-Medium Price Tier

Chicago-Medium Price Tier

Miami-Low Price Tier



Phoenix-Low Price Tier

Chicago-Low Price Tier

Minneapolis-High Price Tier

Portland-Low Price Tier

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San Diego-Medium Price Tier

Washington DC-Medium Price Tier

Seattle-High Price Tier

Washington DC-Low Price Tier

Seattle-Medium Price Tier

Seattle-Low Price Tier

Tampa-Low Price Tier

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Appendix B:

TABLE 1

Individual Income Tax Brackets and Rates
2018

Prior Law					Tax Cuts and Jobs Act				
Taxable Income ($)				Tax Rate (percent)	Taxable Income ($)				Tax Rate (percent)
Single Filers		Married Couples Filing Jointly			Single Filers		Married Couples Filing Jointly		
Over	But not over	Over	But not over		Over	But not over	Over	But not over	
0	9,525	0	19,050	10	0	9,525	0	19,050	10
9,525	38,700	19,050	77,400	15	9,525	38,700	19,050	77,400	12
38,700	93,700	77,400	156,150	25	38,700	82,500	77,400	165,000	22
93,700	195,450	156,150	237,950	28	82,500	157,500	165,000	315,000	24
195,450	424,950	237,950	424,950	33	157,500	200,000	315,000	400,000	32
424,950	426,700	424,950	480,050	35	200,000	500,000	400,000	600,000	35
426,700	and over	480,050	and over	39.6	500,000	and over	600,000	and over	37

Source: Gale et al. (2018)

How did the Tax Cuts and Jobs Act change personal taxes? | Tax Policy Center