



The impact of employment on housing prices: Detailed evidence from FDI in Ireland

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ABSTRACT

Access to employment is one of the most valuable amenities offered by cities. In urban economics, this is the principal driver of the bid-rent gradient and is a key determinant of housing prices and land values. However, little is known about the causal effect of employment on housing prices, due to the problem of identification. This study presents the first causal estimates of employment changes on housing prices, both sales and rental. It does this by using a purpose-built spatially granular dataset of 1.4 million housing prices and FDI employment, covering Ireland 2007–2013. Identification rests on a combination of rich spatio-temporal variation due to the abundance of FDI in Ireland, a rich set of location controls and an inelastic housing supply in the period covered. The main results show that 1–2 years after 1000 extra jobs have been created, monthly rents in nearby properties will be between 0.5% and 1% higher. The effect on prices is at least 2% but less consistent across specifications. On average, net job creation in export-oriented FDI firms 2009–2013 added roughly €48 million to the stock of wealth of owner occupied real estate and €8 million to the stock of wealth of the rental sector. We also estimate that the aggregate effect of the stock of FDI jobs in 2013 on Irish housing prices is €440 million, or just over 1%.

1. Introduction

Urban agglomerations lie at the heart of modern economies, with cities accounting for less than 1% of land use globally but the vast majority of economic activity. In understanding the economics of cities, the concept of the bid-rent gradient is central, as it captures the opportunity cost of distance from urban centres. The value of urban centres reflects both consumption and labour market amenities, with recent discussion often focusing on the rise of consumption amenities (see, for example, Glaeser et al., 2001). Nonetheless, employment remains perhaps the single most important amenity offered by a location.

This paper examines the impact of changes in employment in internationally trading firms on housing prices nearby, both sales and rental. The creation of a job in an internationally trading firm should boost housing demand, thus increasing housing prices and the value of land nearby. This includes direct effects – the new worker's wage. There is a

strong link between the housing market and the labour market, as individuals generally prefer to live close to their workplace.¹ It also includes indirect effects, as that worker's wage circulates through the local economy. Vice versa, job destruction will decrease the demand for housing.

To examine the link between employment and housing prices, this paper uses two uniquely rich spatial datasets, one on housing prices and the other on annual employment in firms engaged in international trade, both covering the entire Irish economy. The case of Ireland is doubly relevant. Firstly, on a per-capita basis, it is one of the world's leading destinations for export-focused FDI jobs. This, coupled with job losses during the Great Recession, creates significant spatio-temporal variation in the dataset. Secondly, for the period analysed, housing supply in Ireland was extremely inelastic. The housing price response to changes in employment will partly depend on the elasticity of supply. Housing price and construction are likely to be jointly determined with employment, as new construction becomes profitable as demand for housing rises. Voith

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¹ Böheim and Taylor (2002) find that employment reasons have the largest impact on the probability of moving between different regions in the UK, and Clark and Withers (1999) find that job changes are an important factor in the decision to move house. Related to this, Hwang and Quigley (2006) construct a model of local housing markets using a panel of 74 U.S. metropolitan areas. Among other findings, they show that changes in employment affect housing prices mainly through changes in housing demand. Furthermore, using a dataset of 88,000 sales in suburban Philadelphia, Voith (1999) finds that city employment growth increases suburban housing prices, but little effect is found for suburban employment growth.

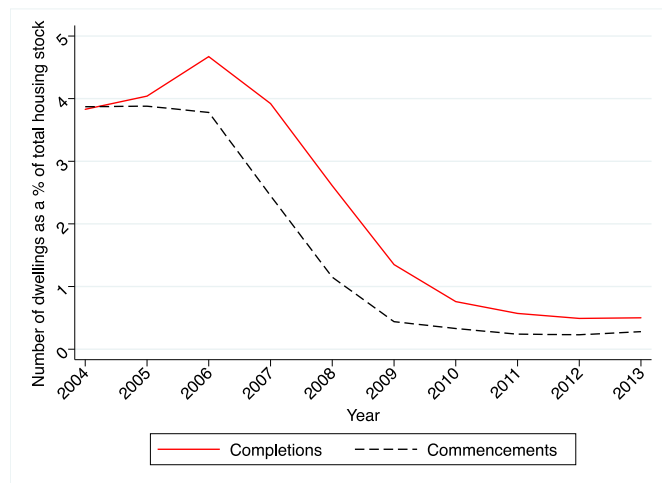


Fig. 1. Residential housing supply in Ireland as a % of total housing stock, 2004–13.

(1999) finds that suburban employment growth increases construction rates close to the urban fringe. However, as outlined in Fig. 1, construction of new dwellings fell by roughly 90% between 2006 and 2012, with housing stock net of obsolescence declining towards the end of this period. Thus, while in more general settings the wealth effect of new employment will be a combination of housing prices and quantities, in this instance, the effect of employment will primarily be reflected through housing prices. Thus, the findings in this paper are particularly relevant for countries or cities that experience an inelastic housing supply. In the large employment centre of Silicon Valley and its surrounding areas, housing prices have surged due to the low supply and high demand of housing.²

To our knowledge, no previous research has empirically investigated the effects of employment on housing prices at a spatially granular level. This lack of existing research is explained by the onerous data requirements for identification. This paper attempts to fill this gap by using a purpose-built dataset that is spatially detailed in housing, employment and other locational characteristics for the entire Irish economy, for the period 2007–2013, including both urban and rural areas.³ An advantageous but unusual aspect of our dataset is that it locates both properties and firms (and thus jobs) by their geographic coordinates. This allows us to construct disaggregated employment measures and exploit significant spatial variations. Our analysis uses an employment survey that tracks employment in internationally trading firms for the period 2004–13. We focus primarily on changes in employment in foreign-owned internationally trading firms for two reasons. Firstly, they are fully represented by the survey. Secondly, the underlying investment is plausibly more exogenous to conditions in the local housing market: if rising property values reflect improving domestic economic conditions, this may make identification of the causal link between domestic investment and accommodation prices trickier, even with rich spatio-temporal controls.

To establish causality, we employ a hedonic approach. We model rent and sale price separately as being determined by employment and a rich list of physical and locational attributes. This paper is related to a large hedonic literature that looks at how amenities are capitalised into housing prices. A range of local characteristics, including job opportunities, determines housing prices. Everything from school quality (Black, 1999), urban property crime (Gibbons, 2004), flooding (Lamond et al., 2007) and wind facilities (Hoen et al., 2013) have been measured and

evaluated using hedonic analyses of housing prices. The hedonic approach dates back to Court (1939), Griliches (1961) and Lancaster (1966), but it was Rosen (1974) who developed a theoretical structure for the regression. Hedonic regression techniques are commonly used to estimate the value of individual attributes of a property whose prices are not directly observed. As described by Rosen (1974), the implicit prices of the characteristics are estimated by regressing the observed price of a house on its attributes, e.g. number of bedrooms and access to transport.

As housing prices may not instantaneously adjust to employment, we construct current and lagged measures of employment. The baseline models use four measures of employment changes: changes at the nearest firm of any size, at the nearest medium or large firm, amongst the nearest five firms and in the Census tract in which the property is located. In these instances, we allow the nearest firm to change between years, so as to take a dynamic view of employment activity. As an additional measure, we track changes in employment at the nearest firm in the year of listing.

We also test for a proximity effect on housing prices, with the expectation that the effect of employment changes will be greater, the closer the property is to the employment. Theoretical urban models predict a negative relationship between housing price and distance to an employment centre(s). There is a long tradition of estimating rent and price gradients around employment centres (Alonso, 1964; Mills, 1972; Muth, 1969; Papageorgiou and Casetti, 1971; Yinger, 1992). These early models are based on the idea that lower transport costs are capitalized into housing prices. Empirical studies find mixed results. Some find the expected negative relationship, while others find a significant positive relationship or no relationship whatsoever (Bender and Hwang, 1985; Coulson, 1991; Heikkilä et al., 1989; Osland et al., 2007).

We find the expected relationship between employment and prices: job creation increases housing prices and job destruction decreases housing prices.⁴ Our findings show that 1–2 years after 1000 extra jobs have been created, monthly rents in nearby properties will be between 0.5 and 1% higher, and at least 2% for prices. However, the result for sale price is less robust across specifications. We find that rental prices adjust to all employment activity, whereas sales prices react only to employment changes in the presence of medium or large start-ups and shut-downs. The significance and magnitude of the employment coefficients are also typically greater in the post-crisis period, and we find that job destruction is associated with larger price effects than job creation. We find that the effects of employment at the nearest medium or large firm vary by sector. One year after employment changes, information and communication firms exert a large effect on both rents and prices, roughly 10% per 1000 jobs, while employment at manufacturing firms exerts a relatively smaller effect on rents (1%). Depending on the specification, we also find a negative relationship between distance to the nearest firm and housing price.

Taking our baseline estimates of the effect of an additional 1000 jobs on rent price (1%) and sale price (2%), we estimate the contribution of net job creation in export-oriented FDI firms in Ireland during 2009–2013 to the wealth of residential real estate. We estimate that the stock of wealth in owner-occupied real estate increased by €48 million, and similarly of €8 million in the rental sector. Applied to the whole stock of FDI jobs, these estimates imply that the aggregate effect of the stock of FDI jobs on residential real estate in 2013 is €440 million, or a little over 1%. Furthermore, as house prices are rising due to employment growth, policymakers may wish to take into account the impact of employment on housing affordability.

The remainder of the paper is structured as follows. In Section 2, we outline the variables in our dataset. Section 3 presents our identification

² See the Silicon Valley Competitiveness and Innovation Project in 2017, available at https://svcip.com/files/SVCIP_2017.pdf.

³ The “New Economic Geography” literature highlights the importance of agglomeration economies in forming the spatial pattern of economic activity e.g. Krugman, 1991.

⁴ Although not addressed in this paper, an interesting avenue for future work is the extent to which the effect of employment varies with the degree to which FDI jobs involve new migrants in an area. This difference is likely to be strongest in Ireland's online services segment, where a large fraction of workers come from abroad, in contrast to manufacturing where it is less prevalent.

Table 1

Location of residential listings by geographic area, 2007–13.

Geographic area	Number of listings	
	Rent	Sale
Border	66, 216	41, 181
Dublin	473, 959	68, 979
Mid-East	125, 698	35, 348
Mid-West	58, 251	27, 424
Midland	53, 445	25, 061
South-East	93, 406	43, 726
South-West	144, 710	51, 365
West	74, 487	31, 535
Total	1,090,172	324, 619

strategy and Section 4 discusses the empirical findings. Section 5 discusses extensions to our analysis and robustness checks. Section 6 concludes.

2. Data

2.1. Housing market

Property listings are obtained from a dataset maintained by Ireland's most popular property listing website, daft.ie. The dataset includes over 1 million residential listings to rent and over 300,000 properties listed for sale from 2007 to 2013. For scale, Ireland's 2011 Census recorded a total housing stock of just under 2 million dwellings, with almost 0.5 million households in rented accommodation.⁵ Each dwelling is located by its address to its geographic coordinates.⁶ In addition to location, the dataset includes the date of listing, the listed price, the type and size (in bedrooms and bathrooms) of the dwelling, as well as other physical characteristics. There are seven years of listings, ranging from 2007Q1 to 2013Q4. Table 1 shows the number of listings by geographic area and segment.⁷

2.2. Employment

Employment data is retrieved from the Department of Jobs, Enterprise and Innovation's *Annual Employment Survey* 2004–2013. This is an annual census of employment in all known manufacturing and internationally traded services in Ireland. It therefore is not a dataset of all employment in Ireland (Lawless, 2012). The employment survey records employment as of October 31st each year, and is carried out by postal survey and an extensive telephone follow-up.⁸ Each firm records an annual employment level taking place between November 1st and the following October 31st. The survey locates each branch of each firm by its geographic coordinates, which allows the calculation of distance between dwellings and firms, as well as recording the firm's sector, number of employees, and whether the firm is majority foreign or Irish-owned. Throughout this paper we refer to 'the nearest firm' instead of 'the nearest branch of a firm' for ease of reading. Fig. 2 shows the location of 1770 foreign-owned firms in the dataset. Just over one-quarter (27%) of foreign-owned firms are in central Dublin, with a further 18% elsewhere in Dublin County. Nonetheless, the location of firms is spread across the

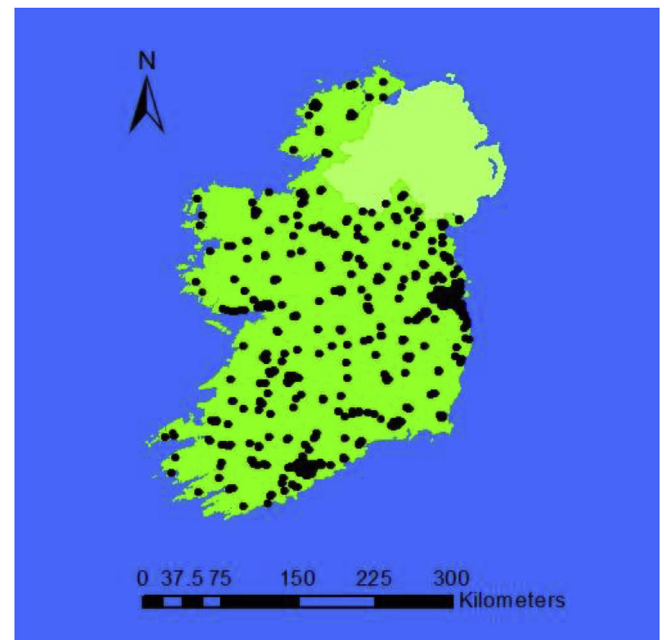


Fig. 2. [use colour] Location of foreign-owned firms, 2004–13. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 2

Foreign-owned firms by sector, 2004–13.

Sector	Number of firms	Average no. jobs by sector
Accommodation and food services	1	4.0
Administrative and support service	12	19.2
Arts, entertainment and recreation	5	1.1
Agriculture, forestry and fishing	7	11.6
Education	1	0.7
Financial and insurance	323	1043.9
Information and communication	588	3724.5
Manufacturing	789	8579.2
Professional, scientific and technical	22	51.9
Transportation and storage	10	20.5
Water supply, sewage and waste management	1	0.2
Wholesale and retail trade	11	33.3
Total	1770	134,90.1

Note: Sectors are classified using NACE Rev.2.

country. Table 2 shows the number of firms by sector and the average number of jobs by sector. Firms and jobs are concentrated in manufacturing, finance and insurance activities, and information and communication (ICT) services. See Appendix A for a breakdown of foreign-owned firms by geographic area, year, establishments and shutdowns.

The most important variable for our purposes is the annual employment level at each firm. We construct employment changes by calculating the annual change in employment. For example, if a firm increases its workforce from 1000 to 1200, this +200 change in the employment level signals job creation. While it could be true that 210 workers are hired and 10 fired, the focus is on net job flows and not individuals workers. Fig. 3 shows the total number of jobs in foreign firms each year.⁹ During the period associated with the Financial Crisis (2007–9), employment in

⁵ This paper focuses on (the Republic of) Ireland; Northern Ireland is a separate country that is part of the United Kingdom.

⁶ This is done to differing degrees of accuracy. In Section 5, we conduct a robustness check using the accuracy of the remaining dwellings.

⁷ A possible concern is that the listed price does not equal the transaction price. For example, an apartment may be listed at €200,000 but sell for €180,000. The dataset records the former price but cannot observe the latter. While for any given property, there will be a gap between the list and transaction prices, research covering Ireland over the period 2006–2012 found that, for the market as a whole, there is very little structural difference in trends once initial list date is used (Lyons, 2013).

⁸ If a firm does not respond, the previous years employment is rolled over to the current year.

⁹ FDI inflows as measured by official statistics bear little relationship to the activities of foreign corporations in Ireland as expressed in this employment survey. The major difference is that the official data includes non-tradables and aggregates Financial Services Centre and non-Financial Services Centre FDI (Barry and Bergin, 2010).

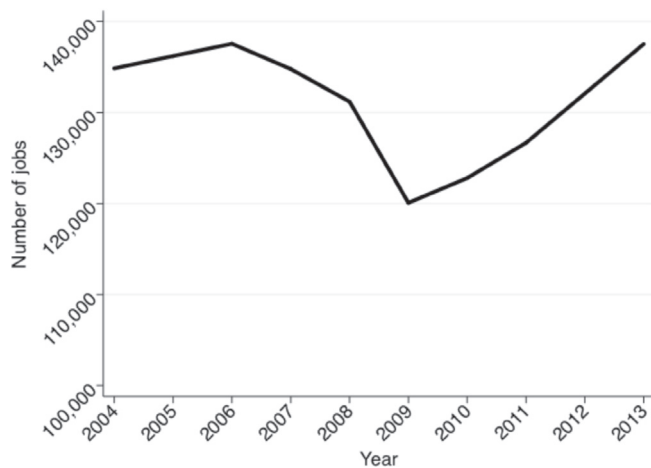


Fig. 3. Total number of jobs in foreign firms, 2004–13.

foreign-owned firms dropped by 11% but recovered by 12% between 2009 and 2013.

2.3. Location

Other factors may affect the value of a particular property or area to a potential buyer or renter and some of these may be correlated with employment in international trading firms. Therefore, a rich set of control variables are included; see Appendix B for a full description of the variables in our dataset. The distance between each dwelling and a range of amenities are included. Better access to transport generally feeds into higher housing prices, so distance to the nearest rail station and road networks are included in the estimation. Access to environmental (dis) amenities may also affect housing prices (Kuminoff et al., 2010). The distance to features such as the coastline, lakes, waste facilities and rivers are included. Also included are educational amenities. Buyers or renters may seek to live closer to schools or universities in a bid to reduce transport costs and time spent driving. Distance to the nearest higher education institution, primary school and post-primary school are included to control for this effect on prices. The distance to the nearest Central Business District and airport are included. Controlling for proximity to both will eliminate the measures of employment picking up effects on prices that are due to the uniqueness of these centres rather than the effect of employment changes. Other variables include distance to the nearest national monument, supermarket and stadium.

As well as property-specific distance measures, area-level attributes are also included. Higher crime rates are often associated with lower housing prices (Gibbons, 2004). Crime statistics are taken from the Garda Recorded Crime Statistics and are provided for each Garda (police) station.¹⁰ Each dwelling is assigned the average number of crimes recorded at the nearest station between 2004 and 2010. Information is also taken from the 2011 Census, at the level of official Small Areas (tract), of which there are 18,488 in the country. It is standard in the hedonic literature to include local unemployment rates to capture neighbourhood quality. Also included is the fraction of the population achieving greater than post-secondary education, population density and the fraction of the neighbourhood that is foreign-born. Lastly, local variations in the supply of housing generate differences in housing prices. The fraction of vacant houses is included to account for this.

3. Identification

To find how employment is capitalized into housing prices, we apply

a standard hedonic approach and then estimate a pooled model of housing prices. Hedonic models exploit cross-sectional variation in goods with bundles of attributes to estimate the average value of each measurable attribute. In relation to housing, hedonic models typically include vectors of characteristics relating to the house itself (e.g. number of bedrooms and property type) as well as characteristics relating to the location (e.g. job opportunities and crime rates). Here, lhp represents the natural log of the housing prices, either sale or rent per month, the basic relationship is as follows:

$$lhp = f(\text{employment, physical, location}) + \varepsilon \quad (1)$$

Employment is separated from location in Equation (1) because it is the variable of interest. As previously mentioned, the core models use employment at foreign-owned firms. The estimation also includes Electoral Division (ED) dummies, county dummies and year-month dummies, to control for unobserved effects.¹¹

We define employment as the change in the number of jobs in a chosen proximity. Changes in employment are included for the current period and also for two lagged periods, reflecting the fact that housing markets may take some time to respond in full to changes in employment. We expect that changes in employment will have a positive coefficient: an increase in jobs at the nearest foreign firm increases price (vice versa, a decrease in jobs decreases price).

As described in Section 2.2, the employment survey refers to employment taking place between November 1st and the following October 31st, inclusive. For example, for a house listed for sale in January 2012, the contemporaneous change in employment is the one occurring between the November 2010–October 2011 year and the November 2011–October 2012 year.

One dimension of the empirical specifications relates to the proximity at which changes in employment occur. Firstly, we measure changes in the number of jobs at the nearest firm of any size, and secondly at the nearest medium or large firm (MOL), defined by the European Commission as firms with at least fifty employees. The nearest firm is the firm that is closest in distance to the property. We differentiate based on size because we expect that bigger employers exert larger effects.¹² We then extend beyond the nearest firms and calculate total employment among the nearest five firms of any size, and the changes in employment in the ED in which the property is located.

A second dimension of the empirical specifications relates to the calculation of employment changes at the nearest firm(s). In the core specifications, we calculate employment changes between the nearest firm(s) in each year, i.e. the nearest firm(s) in time t , may not be the nearest in time $t-n$. We do this for the nearest firm, the nearest MOL firm and the nearest five firms. For robustness, we also track employment changes at the nearest firm in the year the property is listed, i.e. the nearest firm in time t is the nearest firm in time $t-n$. We do this for the nearest firm and the nearest MOL firm.

The effect of changes in employment on housing prices may vary depending on how close or far away the employment is. One measure of distance is used throughout as a separate regressor: the log of the direct line (planar) distance between each dwelling and the nearest firm(s).¹³ We do this only for the year of the listing, as we do not expect distance to

¹¹ Electoral Divisions are the smallest Census unit, other than Small Area, in Ireland. There are 3409 Electoral Divisions. Ireland also has 26 counties. While these no longer have any legal status, they are widely used in daily life, including in real estate markets.

¹² Small employers tend to make incremental adjustments to their employment levels, while larger employers may hire or fire in bulkier numbers.

¹³ For the nearest five firms, the distance is an average. Studies find a very high correlation between straight line distances and drive time distances (Boscoe et al., 2012; Phibbs and Luft, 1995). However, exceptions exist near physical barriers (Boscoe et al., 2012). We estimated models where we control for the average journey to work time; our measure of distance is unaffected by this.

¹⁰ Available at: <http://www.cso.ie/en/statistics/crimeandjustice/>.

Table 3

The impact of employment on housing prices, using changing nearest firms.

Independent variables	Foreign-owned firms							
	Log of monthly rent				Log of sale price			
	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED	(5) Nearest	(6) Nearest MOL	(7) Nearest five	(8) ED
Δemp_t	.0051** (.0023)	.0009 (.0019)	.0019* (.001)	.0203*** (.002)	.0174* (.0098)	.0096 (.0067)	.0002 (.0038)	.0057 (.0071)
Δemp_{t-1}	.0106*** (.0027)	.0051*** (.0018)	.007*** (.0011)	.0095*** (.002)	.0157 (.0103)	.0301*** (.0071)	-.004 (.0041)	.0261*** (.0099)
Δemp_{t-2}	.005* (.0027)	.0084*** (.0019)	.0086*** (.0011)	.0063*** (.0017)	.0427*** (.0084)	.0206*** (.0061)	.012*** (.0034)	.0053 (.0074)
$ldist_t$	-.0048*** (.0004)	-.0076*** (.0005)	.0001 (.0009)	–	.0051*** (.0014)	-.0029* (.0016)	.0287*** (.0038)	–
Physical controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.76	0.76	0.76	0.69	0.69	0.69	0.69
N	1,090,172	1,090,172	1,090,172	1,090,172	324, 619	324, 619	324, 619	324, 619

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

have a time-varying effect, at least not in our time period. Summary statistics for distance to the nearest firm of any size are presented in [Appendix C](#). The strength of the distance variables is that they are continuous, as opposed to categories of distance. This means that we can identify the effect of a one-unit change in distance on prices. We expect that distance will be negatively related to price.

We believe the econometric strategy presented here is strong because of its three-pronged approach. Firstly, it attempts to isolate the effect of employment by exploiting the combination of variation over time and across space, with spatial variation measured in a very granular way. Secondly, and as is standard in the hedonic literature when attempting identification, we include a rich list of physical and locational variables. Thirdly, we believe the use of ED dummies removes the possible omitted variable bias that is associated with this model. In total, for an omitted variable to disrupt our measure of changes in employment, this variable must have the following characteristics: it must be jointly collinear in space and time with changes in employment, while also being more local than the ED level. Although possible, we believe it is unlikely for such a variable to exist.

There are concerns relating to the endogenous placement of FDI firms because firms are not randomly placed. Firms may choose to locate in areas of relative affluence, and thus areas of high housing prices. Consequently, employment will be related to housing price but not in a causal way. In the absence of a formal test such as an instrumental variable, we cannot rule out this possibility. However, we are able to say that the distribution of this effect is not significantly related to employment changes or distance to employment, because of the three step approach described in the preceding paragraph and because we use data that covers the entire country. Regarding the unemployment rate as an indicator or local economic conditions, firms locate in a diversity of areas, outlined in [Appendix A](#).

Another identification issue is reverse causation. One potential concern might be that firms locate in areas where there is plentiful supply of housing to house their workers and thus in locations where housing is cheap. This would imply a negative correlation between housing prices and jobs created, rather than our hypothesized positive relationship. Nonetheless, in [Section 6](#), we attempt to alleviate this concern by showing that our results are robust to the presence of vacant homes, using the existence of unfinished developments after Ireland's housing market bubble.

4. Results

This section first presents our core results, on the impact of changes in

employment – measured in four different ways – on nearby housing prices, both sale and rental. The measures allow the closest firm to vary over time, and in [Section 4.2](#), within-firm job changes are analysed. The latter is relevant in particular for job losses, and [Section 4.3](#) directly compares job creation and job destruction. [Section 4.4](#) examines whether the effect differs during and after the crisis, while the final subsection examines the effects by sector.

4.1. Baseline results

[Table 3](#) presents the core results, for both rental and sale sectors, of a regression of housing prices on employment changes. For robustness, these changes are measured in four ways: at the nearest firm of any size, the nearest or large (MOL) firm, among the nearest five firms and for the ED in its entirety. The control variables are as described in [Section 2](#) and a set of full results containing most of the variables is presented in [Appendix D](#). Employment changes are denoted by Δemp and are included contemporaneously and with two lags. For example, Δemp_t at the nearest firm is the number of jobs at the nearest firm in the current year minus the number of jobs at the nearest firm in the previous year (where in this specification, that firm may have changed). Changes in employment are scaled to show the impact of 1000 new jobs (or job losses) on housing prices. We control for the distance ($ldist_t$) from the dwelling to the nearest firm(s) in the year the property is listed. Due to the use of the log transformation the coefficient on distance shows the impact of a 1% increase in distance (metres) on prices.

Looking first at rental properties, the four measures of employment changes are strongly statistically significant, contemporaneously and at up to two lags, in almost all cases. All four measures of employment change suggest that, 1–2 years after 1000 extra jobs have been created, properties nearby will see monthly rents between 0.5% and 1% higher. The exact pattern over time varies by specification: taking the nearest firm, the effect is 0.5% immediately, then doubles after a year, before falling back to its original level. Taking the nearest MOL firm, or the nearest five firms, the effect grows over time, to 0.9% after two years. When measured at ED level, an extra 1000 jobs is estimated to have the biggest impact immediately (2%).

In general, results for the effect of changes in employment on the prices of properties for sale are larger, but less stable.¹⁴ An extra 1000

¹⁴ A possible explanation for the larger effect on sale price is that large multinational corporations might offer financial assistance to employees for purchasing homes.

jobs at the nearest FDI firm (of any size) is associated with 2% higher prices the same year and the year after, rising to 4.3% in the following year. Results for the nearest MOL firm are significant with lags and suggest a 2–3% effect, while results for the nearest five firms are significant only at the second lag (roughly 1%). At ED level, only the first lag is statistically significant (roughly 2.5%).

As discussed in Section 3, our econometric strategy attempts to isolate the effect of employment by exploiting the spatial and temporal variation in employment changes, including a rich control list of physical and locational characteristics, and including ED dummies. Appendix E contains regressions for medium or large firms with and without the locational characteristics and ED dummies. For example, excluding ED dummies, leads to larger coefficients and statistical significance on more occasions. These results show to some extent, the success of our identification strategy.

Our results in Table 3 overwhelmingly show the correct sign (23 of 24 coefficients) and typically achieve statistical significance (17 of 24).¹⁵ In other words, it is clear from this uniquely granular dataset that job creation is associated with increased housing prices, both sale and rental.¹⁶ In addition, the closer the dwelling is to the nearest firm, the bigger the effect – in the rental segment and, depending on the specification, also in the sale segment.

4.2. Within-firm changes

The results presented in Table 3 allow for within-firm employment growth and for new FDI firms to establish and create jobs. This section focuses only on within-firm creation. Table 4 shows the results for the nearest firm of any size and for the nearest MOL firm, where in both cases, those firms do not change over time. For rental price, again there are clear positive effects of job creation on rental prices, with strong statistical significance in most cases.¹⁷ The estimated effects are significantly larger than in Table 3: 2–3% after one year, compared to 0.5–1% where nearest employer could vary. Again, greater proximity to employment is associated with higher rents. For sale price, the effect of employment changes is imprecisely estimated in general. In both specifications, though, there is a statistically significant positive effect after two years – of between 1.8% and 3.5%.

Of the two sets of results presented in Tables 3 and 4, Table 3 is our preferred specification, as it takes a more dynamic and complete assessment of employment conditions near the property listed. Table 3 recognizes start-ups and exiting firms, who will have more rapid employment changes and changes that are less likely to be marginal. For example, when a firm shuts down, it will shed its entire workforce. Similarly, newly established firms tend to grow their labour force more suddenly than mature firms (Haltiwanger et al., 2013; Adelino et al., 2014). Nonetheless, Table 4 may reflect the impact of job losses more clearly, while it also allows analysis by sector. Thus, the differences between Tables 3 and 4 shows that sales prices in particular are sensitive to employment changes at newly established and withdrawing MOL firms.

¹⁵ Empirical specifications with spatial spillovers were tested and the results are unaffected.

¹⁶ A possible concern is that rent controls restrict monthly rents from increasing or decreasing. However, during the period of analysis, there is only a minimal element of rent control in place. For any tenancy registered with the Private Residential Tenancies Board, the landlord can seek an increase once a year.

¹⁷ There are two possible reasons that the employment coefficients in the rent model are statistically significant on more occasions than in the price model. A person taking on a new job may wish to rent for a while, and purchase a property when they become settled in the job, meaning that employment changes effect the rental market quicker. Or, different employment contracts offered by firms may effect housing prices differently e.g. shorter-term contracts might have a bigger effect on rents.

Table 4

The impact of employment on housing prices, using the same nearest firm foreign-owned firms.

Independent variables	Log of monthly rent		Log of sale price	
	(1) Nearest	(2) Nearest MOL	(3) Nearest	(4) Nearest MOL
Δemp_t	.0042 (.0039)	.0119*** (.0023)	-.0243** (.0118)	.0034 (.0097)
Δemp_{t-1}	.0324*** (.0043)	.0182*** (.0023)	.0037 (.0135)	.0049 (.0107)
Δemp_{t-2}	.0184*** (.004)	.0326*** (.0027)	.0352** (.0149)	.0181* (.0108)
ldist_t	-.0042*** (.0005)	-.0073*** (.0005)	.0056*** (.0015)	-.003*** (.0016)
Physical controls	YES	YES	YES	YES
Location controls	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
County dummies	YES	YES	YES	YES
R-squared	0.76	0.76	0.70	0.70
N	982,396	1,052,967	302,238	313,750

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places. There are fewer observations than in Table 3, as not all firms are active in the four-time periods e.g. 29% of properties for rent and 24% of properties for sale have at least one changing nearest MOL firm.

4.3. Job creation vs. job destruction

Table 5 examines whether the effect of changes in employment is asymmetric between losses and gains. Categorical variables that indicate whether the employment change is greater than or equal to zero, or negative are interacted with the core regressors. We expect positive coefficients such that that job creation (destruction) will increase (decrease) housing prices, everything else being equal. For the most part, we find that the magnitude and statistical significance of job destruction is greater than job creation. In the case of a single firm where 1000 jobs are lost, properties nearby experience a fall in monthly rents of 7–12% after 1–2 years. Vice versa, 1000 new jobs increases rents by 1–2%. Given the inelasticity of the housing stock to respond to negative shocks, job losses decrease housing demand and potentially free up housing units, increasing effective housing supply. These two actions will push housing prices downwards.

4.4. During and after the financial crisis

The Irish economy contracted sharply after 2007, before stabilizing in 2010. In Table 6, we interact employment changes with a crisis dummy variable, that is equal to 1 if the dwelling is listed during 2007–9, and 0 if it is listed during 2010–13. The crisis dummy is large and positive, reflecting how much higher sales and rental prices were earlier in the sample. Turning to the variables of interest, the significance and magnitude of the employment coefficients are typically greater in the post-crisis period. Under crisis conditions, housing prices and labour market conditions are more volatile. This may help to explain our finding in Section 4.3, where job destruction changes housing prices by a greater magnitude. The finding also supports our claim that we are capturing the effect of housing demand, as housing supply in Ireland was most inelastic during the post crisis period (Fig. 1).¹⁸

¹⁸ A possible concern is that a lack of commercial office space during and after the crisis is driving out result. However, during 2008–2012 choice of Dublin office space was high, with a 24% vacancy rate and rents that were 50% lower than the peak of 2007 (Duffy and Dwyer, 2015).

Table 5

The impact of job creation and job destruction on housing prices.

Independent variables	Nearest foreign-owned firm				Nearest MOL foreign-owned firm			
	(i) Changing nearest firm		(ii) Same nearest firm		(i) Changing nearest firm		(ii) Same nearest firm	
	(1) Rent	(2) Sale price	(3) Rent	(4) Sale price	(5) Rent	(6) Sale price	(7) Rent	(8) Sale price
Δemp_t	-.016*** (.0039)	.0113 (.0128)	.0004 (.0045)	-.033** (.015)	-.0064*** (.0025)	-.0209** (.0088)	.0067** (.0028)	-.0233** (.0114)
Δemp_{t-1}	-.0044 (.0042)	.0099 (.0133)	.0183*** (.0047)	-.0164 (.0159)	-.0129*** (.0024)	.0189** (.0087)	.0001 (.0028)	-.036*** (.0127)
Δemp_{t-2}	-.0052 (.0039)	.0383*** (.0119)	.0122** (.0049)	.0313* (.0167)	.004 (.0026)	.0291*** (.0099)	.0292*** (.0031)	.0104 (.0129)
ldist_t	-.0047*** (.0004)	.0051*** (.0014)	-.004*** (.0005)	.005*** (.0015)	-.0075*** (.0005)	-.0031* (.0016)	-.0072*** (.0005)	-.003* (.0016)
negative $t^* \Delta \text{emp}_t$	.0282*** (.0051)	.0403* (.0225)	.0189* (.01)	.0782*** (.0263)	-.0028 (.0045)	.0614*** (.0159)	.0148** (.0068)	.0868*** (.0283)
negative $t_{-1}^* \Delta \text{emp}_{t-1}$	.0419*** (.0058)	.0526** (.0234)	.0965*** (.011)	.0991*** (.032)	.0386*** (.0045)	.0249 (.0188)	.0554*** (.0062)	.1566*** (.029)
negative $t_{-2}^* \Delta \text{emp}_{t-2}$	.038*** (.0057)	.0218 (.0172)	.0604*** (.0095)	.0856** (.045)	.0248*** (.0045)	-.013 (.0128)	.0408*** (.0081)	.0919*** (.0306)
negative t_t	-.0014*** (.0005)	.0044*** (.0015)	.0008 (.0005)	.0081*** (.0016)	-.0054*** (.0005)	-.0047*** (.0015)	-.0044*** (.0005)	-.003* (.0016)
negative t_{-1}	.0038*** (.0005)	.0054*** (.0015)	.0055*** (.0005)	.0055*** (.0016)	.0019*** (.0005)	-.002 (.0015)	-.0007 (.0005)	.0027* (.0016)
negative t_{-2}	.0039*** (.0005)	.0021 (.0014)	.0044*** (.0005)	.0049*** (.0016)	.0016*** (.0045)	.0008 (.0014)	.0023*** (.0005)	.0063*** (.0016)
Physical controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.69	0.76	0.70	0.76	0.69	0.76	0.70
N	1,090,172	324,619	982,396	302,238	1,090,172	324,619	1,052,967	313,750

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

Table 6

The impact of employment on housing prices, during and after the crisis.

Independent variables	Nearest foreign-owned firm				Nearest MOL foreign-owned firm			
	(i) Changing nearest firm		(ii) Same nearest firm		(i) Changing nearest firm		(ii) Same nearest firm	
	(1) Rent	(2) Sale price	(3) Rent	(4) Sale price	(5) Rent	(6) Sale price	(7) Rent	(8) Sale price
Δemp_t	-.00078 (.0032)	.0138 (.0129)	.0048*** (.0043)	-.0158 (.0148)	-.0107*** (.0021)	.0087 (.0092)	.0118*** (.0026)	.0031 (.0112)
Δemp_{t-1}	.0077*** (.0029)	.0149 (.014)	.0277*** (.0044)	-.0026 (.016)	.0088*** (.0022)	.0284*** (.0098)	.0155*** (.0024)	-.0055 (.0123)
Δemp_{t-2}	.0154*** (.0031)	.0702*** (.0135)	.0324*** (.0049)	.091 (.0196)	.0251*** (.0024)	.041*** (.0097)	.0443*** (.0029)	.0676*** (.015)
ldist_t	-.0047*** (.0004)	.0051*** (.0014)	-.004*** (.0005)	.0051*** (.0015)	-.0076*** (.0005)	-.0031** (.0016)	-.0073*** (.0005)	-.003* (.0016)
crisis* Δemp_t	.0123*** (.0045)	.0155 (.0196)	.003 (.011)	-.0115 (.0253)	.0386*** (.0044)	.0039 (.0135)	.0105* (.006)	.0232 (.0228)
crisis* Δemp_{t-1}	.0115* (.0068)	.0072 (.0206)	.0194* (.0115)	.0161 (.0265)	-.0099** (.0041)	.003 (.0143)	.03*** (.0087)	.0346 (.0238)
crisis* Δemp_{t-2}	-.0282*** (.0058)	-.0372 (.0175)	-.0403*** (.0086)	-.0931*** (.0281)	-.0477*** (.004)	-.0339*** (.0124)	-.064*** (.0076)	-.0983*** (.0205)
crisis	.182*** (.0045)	.8629*** (.0177)	.183*** (.0048)	.8616*** (.0183)	.182*** (.0045)	.8635*** (.0177)	.1863*** (.0046)	.868*** (.018)
Structural controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.69	0.76	0.70	0.76	0.69	0.76	0.70
N	1,090,172	324,619	982,396	302,238	1,090,172	324,619	1,052,967	313,750

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

4.5. Effects by sector

Policymakers may be more interested in attracting high-skilled jobs in internationally traded services than those in a heavily polluting manufacturing facility. Table 7 examines the differential effects of employment changes on nearby housing prices, focusing on firms in the three predominant FDI sectors in Ireland: manufacturing, finance &

insurance, and ICT. It does this in two ways. Firstly, it looks at the income channel. If a rise in income increases housing demand, then the rise in demand should be greater, the larger the income. Unfortunately, our dataset does not provide information on earnings, so we instead use the average annual earnings associated with each sector to examine this hypothesis. Table 7 confirms that a larger income is associated with larger rents, but has little effect on sale price.

Table 7

The impact of employment on housing prices by sector, using the same nearest foreign-owned firm.

Independent Variables	Log of monthly rent				Log of sale price			
	(1) Nearest	(2) Nearest MOL	(3) Nearest	(4) Nearest MOL	(5) Nearest	(6) Nearest MOL	(7) Nearest	(8) Nearest MOL
Δemp_t	.0034 (.0039)	.0122*** (.0023)	.0138** (.0066)	-.0049** (.0025)	-.018 (.0118)	.0028 (.0097)	.0006 (.0184)	-.0011 (.011)
Δemp_{t-1}	.0305*** (.0043)	.0173*** (.0023)	.0213*** (.0062)	.0066*** (.0025)	.0086 (.0135)	.0051 (.0107)	.0511*** (.0185)	-.0223 (.0119)
Δemp_{t-2}	.0178*** (.004)	.0317*** (.0027)	-.0051 (.0055)	.0181*** (.0031)	.0407*** (.0149)	.018* (.0108)	.0372** (.0177)	.0014* (.0135)
ldist_t	-.0042*** (.0005)	-.0073*** (.0005)	-.0053*** (.0005)	-.0063*** (.0006)	.0056*** (.0015)	-.0028* (.0016)	.0072*** (.0016)	-.0023 (.0017)
average_earnings	3.64e-07*** (6.68e-08)	1.39e-06*** (1.09e-07)	–	–	–4.74e-07** (2.04e-07)	–2.27e-07 (3.51e-07)	–	–
finance&insurance* Δemp_t	–	–	-.0434** (.0183)	.0839*** (.0097)	–	–	-.033 (.0455)	.0892 (.0824)
finance&insurance* Δemp_{t-1}	–	–	.0318** (.0131)	.0164 (.0182)	–	–	.06 (.0433)	.2789*** (.0871)
finance&insurance* Δemp_{t-2}	–	–	.1152*** (.019)	.0301* (.0182)	–	–	-.0363 (.0597)	.3084*** (.083)
info&comm* Δemp_t	–	–	-.0146* (.0082)	.0673*** (.0077)	–	–	-.0517** (.0241)	.0014 (.0247)
info&comm* Δemp_{t-1}	–	–	.0145 (.0093)	.0965*** (.0076)	–	–	-.1327*** (.0293)	.1041*** (.027)
info&comm* Δemp_{t-2}	–	–	.0392*** (.0081)	.0213*** (.0075)	–	–	.0124 (.0344)	.0289 (.0224)
finance&insurance* ldist_t	–	–	.0002 (.0006)	-.012*** (.001)	–	–	-.0102*** (.0021)	-.0014 (.0044)
info&comm* ldist_t	–	–	.0017 (.0037)	.0008 (.0008)	–	–	-.002 (.0017)	-.0028 (.0031)
Sector controls	YES	YES	YES	YES	YES	YES	YES	YES
Physical controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.76	0.76	0.76	0.70	0.70	0.70	0.70
N	976,767	1,048,563	976,767	1,048,563	300,118	311,299	300,118	311,299

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places. Average earnings by economic sector NACE Rev 2 (2008–13) are retrieved from the Central Statistics Office in Ireland, available at: <http://www.cso.ie/en/statistics/earnings/>.

The alternative method shown in Table 7 is to interact employment changes and distance with sector dummies, setting manufacturing as the base. Once again, there are clear effects on rents, across all sectors, using the nearest MOL firm. A year on from employment changes, ICT firms exert a large effect on both rents and prices (roughly 10% per 1000 jobs). Employment changes in financial services firms are associated with large price increases after one year (30% per 1000). In contrast, manufacturing firms exert a much smaller employment effect (2%), and in certain specifications negative, possibly reflecting negative production externalities associated with manufacturing firms (Osland and Pryce, 2012).

5. Extensions and robustness

The depth of the data allows many other potential specifications and robustness checks. Five are described briefly in this section. Firstly, the analysis is extended to domestically-owned internationally trading firms in the dataset. The analysis is repeated using employment in domestically-owned firms and all firms in the survey (Appendix F). We find contrasting results. The expectation is that changes in employment will be positively related to housing price regardless of firm ownership; however we find a negative relationship. This may reflect the greater endogeneity of the investment, employment and trade decisions of Irish-owned firms to local economic conditions.

Secondly, the effect of changes in employment is allowed to vary by region, specifically by EU NUTS3 regions, of which there are eight; Appendix G contains the full results. The effect of employment changes at changing MOL firms on rents is largest in the West and South East of Ireland and the effect on prices is largest in the South East and South West – perhaps reflecting lower prices and greater scarcity of FDI jobs in the

region.

Thirdly, we repeat our analysis controlling for the potential elasticity of supply, as discussed in Section 3. Notwithstanding the dramatic reduction in housing construction after 2007 in Ireland, the existence of unfinished developments from the preceding housing market bubble may act as a source of latent supply. To the extent that this occurs, this would dampen down the estimate of how housing prices respond to new demand, as FDI jobs triggered empty properties to come on the market, a quantity response rather than a price response. In 2010, Ireland's Housing Agency compiled a register of unfinished developments, including geographic coordinates. We repeat our analysis adding the log of the distance of every dwelling to the nearest unfinished housing estate as a control variable, with the expectation of a positive coefficient (proximity to latent supply should lower housing supply). The coefficient is statistically insignificant for rents, but positive and statistically significant for sale price. However, there is no disruption to our employment coefficients as we find similar results in all specifications.

Lastly, two robustness checks are performed. As mentioned in Section 2.1, each dwelling is located by its geographic coordinate with a certain degree of accuracy. There are six levels of accuracy in the dataset: area, building, general estate, street, village and unmatched. The majority of dwellings in the dataset are matched with a high degree of accuracy; 68% of dwellings for rent and 67% of dwellings for sale are matched at the building or street level. However, a problem may arise if the remainder of the dwellings are inaccurately located in the centre of an area, where employment is also located. We repeat our analysis including a control for location accuracy and we find similar results to Section 4.

As explained in Section 2.2 And 3, there is a mismatch in the dataset between the listings and the employment numbers e.g. for a house listed

Table 8

The impact of employment on housing prices, excluding November and December 2007–13.

Independent variables	Nearest foreign-owned firm				Nearest MOL foreign-owned firm			
	(i) Changing nearest firm		(ii) Same nearest firm		(i) Changing nearest firm		(ii) Same nearest firm	
	(1) Rent	(2) Sale price	(3) Rent	(4) Sale price	(5) Rent	(6) Sale price	(7) Rent	(8) Sale price
Δemp_t	.0036 (.0024)	.0167* (.0091)	.002 (.0042)	-.0209* (.0119)	-.0016 (.002)	.0098 (.0068)	.0104*** (.0024)	.003 (.0097)
Δemp_{t-1}	.0118*** (.0029)	.0199* (.0104)	.0323*** (.0046)	.0108 (.0137)	.0066*** (.002)	.0314*** (.0073)	.0181*** (.0025)	.009 (.0107)
Δemp_{t-2}	.0058** (.0027)	.0382*** (.0084)	.0211*** (.0043)	.0381** (.0151)	.0085*** (.002)	.0197*** (.0064)	.0334*** (.003)	.018* (.0108)
ldist_t	-.0048*** (.0004)	-.0051*** (.0015)	-.0041*** (.0005)	.0054*** (.0016)	-.0076*** (.0006)	-.0021 (.0016)	-.0075*** (.0006)	-.0022 (.0016)
Structural controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.70	0.76	0.70	0.76	0.70	0.76	0.70
N	945,875	307,085	851,382	285,848	945,875	307,085	913,165	296,830

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

for sale in January 2012, the contemporaneous change in employment is the one occurring between the November 2010–October 2011 year and the November 2011–October 2012 year. In Table 8, we repeat our analysis using only property listings between January and October, as they are aligned correctly. We find that the results are similar and the misalignment is not a cause for concern.

6. Conclusion

The results presented above can be used to calculate the effect of increased FDI employment in the period 2009–2013 on Irish housing prices, a time when housing prices fell by 27% on average, according to official indices. Using our baseline estimates of the effect of 1000 additional FDI jobs on rent price (1%) and sale price (2%), we find that net job creation 2009–2013 increased the stock of wealth in owner-occupied real estate by €48 million, and €8 million in the rental sector. This is done as follows. Firstly, we calculated the number of households affected by employment using the 50th percentile of distance to the nearest firm. i.e. the number of rental dwellings within 0.9 km of employment, and within 1.6 km for properties for sale. Next, for properties listed in 2013, we estimated the average change in employment between 2009 and 2013 at the nearest firm. Using this estimate and the average housing price in our dataset, we calculated the aggregate effect of net job creation during 2009–13 on the stock of residential real estate.

Applying our result about marginal changes in employment to the entire stock of FDI jobs provides the first estimate of the effect of aggregate FDI employment in Ireland on its residential real estate wealth. In particular, we estimate that the aggregate effect of the stock of nearly 140,000 FDI jobs in Ireland in 2013 on residential real estate wealth was €440 million. This is calculated by dividing the aggregate effect of net job creation during 2009–13, derived from the first calculation above, by the total change in employment among all firms in the period. Finally, we divide the result by the stock of jobs in 2013 to obtain the average effect on the wealth of residential real estate in 2013.

This paper provides the first estimates of the causal effect of employment on housing prices. Two spatially granular datasets for Ireland are used, the first on housing prices and the second on changes in employment at internationally trading firms. In a hedonic framework, we model rent and sale price as being determined separately by changes in employment and a rich list of physical and locational attributes. Housing supply in Ireland was extremely inelastic during our time period, which allows us to observe the effect of employment on housing prices, not

quantities. The empirical results provide clear evidence that job creation (destruction) is associated with increased (decreased) rents and sales prices.

We find that 1–2 years after 1000 jobs have been created, nearby housing will have rents 0.5%–1% higher, and sale price at least 2% higher. Rental prices adjust to employment changes in all specifications: the nearest firm (of any size), the nearest medium or large firm, the nearest five firms and in the Electoral Division. This is true when we allow the nearest firm to change, and when we track employment at a single nearest firm. These results imply that rental prices adjust to all employment activity. In contrast, sale price reacts only to employment changes in the presence of medium or large start-ups and shutdowns. We also control for distance to the nearest firm and find a negative relationship in most instances. We find that the significance and magnitude of the employment coefficients are greater in the post-crisis period, and larger for job destruction than job creation, as well as varying employment effects by sector. In all, these results confirm one of the core intuitions of urban economics: households pay more for better access to the labour market.

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Appendix A

Table 9

Summary statistics for foreign-owned firms

Geographic Area	Number of firms		
Border	139		
Dublin	834		
Mid-East	92		
Mid-West	133		
Midland	69		
South-East	103		
South-West	257		
West	143		
Dublin City	529		
Year	Number of firms	Establishments	Shutdowns
2004	1320	–	82
2005	1276	38	49
2006	1274	47	54
2007	1273	53	52
2008	1257	33	73
2009	1223	41	83
2010	1188	52	54
2011	1201	65	48
2012	1231	77	37
2013	1247	52	–
Unemployment rate in office locations, by Electoral Division			
Mean	0.16		
Max	0.5		
Min	0.02		
25 th percentile	0.09		
50 th percentile	0.14		
75 th percentile	0.22		

Notes: The year of entry is defined as the year in which the firm first records non-missing employment. The year of exit is defined as the last year the firm records non-missing employment. Unemployment rates are taken from the 2011 Census records and are available at: <http://www.cso.ie/en/census/census2011reports/>.

Appendix B

Table 10

Description of main variables

Variable	Definition
1. Employment and distance	
Δemp_{t-n}	The employment level in time t minus the employment level in time $t-n$, where $n = 0, 1, 2$ or 3
ldist_t	Log of distance to the nearest firm(s) in the year the property is listed
2. Physical characteristics	
Rental listings	
bedbaths	combines the number of bedrooms and bathrooms
property_type	specifies the property type: apartment, house, studio or flat
garden	takes on the value 1 if there is a garden, 0 otherwise
furnished	takes on the value 1 if furnished, 0 otherwise
parking	takes on the value 1 if there is parking, 0 otherwise
cnheating	takes on the value 1 if there is central heating, 0 otherwise
halarm	takes on the value 1 if there is a house alarm, 0 otherwise
wheelchair_access	takes on the value 1 if there is wheelchair access, 0 otherwise
agent	takes on the value 1 if it was listed by an agent, 0 otherwise
dwasher	takes on the value 1 if there is a dishwasher, 0 otherwise
microwave	takes on the value 1 if there is a microwave, 0 otherwise
pets	takes on the value 1 if pets allowed, 0 otherwise
cableTV	takes on the value 1 if there is cable TV, 0 otherwise
rent_allowance	takes on the value 1 if the landlord accepts rent allowance
wmachine	takes on the value 1 if there is a washing machine, 0 otherwise
For sale listings	
bedbaths	combines the number of bedrooms and bathrooms
property_type	specifies the property type: apartment, house, duplex or bungalow.
garden	takes on the value 1 if there is a garden, 0 otherwise.
house_type	specifies the house type: terraced, semi-detached, detached, end-of-terrace or townhouse
ndevelopment	takes on the value 1 if it is a new development, 0 otherwise
3. Locational characteristics	
<i>Distances are expressed in logarithms</i>	
Education	

(continued on next page)

Table 10 (continued)

Variable	Definition
ldist_heduc	Distance to the nearest higher education institution
ldist_postprim	Distance to the nearest post primary school
ldist_prim	Distance to the nearest primary school
Transport	
ldist_airport	Distance to the nearest regional or international airport
ldist_rail	Distance to the nearest rail link (including train, rapid transit and light rail)
ldist_road1	Distance to the nearest motorway
ldist_road2	Distance to the nearest primary road
ldist_road3	Distance to the nearest secondary road
Environment	
ldist_river	Distance to the nearest river
ldist_lake	Distance to the nearest lake
ldist_coast	Distance to the nearest coastline
ldist_ippc	Distance to the nearest polluting facility (IPPC)
ldist_waste	Distance to the nearest waste facility
Crime	
crime1	Attempts and threats to murder, assaults, harassments
crime2	Dangerous or negligent acts
crime3	Robbery, extortion and hijacking offences
crime4	Burglary and related offences
crime5	Theft and related offences
crime6	Fraud, deception and related offences
crime7	Controlled drug offences
crime8	Weapons and explosives
crime9	Damage to property and to the environment
crime10	Public order and other social code offences
Census	
unemp	Fraction of population unemployed, by small area in 2011
educ	Fraction of population that have achieved greater than post-secondary education, by small area in 2011
foreign	Fraction of the population born outside of Ireland, by small area in 2011
popdens	Population divided by land area (kmsq), by small area in 2011
vacant	Fraction of properties that are vacant, by small area in 2011
Other	
ldist_cbd	Distance to the nearest Central Business District (including Northern Ireland)
ldist_smarket	Distance to the nearest supermarket
ldist_stadium	Distance to the nearest stadium
ldist_monument	Distance to the nearest monument
ldist_prison	Distance to the nearest prison

Appendix C

Table 11

Summary statistics of distance (metres) to the nearest firm of any size 2007–13, by segment

	Rent	Sale
Min	0	0
Max	31,320.19	32,062.47
Mean	2108.68	3569.89
N	1,090,172	324,619
Percentile		
25 th	416.57	692.04
50 th	863.75	1329.59
75 th	1682.74	5203.89

Notes: Numbers are rounded to two decimal places.

Appendix D

Table 12

Nearest regressions in Table 3 continued

Independent variables	Log of monthly rent	Log of sale price
bedbaths	d	d
house_type	–	d
property_type	d	d
ndevelopment	–	.0038848
		.0039194
garden	.0211745*** (.0004844)	.0384338*** (.001337)

(continued on next page)

Table 12 (continued)

Independent variables	Log of monthly rent	Log of sale price
furnished	-.1138607*** (.0019711)	–
parking	-.0083384*** (.00077)	–
cnheating	.0013582* (.000724)	–
halarm	.0078096*** (.0005601)	–
wheelchair_access	.0079561*** (.0009396)	–
agent	.019202*** (.000445)	–
dwasher	.0284264*** (.0004412)	–
dryer	-.0008738 (.0006756)	–
microwave	.0336936*** (.0004748)	–
pets	-.0045377*** (.0005115)	–
cableTV	.0176501*** (.0005184)	–
rent_allowance	-.0291184*** (.0006164)	–
wmachine	-.0057695*** (.0005294)	–
ldist_heduc	-.0190534*** (.0013413)	.0285966*** (.0044241)
ldist_postprim	-.002823*** (.000509)	.0037316*** (.001369)
ldist_prim	.0010842*** (.0004182)	.0100531*** (.0011248)
ldist_airport	-.0528714*** (.0054403)	-.1236725*** (.0134509)
ldist_rail	-.0079348*** (.0010299)	-.0189104*** (.0063177)
ldist_road1	-.0002678 (.0004339)	-.0051341*** (.0012873)
ldist_road2	-.0003595 (.0004371)	.0062006*** (.0013834)
ldist_road3	.0016137 (.0002668)	-.0004236 (.0007721)
ldist_cbd	-.0001519 (.0016981)	-.0299319*** (.007833)
ldist_cstore	.0030831*** (.0001914)	-.0034395*** (.0006447)
ldist_smarket	-.0027374*** (.0003353)	-.0072056*** (.0010449)
ldist_stadium	-.0044053*** (.0011615)	-.0143987*** (.0028622)
ldist_monument	-.0042273*** (.0003558)	-.0085318*** (.0010156)
ldist_prison	-.0136701*** (.0021176)	-.0189104*** (.0063177)
ldist_river	.0023164*** (.0003054)	.0052954*** (.0008461)
ldist_lake	-.0045562*** (.0006938)	-.0092979*** (.0018264)
ldist_coast	.0001835 (.0001279)	.0003155 (.0003646)
ldist_ippc	.0060659*** (.0007105)	.0182141*** (.0018445)
ldist_wfarm	.0157136*** (.0028609)	.0326825*** (.0067527)
ldist_waste	.0002987 (.0009353)	.0084741*** (.0024839)
crime1	-.00006*** (4.16e-06)	-.0001188*** (.0000174)
crime2	-.0000139*** (3.59e-06)	-.0000313*** (.0000108)
crime3	-.0001723*** (.0000115)	-.0001608*** (.0000479)
crime4	.0000334*** (2.63e-06)	.0000342*** (8.96e-06)
crime5	–2.30e-06*** (5.01e-07)	7.07e-07 (1.93e-06)

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Table 12 (continued)

Independent variables	Log of monthly rent	Log of sale price
crime6	7.19e-06 (8.57e-06)	-.0000993*** (.0000249)
crime7	-.000014*** (1.90e-06)	-.0000254*** (6.70e-06)
crime8	.0001359*** (.0000143)	-.0000564 (.0000441)
crime9	–1.17e-06 (1.68e-06)	.0000287*** (5.29e-06)
crime10	.0000121*** (9.07e-07)	.0000261*** (3.16e-06)
unemp	-.1696032*** (.005864)	-.433431*** (.0167491)
educ	.0746752*** (.0024684)	.2617781*** (.0078406)
foreign	-.051335*** (.0036546)	-.0647044*** (.013673)
popdens	–9.12e-07*** (4.30e-08)	-.0000103*** (3.12e-07)
vacant	.0002619*** (.0000299)	-.000057 (.0001081)
ED dummies	YES	YES
Time dummies	YES	YES
County dummies	YES	YES
R-squared	0.76	0.69
N	1,090,172	324,619

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors in parentheses. “d” signifies a categorical variable.

Appendix E

Table 13

The impact of employment at medium or large firms on housing prices, using changing nearest firms

Independent variables	Foreign-owned firms					
	Log of monthly rent			Log of sale price		
	(1) Nearest MOL	(2) Nearest MOL	(3) Nearest MOL	(1) Nearest MOL	(2) Nearest MOL	(3) Nearest MOL
Δemp_t	.0236*** (.0027)	.0036** (.0018)	.0009 (.0019)	.0905*** (.0096)	.0121* (.0067)	.0096 (.0067)
Δemp_{t-1}	.0722*** (.0028)	.0147*** (.0018)	.0051*** (.0018)	.1801*** (.0101)	.0346*** (.0071)	.0301*** (.0071)
Δemp_{t-2}	.0763*** (.003)	.0172*** (.0019)	.0084*** (.0019)	.053*** (.0086)	.0515*** (.0059)	.0206*** (.0061)
ldist_t	-.0826*** (.0003)	-.0115*** (.0003)	-.0076*** (.0005)	–0.0615*** (.0008)	-.0028*** (.0008)	-.0029* (.0016)
Physical controls	YES	YES	YES	YES	YES	YES
Location controls	NO	YES	YES	NO	YES	YES
County dummies	NO	YES	YES	NO	YES	YES
ED dummies	NO	NO	YES	NO	NO	YES
Time dummies	YES	YES	YES	YES	YES	YES
R-squared	0.32	0.73	0.76	0.27	0.64	0.69
N	1,090,172	1,090,172	1,090,172	324,619	324,619	324,619

Appendix F

Table 14

The impact of employment (in domestically-owned firms) on housing prices, using changing nearest firms

Independent variables	Domestically-owned firms							
	Log of monthly rent				Log of sale price			
	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED
Δemp_t	-.0403*** (.011)	-.0021 (.0034)	-.0193*** (.0036)	.0014 (.003)	-.04** (.0202)	-.0266** (.011)	-.0283*** (.009)	.0067 (.0092)
Δemp_{t-1}	-.0137 (.01)	.0016 (.0031)	.0003 (.0036)	-.0229*** (.004)	-.0389** (.0159)	-.0006 (.0081)	-.0097 (.0093)	.0025 (.0011)
Δemp_{t-2}	-.0519*** (.0109)	.0063 (.0031)	.0003 (.0035)	-.0027 (.0027)	-.0517*** (.0191)	-.0059 (.0093)	-.0342*** (.0099)	.0142 (.009)

(continued on next page)

Table 14 (continued)

Independent variables	Domestically-owned firms							
	Log of monthly rent				Log of sale price			
	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED
ldist _t	-.00021 (.0003)	-.003*** (.0004)	.0002 (.0007)	–	-.0005 (.0009)	.0019 (.0012)	.0052*** (.002)	–
Physical controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.76	0.76	0.76	0.69	0.69	0.69	0.69
N	1,090,172	1,090,172	1,090,172	1,090,172	324,619	324,619	324,619	324,619

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

Table 15

The impact of employment (in all firms) on housing prices, using changing nearest firms

Independent variables	Log of monthly rent				Log of sale price			
	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED	(1) Nearest	(2) Nearest MOL	(3) Nearest five	(4) ED
Δemp _t	-.0284*** (.0065)	.002 (.0014)	-.0193 (.0036)	.0121*** (.0015)	-.0658** (.015)	-.0093** (.0042)	-.0283*** (.0094)	.003 (.0051)
Δemp _{t-1}	-.014** (.0067)	.0016 (.0016)	.0003 (.0035)	-.00081 (.0017)	-.0567*** (.013)	.0045 (.0047)	-.0097 (.0093)	.0195** (.008)
Δemp _{t-2}	-.0095 (.0061)	.002 (.0013)	.0003 (.0035)	.0019 (.0035)	-.0432*** (.0155)	.012*** (.0043)	.0342*** (.0099)	.0075 (.0059)
ldist _t	-.0011*** (.0003)	-.0062*** (.0004)	.0002 (.0007)	–	.0006 (.0009)	.0016 (.0012)	.0052*** (.002)	–
Physical controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.76	0.76	0.76	0.69	0.69	0.69	0.69
N	1,090,172	1,090,172	1,090,172	1,090,172	324,619	324,619	324,619	324,619

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

Table 16

The impact of employment (in domestically-owned firms and all firms) on housing prices, using the same nearest firm

Independent variables	Domestically-owned firms				All firms			
	Log of monthly rent		Log of sale price		Log of monthly rent		Log of sale price	
	(1) Nearest	(2) Nearest MOL	(1) Nearest	(2) Nearest MOL	(1) Nearest	(2) Nearest MOL	(1) Nearest	(2) Nearest MOL
Δemp _t	-.029 (.0204)	-.018** (.0073)	.036 (.0304)	-.0309* (.0184)	-.0318*** (.0106)	.0373*** (.0037)	.0334 (.0277)	-.0309* (.0184)
Δemp _{t-1}	.013 (.204)	-.0008 (.0076)	-.041 (.0416)	.0111 (.023)	.0196* (.0118)	.0318*** (.0041)	-.0328 (.0283)	.0111 (.023)
Δemp _{t-2}	-.0153 (.0192)	-.0214*** (.0074)	-.0961* (.0574)	.0133 (.0199)	.0363*** (.0101)	.0274*** (.0045)	-.065 (.0477)	.0133 (.0199)
ldist _t	.0005 (.0003)	-.0038*** (.0004)	.0004 (1.38e-06)	.0004 (.0013)	-.001*** (.0003)	-.0064*** (.0004)	.0013 (.001)	.0004 (.0013)
Structural controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.76	0.69	0.69	0.76	0.76	1.69	0.76
N	909,064	1,035,686	278,147	305,203	920,009	1,041,647	280,462	305,200

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places.

Appendix G

Table 17

The impact of employment on housing prices, by NUTS3 region

Independent variables	Nearest foreign-owned firm				Nearest MOL foreign-owned firm			
	Changing nearest firm		Same nearest firm		Changing nearest firm		Same nearest firm	
	(1) Rent	(2) Sale price	(3) Rent	(4) Sale price	(5) Rent	(6) Sale price	(7) Rent	(8) Sale price
Δemp_t	.0091*** (.0026)	-.0076 (.0156)	.0134*** (.0052)	-.00003* (.00001)	-.005** (.0023)	-.0226** (.0113)	.0239*** (.0027)	-.0001*** (.00001)
Δemp_{t-1}	.0279*** (.0032)	-.0029 (.0184)	.0447*** (.0055)	-3.06e-06 (.00002)	.0032 (.0024)	-.0248* (.0127)	.026*** (.0028)	-4.77e-06 (.00002)
Δemp_{t-2}	.0217*** (.0034)***	.0295** (.0118)	.0315*** (.0056)	.00002 (.00003)	.0008 (.0026)	-.0084 (.0086)	.0512 (.0036)	-6.81e-06 (.00002)
Border* Δemp_t	.0325** (.0147)	-.0115 (.0422)	.0673** (.0287)	.00001 (.00006)	-.0772*** (.0193)	.0775** (.0354)	.0388 (.0272)	.0000705 (.00005)
Border* Δemp_{t-1}	-.0118 (.0162)	.0964** (.0426)	.0038 (.039)	.0001** (.00006)	-.0131 (.0265)	.0939** (.0368)	-.0005 (.0306)	.00007 (.00008)
Border* Δemp_{t-2}	-.056*** (.0139)	.0263 (.0242)	-.0025 (.0151)	.00005 (.00004)	-.0237 (.0149)	.0396* (.024)	-.0718*** (.0146)	.00005 (.00003)
MidEast* Δemp_t	-.0295*** (.0078)	.0233 (.0306)	-.0231** (.0093)	.00003 (.00003)	-.0097** (.0047)	.0797*** (.0175)	-.0368*** (.0053)	.0001*** (.00002)
MidEast* Δemp_{t-1}	-.055*** (.0075)	-.021 (.0337)	-.0348*** (.0093)	.00001 (.00003)	-.0094** (.0047)	.0312 (.0204)	-.0281*** (.0054)	-5.43e-06 (.00002)
MidEast* Δemp_{t-2}	-.0552*** (.0077)	-.0089 (.0275)	-.0351*** (.009)	.00005 (.00004)	-.0146*** (.0049)	.0514*** (.0191)	-.0551*** (.0061)	.00003 (.00003)
MidWest* Δemp_t	.0006 (.0006)	.0916*** (.0319)	-.0624* (.0378)	.0001 (.00008)	-.0318*** (.0124)	.0517** (.0246)	-.1096*** (.017)	.0003*** (.00006)
MidWest* Δemp_{t-1}	-.0123 (.0183)	.046 (.0363)	.0047 (.0317)	.00006 (.00009)	-.0031 (.0094)	.071*** (.0268)	-.0889*** (.0328)	-.0001 (.00007)
MidWest* Δemp_{t-2}	.0068 (.0183)	.0652 (.0414)	-.0451 (.0322)	.00013* (.00008)	.0006 (.009)	.083*** (.0257)	-.0591* (.0315)	.00005 (.00007)
Midland* Δemp_t	-.167*** (.0259)	.1146 (.0712)	-.2296*** (.0399)	-.00004 (.00009)	-.0354*** (.0092)	-.0879 (.0534)	-.2914*** (.0255)	-.0002** (.00007)
Midland* Δemp_{t-1}	-.0839*** (.0228)	.1723*** (.066)	-.0735 (.0501)	.0002** (.0001)	-.0013 (.0097)	.034 (.046)	-.0723*** (.0228)	.0001** (.00007)
Midland* Δemp_{t-2}	-.0882*** (.0195)	.0529 (.0548)	-.2088*** (.0552)	.0002 (.0001)	.0301*** (.0095)	.0268 (.0292)	.0841*** (.0218)	.0003*** (.00008)
SouthEast* Δemp_t	-.0031 (.0095)	.0506 (.0372)	-.0541*** (.0137)	-.0002*** (.00004)	.0234*** (.007)	.0008 (.022)	-.0345 (.0218)	-.0001** (.00005)
SouthEast* Δemp_{t-1}	-.0376*** (.0098)	.0492 (.0347)	-.0116 (.0276)	-.0002*** (.00006)	.0576*** (.0083)	.0923*** (.0215)	.0365* (.0212)	-.00002 (.00005)
SouthEast* Δemp_{t-2}	.0027 (.008)	.0259 (.0315)	.06** (.0272)	-.0002*** (.00007)	.1032*** (.0081)	.0472** (.0207)	.0072 (.0209)	-.00002 (.00005)
SouthWest* Δemp_t	-.0207** (.0096)	.0221 (.0287)	-.0398** (.0156)	.0001** (.00004)	.0201*** (.0072)	.0845*** (.0226)	-.0488*** (.0124)	.0002*** (.00004)
SouthWest* Δemp_{t-1}	-.0465*** (.0104)	.0117 (.0287)	-.0412*** (.0159)	.00002 (.00004)	-.0166*** (.0065)	.1523*** (.0229)	-.0232* (.0131)	.0001*** (.00004)
SouthWest* Δemp_{t-2}	-.0091 (.0103)	.0298 (.0294)	-.0021 (.016)	.00002 (.00005)	-.0037 (.0058)	.0624*** (.019)	-.0414*** (.013)	-.00003 (.00004)
West* Δemp_t	.0077 (.0138)	.0539 (.0352)	.1415*** (.027)	.0001 (.00008)	.0818*** (.0119)	.0627*** (.0207)	.259*** (.0285)	.0001 (.00007)
West* Δemp_{t-1}	-.0461*** (.0142)	-.0471 (.0455)	.0254 (.0246)	-.00008 (.0001)	.0297*** (.0085)	.017 (.0212)	.0959*** (.0222)	-.0003*** (.00007)
West* Δemp_{t-2}	-.1195*** (.0132)	.0029 (.038)	-.0883*** (.0223)	.00002 (.00009)	.0234** (.0103)	.0211 (.0228)	-.0386** (.0189)	.00004 (.0001)
ldist _t	-.0047*** (.0004)	.0051*** (.0014)	-.0042*** (.0005)	.0055*** (.0015)	-.0076*** (.0005)	-.0032** (.0016)	-.0074 (.0005)	-.003* (.0016)
Nuts3 dummies	YES	YES	YES	YES	YES	YES	YES	YES
Structural controls	YES	YES	YES	YES	YES	YES	YES	YES
Location controls	YES	YES	YES	YES	YES	YES	YES	YES
ED dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
County dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.76	0.69	0.76	0.70	0.76	0.69	0.76	0.70
N	1,090,172	324,619	982,396	302,238	1,090,172	324,619	1,052,967	313,750

Notes: ***p < 0.01 **p < 0.05 *p < 0.1. Robust standard errors are in parentheses. Numbers are rounded to four decimal places. County Dublin is the base.

Appendix H. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.regsciurbeco.2018.01.011>.

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