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Can toll prices changes affect the housing market? The case of the Severn Crossing toll removal

Danai Protopsalti
Lloyds Banking Group, London, UK

Alexandros Skouralis*
Bayes Business School, City, University of London, London, UK

February 29, 2024

Purpose: Since 1966 the Severn crossing has been connecting England and Wales. In January 2018 its ownership has returned to the UK government and this marked the start of a toll-free journey across the two countries and made commuting between the regions more affordable. In this paper, we examine the impact of the toll removal on the property market.

Methodology: We employ property-level data from the Land Registry and a difference-in-differences (DiD) empirical model for the periods 2016-2018 and 2019-2021 to capture the pre- and post-toll removal dynamics. The DiD estimation allows us to examine the causal relationship between policy changes and property prices.

Findings: Our findings suggest that property prices in Newport and Monmouthshire (South East Wales) are positively affected by the policy, which results in an statistically significant increase by 5.8% more than those located in South West England (Bristol and South Gloucestershire) region in the period 2019-2021. The impact can reach up to 13.1% for properties located in a 10km radius from the bridge. The results indicate that the toll removal enables the ripple effect across the two markets by reducing commuting costs.

Originality: This is the first paper that examines the Severn Crossing case study. Its contribution is significant since we provide empirical evidence on how reduced transportation costs increase property prices in the lowest income region, and have the opposite effect on the area with higher incomes and economic activity levels.

Keywords: *House Prices ; Toll removal ; Transportation costs; Ripple Effect ; Difference-in-Differences*

JEL codes: O18 ; R21 ; R31 ; R41

*Contact: alexandros.skouralis@city.ac.uk

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1. Introduction

The inaugural of the first motorway Severn Crossing bridge took place on September 8, 1966, followed by the inauguration of the newer cable-stayed bridge on June 5, 1996.[1] Since then, the two Severn Bridges are the main connection point between South Wales and South West England. In January 2018, when the revenue required to build and maintain the bridges was collected, their ownership returned to the UK government, which in turn removed the toll charge in December 2018.[2] The two connected areas exhibit significant economic differences. More specifically, in 2018, the gross disposable income per person in Newport was 14.7% lower than the respective figures in Bristol (ONS data). Therefore, the commuting figures between the regions are considerable and a year after the toll removal, traffic in the Severn Bridges had increased by 16%.[3] According to the UK National Travel Survey 2020, despite the UK Government's restrictions on non-essential work, the average person in England travelled to work 91 times in 2020.[4] This marks a 35% decline compared to 2019. However, since 2021 almost no COVID-19 public health care regulations are still in place and the economy has started to scale up, therefore commuting volumes are expected to increase again.

Daily commutes are an integral aspect of everyday life, given the clustering of economic activity and job opportunities, which often surpass the density of residential populations. (Brinkman, 2016). However, commuting carries significant time and monetary costs (Van Ommeren and Fosgerau, 2019).[5] Consequently, commuting distance and time, together with other factors such as household income, play an important role in housing preferences. The theory is backed by empirical research on this area. Tse and Chan (2003) find that greater commuting distance from the central business district has a negative effect on property values in Hong Kong. Land Registry data supports the aforementioned literature. The 2018 average house price in Bristol was £280,540, whereas for Newport, that is located just 31miles away, property prices were lower by 35.4% at around £181,214. However, we have to take into consideration the area's transportation system. Commuters from Wales to Bristol had to go through the Severn Crossing, and additionally to the cost of gas, they were facing a minimum

[1] Currently there are two two-way Severn Bridges, the Severn Bridge (M48) and the Prince of Wales Bridge (M4).
[2] Up until then, it was privately owned by John Laing, a British developer (35%), Vinci, a French construction company and two banking institutions, Bank of America (15%) and Barclays (15%). For more information, see public records from "The Severn Crossings Toll", Welsh Affairs Committee, UK Parliament.
[3] See BBC Wales 2018 article by Peter Shuttleworth.
[4] See Department of Transport, UK National Travel Survey 2020 full report.
[5] Van Ommeren and Fosgerau (2019) estimate that the marginal cost per hour is around 17 euros and therefore is not financial profitable for low-paid workers to commute on everyday basis.

toll fee of £5.40 per passage. In addition, supply factors such as fuel prices can make commuting more expensive and result in a decline in house prices that are not located near a city centre (Blake, 2019 ; Morris et al., 2020). However, an improvement in transport can result in an increase in house prices located near the new transportation routes. Yiu and Wong (2005) study how the development of a new cross-harbour tunnel affected Hong Kong house prices. They find evidence of significant increases in prices even well before the completion of the construction project.

In this paper we focus on the Severn Bridges toll removal, which is not a case of an improvement in infrastructure, but a case of declining marginal transportation cost for commuters. In the three-year period after the toll removal (2019-2021), Newport & Monmouthshire's prices rose, on average, by 24% year-on-year, which is 8.8% more than the average change in Bristol and South Gloucester's house prices. Our empirical results indicate that the impact of the toll removal has economically and statistically significant results. We employ property-level data from the Land Registry and a difference-in-differences (DiD) empirical model for the periods 2016-2018 and 2019-2021 to capture the pre- and post-toll removal dynamics. The DiD estimation allows us to examine the causal relationship between policy changes and property prices. Our results indicate that property prices in Newport and Monmouthshire (South East Wales - treated group) increased up to 5.8% more compared to South West England (control group) after the toll removal. In line with our expectations and the literature[6], the magnitude of the impact is directly associated to the distance from the Severn Bridge (M48) and can reach up to 13.1% for properties located within a 10km driving distance. The results are robust for an extended time period before and after the toll removal, and they are consistent across property types.

The contribution of the paper is significant since we provide empirical evidence on how reduced transportation costs increase property prices in the lowest income region, and have the opposite effect on the area with higher incomes and economic activity levels. The toll removal activates the ripple effect across the UK market since it results in a convergence of house prices across South East Wales and South West England. The benefits from the toll removal can be multidimensional. The increase in household (housing) wealth is an opportunity for lower

[6] Martinez and Viegas (2009) use data from Portugal and they argue that property values are negatively correlated with the proximity to transport lines such as the underground metro lines.

income neighborhoods to catch up in line with government's Levelling up program, which aims to reduce inequalities across UK regions.

The rest of the paper is structured as follows. Section 2 discusses the related literature. Sections 3 and 4 describe our data the difference-in-differences empirical methodology. In Section 5, we present the empirical findings and the robustness analysis. Finally, Section 6 concludes.

2. Related Literature

Our paper fits in the literature that examines the impact of public policy on the housing market. A strand of this literature focuses on the case of public investments. Boarnet and Chalermpong (2001) and Vadali (2008) find that the construction of new toll roads, in California and Texas respectively, created an accessibility premium for nearby areas and drove up their property prices. The impact of road improvements is not apparent only upon the project completion, but affects the housing market since their announcements through the expectation channel (Yiu and Wong, 2005). Changes in public policy can affect house prices through internal migration. An investment in an area results in richer households being attracted to live in those places and low-income households to migrate out. An example of that was the $3 billion investment on the Olympic Village in Beijing (Zheng and Kahn, 2013). Moreover, Guerreri et al. (2013) use data for the US and they support that an exogenous housing demand shock will cause this phenomenon of internal migration, a process that they define as "endogenous gentrification". The impact is more severe for poor households on the border of high-income neighbourhoods.

However, the literature that focuses specifically on this effect of immigration on real estate and labour markets does not provide straight-forward results. Saiz (2006) and Degen and Fischer (2009) argue that an increase in immigration figures is associated with higher property prices and rents. On the other hand, Saiz and Wachter (2011) and Sá (2014) find that immigrants make a neighbourhood less desirable for locals, who will move out and eventually housing demand and prices decline. In our case, we expect that internal migration from England to Wales to have a beneficial effect on the latter. As Pavlov and Somerville (2020) argue, the impact of immigration depends on new residents' income level. They find that wealthy immigrants can raise house prices in the neighbourhood.

Other forms of government interventions that affect the housing market is the adoption of tolls and road pricing policies. Many studies focus on the case of Singapore's electronic road pricing (ERP) that has proven to be an effective tool to reduce traffic congestion (Santos, 2006), but has also affected the real estate prices. Agarwal et al. (2015) find that the toll rate increase in Singapore's ERP resulted in a 19% decline in retail commercial real estate prices, but residential and office spaces remained unaffected. On the other hand, Theisen (2020) finds that house prices in the Norwegian town of Kristiansand have increased within the urban toll ring, compared with those outside the circle. Although there are considerable differences across types of properties, the toll ring premium is estimated at 6.9%. More recently, Tang (2021) investigates the London Congestion Charge and finds that it reduces traffic by around 9% and leads to increases in house prices by 2.8%.

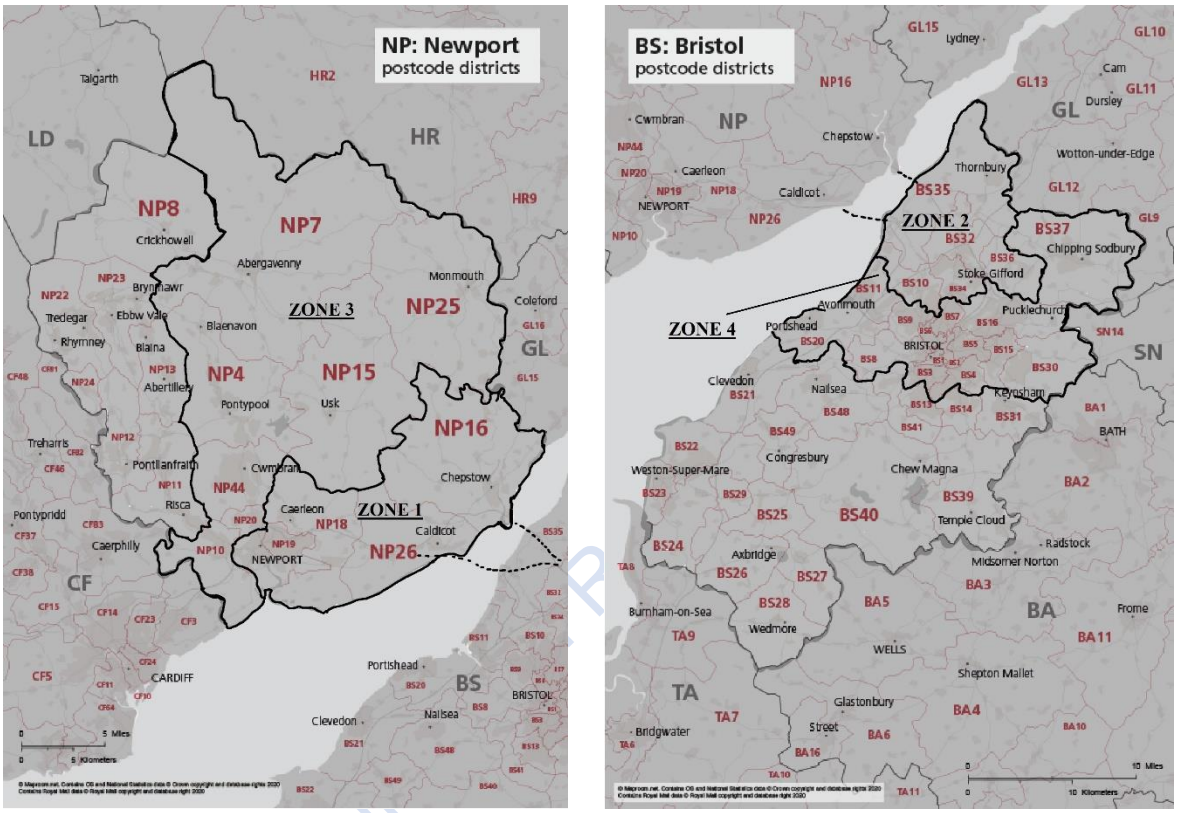
Finally, the paper contributes to the extended literature of co-movement and convergence across (regional) housing markets. Meen (1999) introduced the concept of the "ripple effect" in the UK housing market. He suggests the a cyclical upswing is first observed in the South East part of the country and it spreads out affecting the other regions. This theory has been tested and confirmed empirically by Cook (2005) and Holmes and Grimes (2008) using Monte Carlo simulation and principal components analysis respectively. They find that UK regional house prices are stationary and therefore they follow a stochastic trend as implied by the "ripple effect" theory.[7] In addition, Montagnoli and Nagayasu (2015) examine the convergence in the 12 UK regions through a series of statistical approaches.[8] Their results suggest that London has a significant "ripple effect" on the rest of the UK regions.[9] In addition, they find spillovers across the regional markets but only after they are grouped into four specific clusters. Based on their data, Wales and South West England do not belong in the same cluster and therefore the spillovers between the two are not as significant.

Our results indicate that the removal of the Severn Bridges tolls activate the "ripple effect" across the two regions and countries which gradually convergence to their new equilibrium. Blatt and et al. (2023) use a VAR-based spillover index to study the contagion across UK

[7] More recently, Cook and Watson (2016) find evidence that confirm the existence of a ripple effect in house prices changes rather than the convergence of levels. The results are significantly stronger for the London area that drives property prices in the surrounding areas.
[8] Cipollini and Parla (2020) find evidence of the "ripple effect" in a sample of 93 Italian provinces using a Global VAR model.
[9] Holly et al. (2011) find that shocks in the London area are propagated contemporaneously and spatially to other UK regions.

property markets. They argue a rise in demand for Welsh property might also originate from the Bristol area, following the removal of tolls on the Severn Crossing.

Figure 1: UK Zones



Note: The Figure displays the examined four UK zones. In total 37 district postcodes are included in our analysis. Zones 1 and 3 include properties in South East Wales and most specifically Newport and Monmouthshire and Zones 2 and 4 include properties in Bristol and South Gloucestershire (South West England).

3. Data

We use data from HM Land Registry for the period between January 2015 and December 2022. Our main variable of interest is the property transaction price[10], which includes all property types. We group regions into four zones; Zone 1 includes four Welsh district postcodes in Newport and Monmouthshire, that are located in close distance (<20km) to the bridge and we expect to have been benefited the most from the new policy. More specifically

[10] Using property-level data instead of regional indices offers numerous advantages. Property-level data provides a more granular view of the market and allow us to focus on the area withing a driving distance from the Severn Bridge. Moreover, regional/local authority indices may not accurately reflect the dynamics of specific properties within a region. They can be driven by outliers or by large, high-value properties that skew the average. For that reason in our sample, we exclude properties sold below £10,000 and/or above £1,000,000.

in Zone 1 we include properties located in NP16, NP18, NP19 and NP26. Zone 2 is the control area in the South West England that includes five Bristol and South Gloucesterhire district postcodes (BS10, BS32, BS34, BS35, BS36).

Table 1: Summary Statistics

Postcodes	Distance from the Bridge (in km)	Property Price (2016-2018)	Property Price (2019-2021)	Year-on-Year Property Price growth (2016-2018)	Year-on-Year Property Price growth (2019-2021)
Treated group (Newport and Monmouthshire | South East Wales region)					
NP4	33.3	£147,407	£161,019	7.6%	4.9%
NP7	42.7	£249,152	£280,878	6.9%	4.6%
NP10	27	£216,613	£243,864	6.8%	3.8%
NP15	25.1	£293,373	£357,550	7.2%	12.4%
NP16	7.6	£231,541	£280,850	7.9%	6.9%
NP18	17.7	£241,957	£290,188	6.1%	9.6%
NP19	19.5	£139,280	£169,776	5.5%	7.3%
NP20	23.6	£166,135	£189,537	4.7%	8.7%
NP25	33.9	£281,268	£325,327	5.7%	9.6%
NP26	1.6	£235,570	£281,341	6.5%	6.2%
NP44	27.1	£162,179	£197,723	6.7%	6.3%
Average	**24.67**	**£214,952**	**£252,550**	**6.52%**	**7.29%**
Control group (Bristol and South Gloucestershire | South West England region)					
BS1	25.4	£302,313	£325,897	9.3%	3.5%
BS2	24.5	£248,439	£278,726	9.8%	7.8%
BS3	27.6	£284,403	£326,861	9.1%	5.5%
BS4	28	£251,342	£279,714	9.3%	5.0%
BS6	23	£412,928	£451,093	5.0%	4.2%
BS7	20.4	£337,723	£372,381	8.9%	4.2%
BS8	25.1	£398,105	£420,494	5.3%	3.5%
BS9	20.8	£445,490	£483,443	6.8%	2.0%
BS10	17.7	£249,848	£279,560	7.7%	6.4%
BS11	21.2	£213,757	£234,140	10.2%	4.8%
BS15	25.5	£206,769	£237,311	8.6%	6.3%
BS16	21.7	£245,164	£279,538	8.9%	3.9%
BS20	27.3	£332,818	£362,083	9.1%	3.6%
BS30	28.3	£278,035	£310,736	7.9%	4.2%
BS32	12.1	£277,308	£314,694	6.5%	5.9%
BS34	14.9	£246,427	£275,704	7.0%	4.2%
BS35	1.6	£328,695	£346,738	6.7%	2.3%
BS36	17.1	£353,505	£390,636	7.5%	4.8%
BS37	20.4	£264,870	£290,620	6.9%	4.1%
Average	**21.75**	**£276,822**	**£305,759**	**8.06%**	**4.82%**

Note: The Table displays the district postcodes included in the our empirical analysis. Distance is based on the driving distance between the Severn Bridge (M48) and the centroid of each district postcode area. The property price data is provided by the HM Land Registry. The property prices include all property types.

For robustness purposes, we then extend the two zones. Zone 3 includes 6 district postcodes, additionally to all Zone 1 areas, that are located in between 20 and 45km driving distance from the Severn Bridge (M48). Similarly, Zone 4 includes all Zone 2 areas and fourteen other districts. Figure 1 presents the map of the two examined regions and of all the aforementioned zones.

In addition, Table 1 displays all the district postcodes included in our sample, their distance from the Severn Bridges and the property price summary statistics. The selected districts were chosen purely based on their location, as they are close enough to the bridge that would allow commuting between the two regions. The summary statistics clearly illustrate the difference in the two regions. Property prices in Zone 2 are consistently higher than Zone 1, but they both follow the UK average trend. However, Zone 1 experienced significant growth in the period after 2019 and the toll removal. For illustration purposes, in Figure 2.A we present the equally-weighted house price growth average of areas in Zones 1 (South Wales) and 2 (South West England). In the period 2012-2018, property prices among the two regions and the England average exhibit significant co-movements and parallel trends, in line with the country aggregate property market.

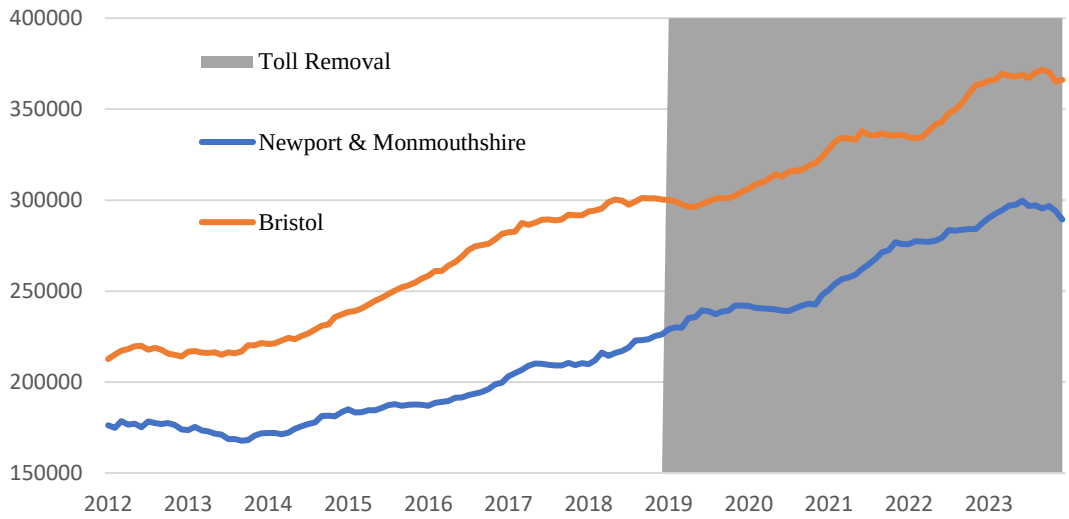
However, we observe that the relationship is not consistent throughout the examined time period. In July 2017, Alun Cairns, the then Welsh Secretary, announced that the plan was for the tolls to be abolished by the end of 2018, to boost the South Wales economy. The toll charges were initially reduced by 16.4% in January of 2018 and eventually removed by the end of the same year. As we observe in Figure 2.A, property prices in Zone 1 exhibit an upward trend in 2019, whereas Zone 2 displays a slow growth rate in line with the UK property market index.

The change in the co-movements between the markets is more evident by looking at the local authority-level property price indices available by the Land Registry. Figure 2.B displays the year-on-year growth of the two examined regions, namely Bristol and Newport-Monmouthshire. The latter index is based on the sales-weighted aggregate index of the two regions as provided by HM Land Registry. The indices include all types of properties and types of buyers. Soon after Cairn's announcement in 2017[11], the property markets exhibit an heterogeneous effect. The property market in South East Wales grew significantly, whereas the Bristol property index experienced a very low growth rate.

[11] As mentioned in the Literature review, Yiu and Wong (2005) argue that even the policy announcement should directly affect the housing market through the expectation channel.

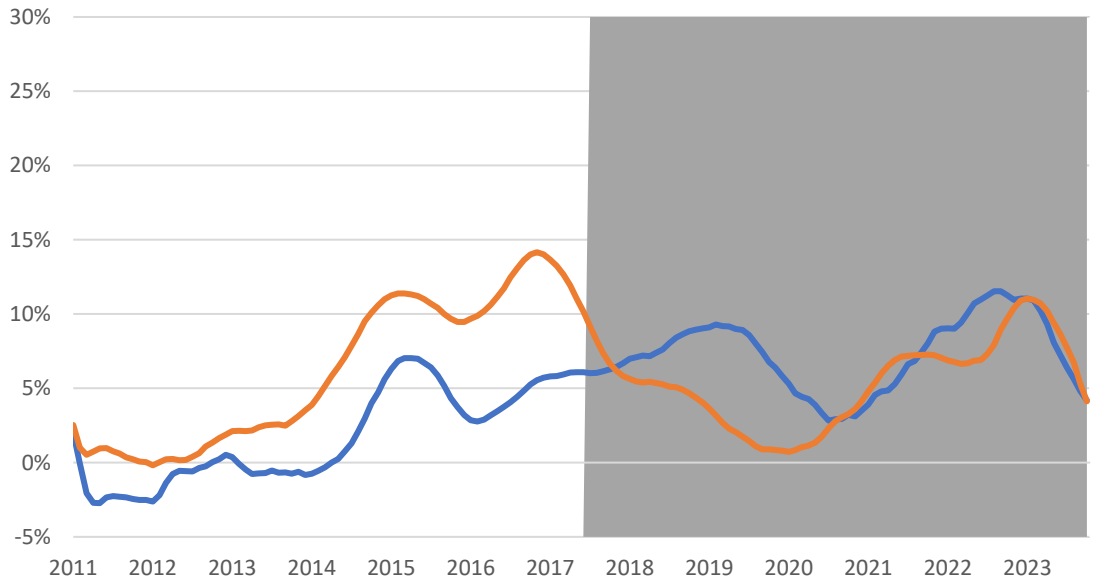
Figure 2: Property Price trends

A. Log Property Prices



Note: The Figure displays the property price 12-month moving average of the two examined regions, namely Zone 1 (Newport & Monmouthshire) and Zone 2 (Bristol and South Gloucestershire). The data is provided by the HM Land Registry. The indices are obtained as the equally-weighted average of the individual district postcodes and they include all types of properties and types of buyers.

B. Year-on-year property price growth



Note: The Figure displays the year-on-year growth of the two examined regions, namely the South East Wales region (Newport & Monmouthshire) and the South West England (Bristol). The data is provided by the HM Land Registry and the Local Authorities House Price Indices. The Newport & Monmouthshire is based on the sales-weighted aggregate index of the two regions as provided by HM Land Registry. The indices include all types of properties and types of buyers.

4. Difference-in-Differences framework

In this section we present our empirical methodology. In order to investigate the impact of toll removal in the two examined regions we use the difference-in-differences (DiD) framework. The DiD framework is a popular approach to examine the impact of policy intervention. Its simplicity and intuitive nature make it applicable to various fields of research, while its longitudinal approach provides insights into both short-term and long-term effects. A part of the DiD literature focuses on policy changes and house prices. Gibbons et al. (2020) use the DiD methodology to study the effect of housing subsidies cuts ("bedroom tax") on the UK property market. They use as a treated group the households that are affected by the cut and as a control the non-affected households. Their findings suggest that the examined policy had limited effect on housing consumption and employment.

More recently, Braakmann and McDonald (2020) use the DiD framework to analyze the rental subsidies cut in England and they find that the policy results in a decline in prices of properties that are usually rented by people in benefits. Moreover, Droës and Koster (2016) use a DiD model to identify the effect of the placement of a wind turbine on the value of nearby properties. They find that close proximity (2km) from a wind turbine results in a decrease in property prices by 1.4%. Similarly, other forms of negative externalities, such as aircraft noise, can cause a decline in rents (Boes and Nuesch, 2011) and house prices (Zheng et al., 2020).

The mathematical representation of the model takes the following form:

$$logPrice_{i,t} = \alpha + \beta\,(Toll\ x\ Treated)_{i,t} + f_p + \delta_t + \varepsilon_{p,t} \quad (1)$$

The dependent variable is the natural logarithm of the paid property (i) prices as provided by the Land Registry. The variable *Toll* is a dummy variable that takes the value equal to one after 2019 and zero otherwise. *Treated* defines the treatment group and therefore takes a value equal to one for district postcodes (p) Zone 1 and zero for Zone 2. The coefficient β captures the change in property prices in Zone 1 (treatment group) relative to Zone 2 in the pre- and post-toll removal periods. Across all specifications we use time fixed effects (δ_t) to control for macroeconomic variation and postcode fixed effects (f_p) to account for neighborhood effects and unobserved differences across the examined areas. Finally, we include robust standard errors $(\varepsilon_{p,t})$ across all model specifications.

Our benchmark specification sample includes 91,611 observations from Zones 1 and 2. The data covers the period between January 2016 and December 2021. During the examined period

other forms of policy such as the COVID-19 support package and more specifically, the stamp duty holiday, were adopted by the government. These policies are expected to have an impact on the UK residential real estate market. However, the DiD design allows us to infer causality by comparing the treatment and the control group since they were both benefited by the stamp duty holiday, but not from the toll removal, in which case the policy is expected to have the opposite effect on the two regions.

5. Empirical results

5.1 Benchmark Model

In Table 2 we present the main results of Equation (1). In all model specifications we include postcode and time fixed effects. The coefficient of the product between the *Toll* dummy variable and *Treated* group variable is statistically significant and positive across all model specifications. In the second column, we present the benchmark model specification that includes all properties sold in a 45km driving distance radius (Zones 3 and 4). The results indicate that property prices in South East Wales increase by 5.8% (exp (0.056)) more compared to South West Bristol after the toll removal. In the pre-toll removal period, properties in Bristol and South Gloucesterhire area outperform those in Newport and Monmouthshire in terms of property price growth. In the post-toll removal period, properties in the England side are still more expensive, but those in Welsh regions are catching up since they exhibit higher growth rates.

We then examine if the effect is associated with the distance from the bridge. We observe that the estimated coefficient increases as we reduce the examined area radius. The results were in line with our expectations since greater distance increases the commuting time needed and reduces any benefits from the toll-free journey. The results are presented in Table 2, columns (3)-(6). Properties in Zone 1, located in Wales, within 20km from the bridge, increase by 10% more than the respective Zone 2 in South West England. The effect is stronger for properties within a 10km driving range, where the difference between the two regions reaches up to 13.1%.

5.2 Alternative time periods

For robustness purposes, we extend the examined time period to four years before and after the toll removal. The empirical results are presented in Table 3, columns (2) and (3). In line with our previous findings, the toll removal changed the dynamics between the two regions, with

properties in Zone 3 (Wales) to increasing by 4.9% more than those in Zone 4 (England). In accordance with the results in Table 2, the effect is considerably higher when we limit our examined area radius to 20km.

Table 2. Difference-in-differences (DiD) results

Radius	<45km	<25km	<20km	<15km	<10km
Toll * Treated	**0.056*** **	**0.078*** **	**0.095*** **	**0.097*** **	**0.123*** **
	(0.006)	(0.008)	(0.010)	(0.015)	(0.020)
Constant	12.326***	12.307***	12.311***	12,318***	12.566***
	(0.006)	(0.010)	(0.010)	(0.009)	(0.015)
Time FE	YES	YES	YES	YES	YES
Postcode FE	YES	YES	YES	YES	YES
Robust SE	YES	YES	YES	YES	YES
Pre-toll removal obs	47,825	26,170	12,627	6,182	2,826
Post-toll removal obs	43,786	24,184	11,735	6,107	2,958
Control group obs	57,740	34,020	13,039	9,253	2,748
Treated group obs	33,871	16,334	11,323	3,036	3,036
Total obs	91,611	50,354	24,362	12,289	5,784
R^2	0.378	0.415	0.412	0.113	0.149

Note: The table reports difference-in-differences estimations. The dependent variable across all model specifications is the logarithm of property price. The pre-toll removal period is January 2016 up until December 2018 and the post-toll removal period is between January 2019 and December 2021. Robust standard errors are presented in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Improvements in transport are expected to have a positive effect on property prices and the effect can be immediate through the expectation channel (Yiu and Wong, 2005). Based on that assumption we run our benchmark model specification for properties located with a 45km and 20km radius from the bridge, however we assume that the effect started in January 2018.[12] The empirical findings are displayed in the columns (4) and (5) of Table 3. Our findings suggest that the impact of the toll removal is evident when we compare the periods 2015-2017 and 2018-2020. In the latter period, after the toll-free journey has been announced, property prices

[12] We chose January 2018 as a month that effect is expected to be capitalized in the property markets, since property transactions in the UK take between three and six months to be completed.

in Newport and Monmouthshire increase by 3.8% more than in South West England (Bristol and South Gloucesterhire). The effect is estimated at a 8.3% difference when examining properties in the 20km radius (Zones 1 and 2). Despite the fact that the results are statistically significant and consistent across all model specifications, the estimated coefficients were smaller in magnitude than those in Table 2 suggesting that the effect is stronger after 2019. The latter outcome is unsurprising, as property transactions inherently involve a significant amount of time for completion. Individuals are unlikely to make the decision to relocate to another country solely on the anticipation of toll removal in the future.

Table 3. DiD results | Alternative time periods

Radius	<45km	<20km	<45km	<20km
Periods (before & after)	**2015-2018 & 2019-2022**		**2015-2017 & 2018-2020**	
Toll * Treated	**0.048*** **	**0.097*** **	**0.038*** **	**0.084*** **
	(0.005)	(0.008)	(0.006)	(0.010)
Constant	12.241***	12.242***	12.182***	12.183***
	(0.005)	(0.008)	(0.014)	(0.025)
Time FE	YES	YES	YES	YES
Postcode FE	YES	YES	YES	YES
Robust SE	YES	YES	YES	YES
Pre-toll removal obs	63,279	16,655	63,279	16,665
Post-toll removal obs	57,437	15,658	26,457	6,955
Control group obs	76,700	17,392	57,064	12,800
Treated group obs	44,016	14,391	32,672	10,820
Total obs	120,716	32,323	89,736	23,620
R^2	0.384	0.420	0.383	0.429

Note: The table reports difference-in-differences estimations for alternative time periods. The dependent variable across all model specifications is the logarithm of property price. In Model (A), the pre-toll removal period is January 2015 up until December 2018 and the post-toll removal period is between January 2019 and December 2022. In Model (B), the toll removal is set as six months after the announcement and when the fare was reduced before becoming zero. The pre-toll removal period is January 2015 up until December 2017 and the post-toll removal period is between January 2018 and December 2020. Robust standard errors are presented in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

5.3 Property and Buyer type

In this Section we investigate if specific types of property or types of buyers are more affected by the toll removal. The estimation is based on a separate DiD model for each type and the empirical findings are presented in Table 4. We re-run the DiD estimation for semi-detached, detached, terraced houses and flats. The empirical evidence indicates that the impact of the toll removal is homogeneous across different property types and in accordance to our previous findings. The effect appears to be relatively weaker for the most expensive properties types, detached properties and flats. In the case of flats, it is worth mentioning that the sample is not similar in size between the two regions and as can been by Table 4, as there are six times more flats in the Bristol area.

Then we run the model for new builds and existing properties. The results suggest that new properties in Newport and Monmouthshire increase by 9.5% compared to Bristol and South Gloucesterhire, whereas the impact is not as strong for existing properties where it is estimated at 2.9%. The impact of toll removal on property prices differs between new builds and existing properties due to several factors. Existing properties may have already been established and being priced accounting for the presence of tolls, meaning their prices might not experience as significant of an increase with toll removal. In addition, the perceived value of new builds, coupled with the potential for developers to adjust prices in response to toll removal, can contribute to a more noticeable impact on new build property prices compared to existing properties. Furthermore, existing properties might already be located in desirable areas with established communities, reducing the relative importance of tolls on their overall value. Finally, in the last two columns of Table 4 we present the results for leasehold (ownership of the property for a set period, with the land typically leased from the freeholder) and freehold (ownership of both the land and the property on it indefinitely) properties. The empirical findings are similar across the type of properties and in line with our benchmark model.

5.4 Falsification test

In this Section, we use a falsification test to confirm that our methodological approach and findings are valid. The falsification can be used to rule out time-dependent endogeneity of the investigation of the toll removal since the estimated effect on property prices may be affected by omitted variables. For that reason, we use a placebo test by randomly assigning the sample observations to the treatment and control groups to address this issue.

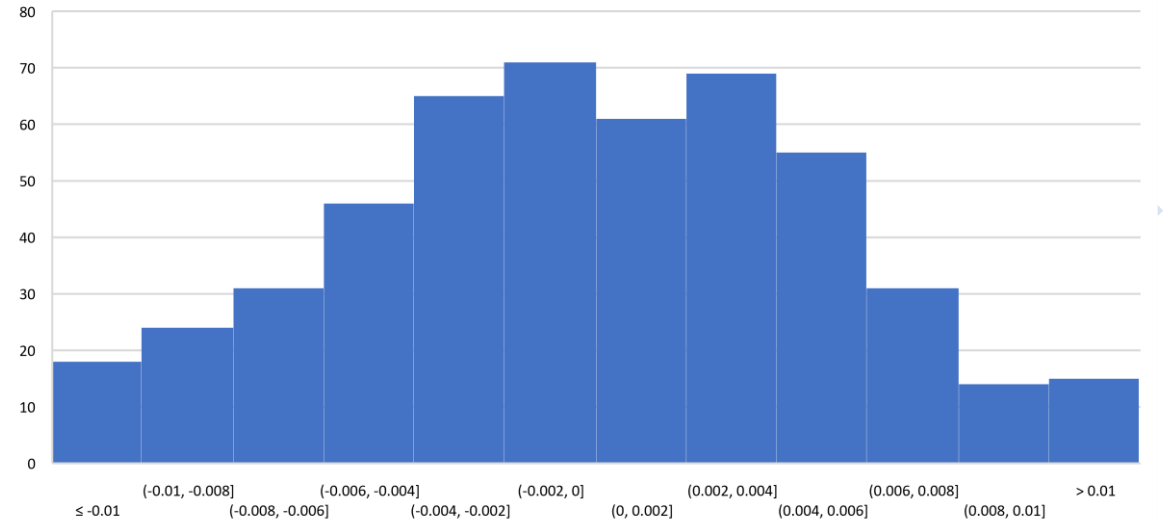
Table 4. DiD results | Property types

Type	Detached	Semi-detached	Terraced	Flats	New properties	Old properties	Freehold	Leasehold
Toll * Treated	**0.036*** **	**0.090*** **	**0.090*** **	**0.058*** **	**0.091*** **	**0.029*** **	**0.061*** **	**0.075*** **
	(0.009)	(0.008)	(0.007)	(0.014)	(0.007)	(0.011)	(0.006)	(0.014)
Constant	12.571***	12.268***	12.396***	11.963***	12.243***	12.270***	12.354***	12.042***
	(0.030)	(0.020)	(0.016)	(0.026)	(0.024)	(0.020)	(0.015)	(0.025)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Postcode FE	YES	YES	YES	YES	YES	YES	YES	YES
Robust SE	YES	YES	YES	YES	YES	YES	YES	YES
Pre-toll removal obs	9,103	11,508	15,980	11,234	32,211	15,614	34,847	12,978
Post-toll removal obs	8,739	11,018	15,106	8,923	30,355	13,431	33,257	10,529
Control group obs	7,661	12,955	19,721	17,403	33,831	23,909	38,167	19,573
Treated group obs	10,181	9,571	11,365	2,754	28,735	5,136	29,937	3,934
Total obs	17,842	22,526	31,086	20,157	62,566	29,045	68,104	23,507
R^2	0.404	0.591	0.723	0.546	0.448	0.202	0.487	0.503

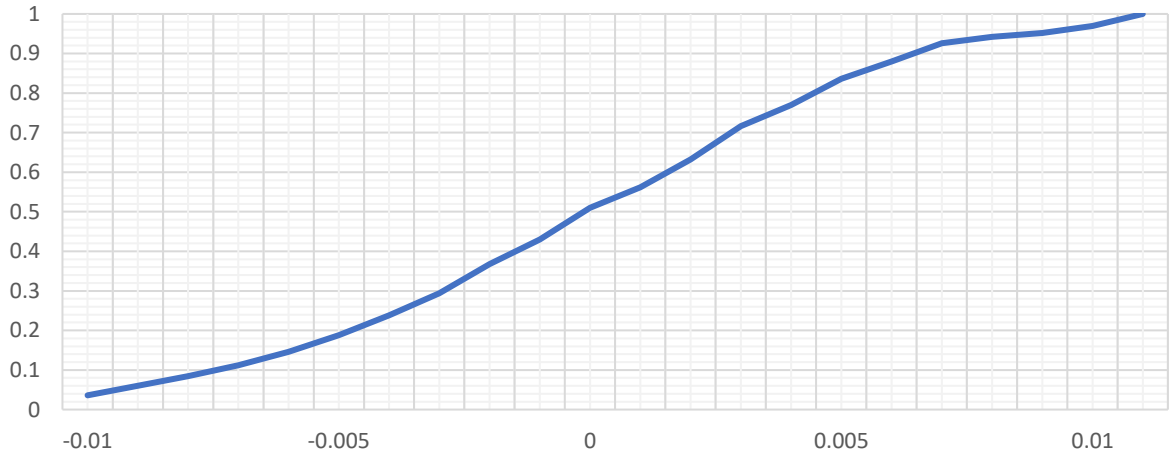
Note: The table reports difference-in-differences estimations. The dependent variable across all model specifications is the logarithm of property price. The pre-toll removal period is January 2016 up until December 2018 and the post-toll removal period is between January 2019 and December 2021. Robust standard errors are presented in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Figure 3: Falsification test estimates

A. Estimated Coefficients Density



B. Estimated Coefficients Cumulative Density



Note: The Figure displays the distribution of the estimated coefficients of the falsifications test. The test is based on a sample of 91,611 properties located within 45km from the Severn Bridge (M48). The properties are randomly allocated to the group of treated or control properties, whereas the time of the toll removal is the one used in the benchmark model specification (2016-2018 and 2019-2021).

More specifically, we generate random numbers from a uniform distribution and those above 0.5 take the value 1 (treated) and those with value below 0.5, take the value 0 (control). In line with the literature, we re-run the estimation of the placebo test 500 times to increase the identification power. The false interaction term is expected to have no statistical significance and to be estimated around zero. The test closely follows the literature. Chetty et al. (2009) and Ferrara et al (2012) apply this placebo test for the studies in tax-inclusive price tags and product

demand and the effect on television on fertility, respectively. This type of robustness test has also been employed by Zheng et al. (2020), who study the impact of airport noise on house prices.

The empirical cumulative distribution function and density of the estimated coefficients of the interactive term (treated*time) are presented in Figure 3. The distribution of the estimates presents a distribution that follows the normal distribution and centralizes to zero. Our benchmark estimates of toll removal effect (0.6) lie outside the whole range of the placebo test estimated coefficients and therefore the effect on property prices is not likely to be affected by unobserved variables.

6. Conclusions

The paper focus on the case of the Severn Crossing toll removal for the first time since the year it was built in 1966. The toll removal led to a notable reduction in transportation costs between South East Wales and South West England, rendering commuting by car a more economically viable option. In addition, by eliminating tolls, accessibility to areas previously hindered by toll barriers is improved, making these locations more appealing to potential buyers or renters. This increased accessibility can enhance the desirability of properties in these areas, driving up demand and subsequently lead to higher property prices. Our findings corroborate these trends, illustrating a convergence in property prices across the two regions to a new equilibrium. Property prices in Wales increased by 5.8% more than South West England since the introduction of the toll-free route. The difference in the two regions' property markets can reach up to 13.1% for properties located with 10km driving distance from the bridge. We then focus on different property types and we find that semi-detached and terraced properties and new builds in Wales are benefited the most by the toll removal, whereas existing and more expensive type of properties (detached houses) exhibit a positive, but weaker growth rate. Notably, our results withstand rigorous testing, including falsification tests, indicating that the observed causal effects are robust and not likely influenced by omitted variables. From a policy perspective, our findings underscore the importance of infrastructure improvements in reducing transportation costs and commuting times. Such enhancements not only mitigate housing inflationary pressures in large city centres, but also contribute to the economic vitality of adjacent lower-income regions.

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