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Price regulation, inflation, and nominal rigidity in housing rents

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type and starting rent levels are evident.

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Abstract

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1 Introduction

The economic dynamics of price inflation for rental housing has long been complicated by two aspects of rental markets. The first issue relates to regulatory tenancy rent control regimes. These regulations have been a common feature of many rental markets globally since the middle of the 20th century, and have been used extensively in the US and Europe. The regimes often act to limit price setting behaviour (often distinguishing between new and current tenants) with a broad policy objective of limiting the exposure of tenants to price increases set by landlords and therefore improve housing affordability (Lind 2001). Security of tenure is also often found to be a secondary objective (Haffner et al. 2008). The research on the costs and benefits of rent control measures is extensive, with considerable focus placed on issues such as investment and housing quality (Sims 2007, Arnott & Shevyakhova 2014), community composition (Sims 2011), the impact on unemployment duration (Svarer et al. 2005), tenancy length (Munch & Svarer 2002) and homelessness (Early & Olsen 1998). Haffner et al. (2008) also explored the degree to which the balance of tenant and landlord rights matter for the efficacy of regulations. Diamond et al. (2019) find that rent controls impact tenant mobility and drive up rents in the long run.

The second issue in housing rental markets is the existence of nominal rigidities where prices are unchanged for the same property from period to period. This degree of price stickiness in housing has been linked to tenant turnover costs (Genesove 2003, Aysoy et al. 2014) and is likely to play a role in determining the degree to which regulations impact price changes. Importantly, the impact of price rigidities in housing is critical in terms of the broad debate about price stickiness and the impact of monetary policy changes. In theory, central bank interventions do not have a full pass through into inflation because prices do not respond sufficiently quickly (Kehoe & Midrigan 2015) or rigidities prevent price changes. From the perspective of aggregate changes in the Consumer Price Index (CPI), the impact of monetary changes should be greater if nominal price rigidity occurs for items which take up a large share of a household budget, like housing costs for private renters. Indeed, given the high share of the household budget that is allocated to housing[1], the extent of nominal price rigidities in the housing market is a critical aspect in understanding the transmission of monetary policy and the measurement of inflation (Ambrose et al. 2017, 2018, Diewert et al. 2009, Dougherty & Van Order 1982).

Despite the extensive literature, there are few studies which directly quantify either the impact of rent controls on rental price inflation and the degree of nominal rigidity in the housing market. This paper addresses this gap in the literature. In particular, we consider the price setting behaviour of landlords across the price distribution after the adoption of a maximum price cap regulation of 4 per cent. In order to do this, we exploit a quasi-natural experimental setting before and after the introduction of rent controls in

[1] Various estimates suggest that renters face high housing costs relative to income internationally. A summary of the literature can be found in Corrigan et al. (2019) with US examples in Quigley & Raphael (2004). Dutch examples in Haffner & Boumeester (2014) and the Turkish case in Aysoy et al. (2014).

the Republic of Ireland in 2017. As a result of the regulations, certain areas in the country were classified as rent control areas with other areas remaining unclassified. In the rent control areas, the rate of nominal rent increases were limited to 4 per cent annually. We use regulatory micro-data on tenancy agreements in Ireland at the property-level taken from the supervisory returns collected by the Irish rental regulator, the Residential Tenancies Board (RTB). For the purpose of this study we extract a property-level panel dataset from the supervisory database of tenancy agreements which covers the period pre and post the introduction of the rental regulations in 2017.

More specifically, our first contribution is to explore the impact of rent controls on rent growth. We assess the impact on the overall inflation rate but go further than the existing literature to assess the implications of the regulations on the share of the market experiencing differing growth rates. For example, landlords could opt to set prices: a) above the 4 per cent maximum; b) at the cap; c)lower than the cap but with positive growth; d) leave rents unchanged (nominally rigid) or e) reduce rents. Which of these options they choose is likely to depend on their bargaining power in the market, the ability to recoup the cost of tenant turnover, and the desire to protect real returns by maximising the inflation rate. Our research design to identify these effects uses a multinomial logit difference-in-difference approach which splits the distribution into five groups which identify whether rents are: 1) falling, 2) remaining the same, 3) growing at less then the regulatory maximum 4 per cent, 4) growing at the regulatory max, 5) growing above the regulatory max. We can then test the relative likelihood of being in each of the groups, as compared to growing above the 4 per cent cap in regulated and unregulated markets before and after the policies were introduced.

In relation to this contribution, our research is closely linked to a number of studies. Two recent studies use micro data to explore changes in Germany rent regulations in 2015 (Breidenbach et al. 2019, Mense et al. 2018) with both finding the regulations had a negative impact on rental inflation. Sims (2007) considered the impact of ending rent control in Massachusetts. He found that rent control had reduced prices, had little effect on new construction but had led to a deterioration in the quality of the units. More recently, Fitzenberger & Fuchs (2017) looked at the impact of rent regulation on prices in Germany using a quantile regression. Their identification relied on comparing tenancies covered and uncovered by regulations over time. Oust (2018) found little affect of the removal of rent control in Oslo on the level of rents but does not focus on the distributional effects or impacts on the growth rates. By exploiting the quasi-natural geographic variation which is unlikely to be impacted by omitted tenant variables, and exploring the distributional effects in more details, our research builds on these studies but explores greater insights. Indeed, the panel nature of our data improves the identification strategy as well as our use of the multinomial group comparison. Another notable study is Diamond et al. (2019) which uses a law change in San Francisco to test the impact of regulation on tenant mobility and prices levels. As our focus is on the price growth distribution, we feel our research is complementary to this study.

Our second contribution is to explore the direct impact of rent controls on nominal price rigidity. Focusing on the share of rental contracts which do not change prices over time, and how regulations impact this share, is important given the implications for the efficacy of tenancy controls as well as the impacts on monetary policy pass through. In this regard, there are two potential competing hypotheses as to how landlords may react to the regulations. First, nominal rigidity may rise if landlords are not able to recoup the cost of tenant turnover. In this case, the cost of losing a tenant due to large rent increases outweighs the loss in real earnings growth with rises now capped by 4 per cent increases per annum. The second hypothesis suggests that nominal rigidity may fall if landlords increase rents by the allowed regulatory level in order to protect real returns. Disentangling these hypotheses is an empirical question. Our strategy to identify these behaviours is twofold. First, using probability modelling we test whether the share of zero growth contracts changes after the introduction of the policies in the treated areas. Second, we then use a multinomial logit model and compare the probability of price changes in each of the five aforementioned groups relative to the nominal rigidity (i.e. unchanged rents) group.

Three previous papers consider the issue of nominal rigidity in housing rents but none interact this with price controls. Genesove (2003) explored the presence of nominal rigidity in apartment rents in the US over the period 1974-1981, focusing on areas without rent controls in operation. He found a high share of properties displayed nominal rigidities (approximately 30 per cent). Shimizu et al. (2010) considered the stability of the Japanese CPI during the 1990's credit boom and focused on the degree of nominal price rigidity in housing as an explanatory factor. They found that 90 per cent of rents are unchanged annually and this depends on the level of the rent as compared to the market. Finally, Aysoy et al. (2014) used a national panel of housing units in Turkey to explore the degree of nominal rigidity over the period 2008 to 2011. They found that 31.5 per cent of rents did not change over time and that this was affected by tenant characteristics and search and moving costs.

While all three of these studies explore aspects of nominal rigidities, they do not test how the impact of rent regulation affects price setting behaviour. Indeed by altering the real expected cash flows from the rental unit, rent controls are likely to considerably change landlords view's on price setting as well as altering the tenant turnover cost. By using a quasi-experimental setting for areas before and after their classification as rent controlled, we can test the degree to which rent controls impact nominal rigidities as well as the overall inflation rate.

Finally, we explore whether heterogeneous effects are evident across different landlord and property characteristics. Using our granular data, we explore whether professional company landlords react differently to individual household landlords. We hypothesize that differential effects may occur due to differences in the ability to manage the cost of tenant turnover as well as differences in profit maximising pricing behaviour. Second, we explore whether the level of the rent, prior, to the regulations affects the subsequent

pricing. If some landlords had been keeping rents low with a view to increasing them between tenancies, this is no longer allowable under the regulations and may force them to begin introducing positive changes. This may alter the impact of the regulations on nominal rigidity. To our knowledge, neither of these aspects have been explored in the existing literature.

A number of findings emerge. First, overall rent controls had a deflationary impact on the market with the inflation rate dropping by approximately 2 percentage points after the introduction of the regulations. Second, we uncover a considerable fall in the share of rent price increases above the 4 per cent limit consistent with the regulatory framework. These findings indicate that the regulations have been broadly effective in lowering the level of rental inflation in the classified areas. Considering the impact across the price distribution, we find that, relative to previously setting prices above 4 per cent, landlords were most likely to price at the regulatory max followed by just below the limit but with above zero growth.

In relation to the impact of rent controls on nominal rigidity, we find that the share of zero growth contracts increased after the introduction of the measures. An increase in no price change contracts may arise due to the risk of tenants leaving after a rent increase and such costs not being recoupable. Furthermore, the findings of the multinomial logit estimates present an interesting picture of the impacts of rent controls across the price distribution. We find that, relative to no change, the likelihood of price increases at, or just below, 4 per cent has increased after the regulations in the treated areas. This may be due to landlords attempting to protect the real value of contracts given their inability to reset rents between tenancies. While the overall effect of the policies has been to dampen rents, they have also caused inflation at other points in the distribution consistent with a protection of real return by landlords (a movement from previous unchanged to positive growth).

We find differences by landlord type with non-professional investors (individual households) more likely to have nominally rigid rents and also less likely to have increases at, or below, the maximum allowable. This may be driven by the fact that such households are unable to absorb tenant turnover costs as easy as professional companies. We also find that landlords with lower than average rents before the regulations were introduced are less likely to leave rents unchanged and more likely to grow rents up to the regulatory maximum after the regulations. If such landlords had left rents low before, with a view to increases this at tenant turnover, this is no longer allowed. They therefore have to increase rents close to the maximum to compensate. Overall, we find that, faced with a common, market-wide regulatory maximum, landlords react heterogeneously to set prices at different points across the distribution.

The rest of the paper is structured as follows. Section 2 presents an overview of the rent control legislation and the rental market in Ireland; section 3 presents the data and summary statistics. Section 4 presents the analysis of the impact of rent controls on rent inflation. Section 5 considers the interaction between rent controls and nominal rigidity

and section 6 concludes.

2 Rent Controls and the Rental Market in Ireland

The onset of the 2008 financial crisis in Ireland led to a dramatic fall in house prices and rents which continued well into 2013. However, from 2014 onwards the economy began to recover and rental prices began to increase rapidly. A continued fall in unemployment, coupled with both rising demographic pressures, low housing supply and tighter mortgage credit conditions for prospective buyers from 2015 all conspired to put further price pressure on the private rental market.

In reaction to the growing public pressure over the cost of private rents, the Government introduced legislation in late 2016 aimed at limiting the rate of price inflation in private rental contracts. While rent controls are a feature of many markets internationally, and were used historically in an Irish context, the explicit inflation cap introduced by these measures represented a marked policy shift for the sector.

The controls were introduced as part of the Planning and Development (Housing) and Residential Tenancies Act 2016. Under this provision, areas can be designated as Rent Pressure Zones (RPZs) by the Minister with responsibility for Housing, Planning and Local Government. This designation limits rental inflation in these areas to a maximum of 4 per cent annually (in a similar vien to the German 10 per cent cap as outlined in Deschermeier et al. (2016)). This limit is applied to rents agreed at the start of the tenancy (i.e. the previous rent on the property, or rent history, is used as the anchor for allowable rent increase) and to rents reviewed in an ongoing tenancy. Two geographic boundary areas can be designated as Rent Pressure Zones: Local Electoral Areas (LEAs) or local authority areas (LAs). At these levels, there are two criteria for determining whether or not the area can be classified as a rent pressure zone: First, the rent inflation must have grown at a rate of 7 per cent or more on an annual basis in four of the previous six quarters. Second, the average rent in the current quarter must be higher than the average national rent (i.e., the Rent Index national standardised rent).

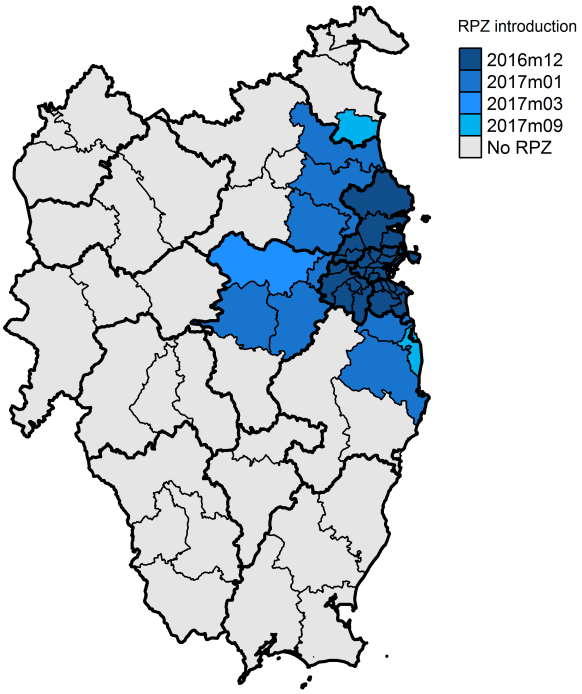
Two exceptions to the 4 per cent maximum increase are currently allowed in the legislation. First, properties new to the rental market (i.e. properties without a rent history for the previous two years relative to when the area in which the property is located was designated an RPZ) are exempt. Second, properties that have experienced a substantial change in the nature of the accommodation (i.e. renovations or reforms of such nature that they involved significant alterations that increased the value of the property) are also exempted. This provides some incentive for landlords to invest and maintain their properties which has been a criticism of the rent control regimes in other countries.

In total, five local authority areas and 16 other additional LEAs around the country have been declared RPZs by Q3 2018 (see Appendix A for details). Most of the current RPZs were designated between December 2016 and January 2017, although two more designation rounds have taken place since as a result of applying the criteria described (the

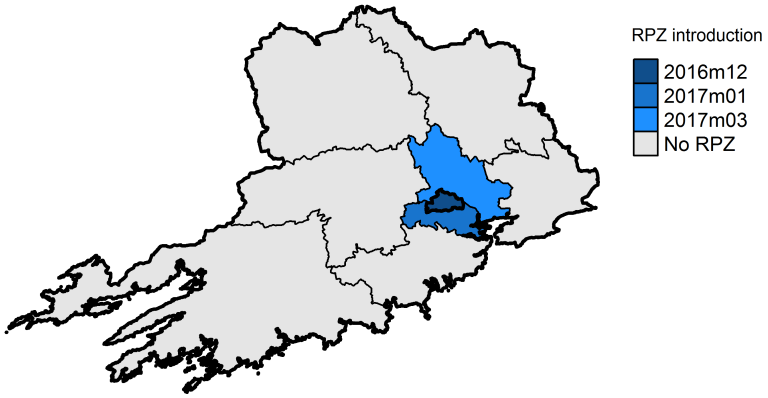
specific dates of each designation are also provided in a table in Appendix A). Visualisation of the declared and undeclared areas are presented in the maps in Figure 1.

Figure 1: Areas Classified as Rent Pressure Zones

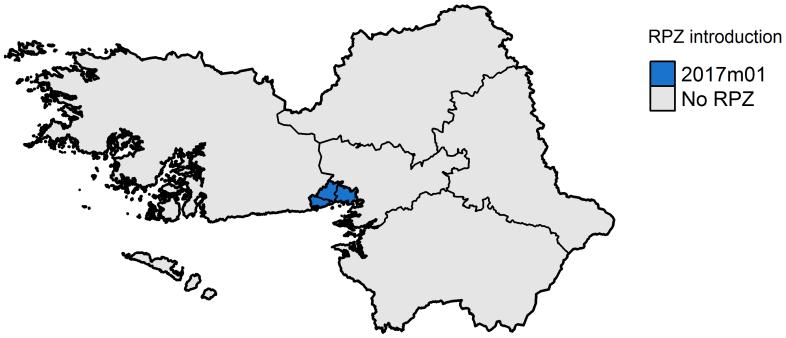
Greater Dublin Area



Cork City and County



Galway City and County



3 Data and Summary Statistics

3.1 Data Overview

The data used for this assessment are provided by the RTB, the state regulator for the Irish private rental sector. By law, all new tenancies in Ireland must be registered on commencement with the RTB and details of the contract provided. This includes the level of the rent and characteristics of the dwelling such as number of bedrooms, number of tenants, address, and other features. The information does not include characteristics of the tenants. These data have been collected and monitored by the RTB since quarter 3 (Q3) 2007 and a tendancy level database of all newly registered tenancies is available from that date onwards. This provides a dataset of approximately 1.3 million registered tenancy agreements from Q3 2007 until Q3 2018. While a majority of the data relate to new tenancies, some tenancy renewals are also contained in the dataset. Renewed tenancies are those re-registered with the RTB after they have existed for between 4 and 6 years (Part IV renewals). There is no requirement in Ireland for tenancies to be re-registered on an annual basis or where the tenancy continues under four years. These data therefore do not measure the stock of outstanding rental contracts and are more in line with the data used in Ambrose et al. (2015) to measure the new, repeat, market rental price.

For the purpose of this research, a specific extract from the database was used. Our interest was in looking at the degree of price stickiness as well as the impact of rent controls on price inflation. We therefore required sufficient data at a within-property level to calculate growth rates. A number of transformations and data cleaning steps are required. The RTB database does not include a property identifier, which would allow matching multiple tenancy agreements to one property and calculate property-specific rent changes over time. The Eircode (i.e. Irish postal code) is the closest approximation to a property identifier in our dataset, but does not distinguish between properties that might share the same Eircode (e.g. apartments in the same building complex). We combine Eircodes with information from the address field in the dataset to match observations to properties.

We identify 201,500 distinct properties that appear more than once (these properties are associated with 614,004 tenancy agreements). A property ID is generated for each of these identified dwellings. With the help of this new ID, we can calculate compound annual growth rates for each property using the formula:

$$CAGR_{it} = \left(\frac{rent_{it}}{rent_{it-s}} \right)^{12/(t-s)} - 1 \tag{1}$$

where s is the time gap between the two tenancy agreements in months. This computation yields 396,251 property-specific growth rates which are used in the econometric estimations [2].

[2] We have discarded the 1 per cent of the smallest and largest growth rates to avoid the results

Once we develop a property level dataset, we can assign each property into LEAs, and, therefore, identify those properties that are located in RPZs and those that are located in non-RPZ areas. This provides us with our treatment (RPZ) and control (non-RPZs) definitions.

3.2 Summary Statistics

Since a number of observations had to be dropped when constructing the property level dataset, there may be concerns that the data omission induces a selection bias, and issues concerning the representativeness of the property level dataset. To rule out this concern, we present summary statistics of the total sample and the reduced property level sample in Table 1. Since there are not substantial variations between the two datasets, we conclude that the property level dataset is representative. Most tenancies correspond to two or three bedroom properties (68 per cent) and nearly half of the registered properties are apartments. The most frequent tenancy length is between 10 and 12 months. Almost half of the rental agreements included only one tenant, while a further 35 per cent of agreements included two tenants. This highlights the high demand for smaller units in the Irish rental market.

being distorted by outliers as standard.

Table 1: Property characteristics comparison

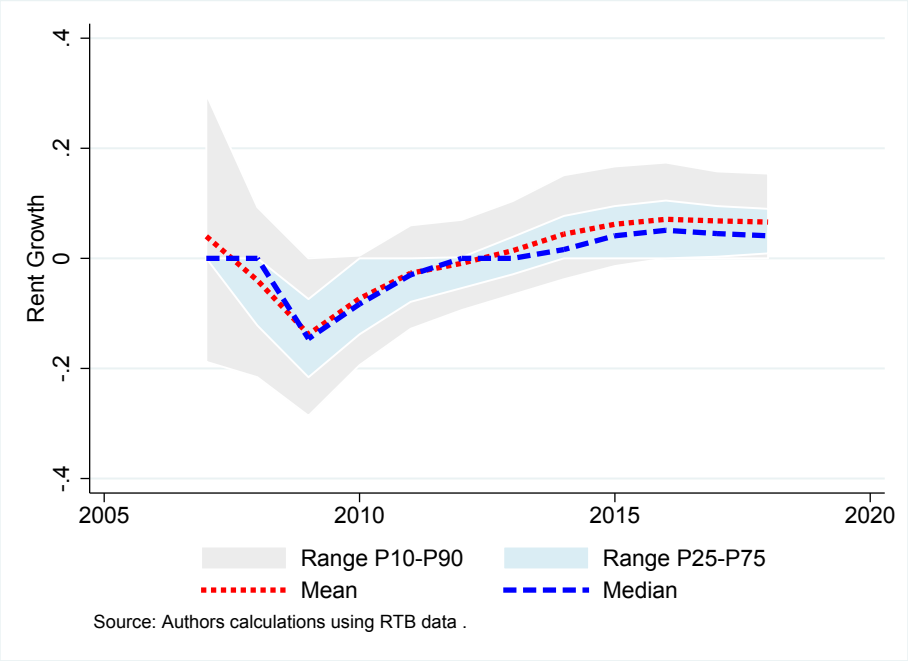
	Total sample (%)	Property sample (%)
1 Bedroom	16.6	15.2
2 Bedrooms	36.9	36.1
3 Bedrooms	31.3	33.7
4 Bedrooms	12.8	12.7
5+ bedrooms	2.4	2.2
Apartment	44.0	42.5
Detached	10.2	5.8
Semi-detached	25.1	29.3
Terrace	14.2	16.7
Other property	6.4	5.7
Part house	1.4	1.0
1 Tenant	47.6	45.4
2 Tenants	35.5	36.4
3 Tenants	7.7	8.4
4+ Tenants	6.5	7.4
1-6 months tenancy	8.2	8.3
7-9 months tenancy	4.7	4.4
10-12 months tenancy	66.4	67.6
1+ year tenancy	20.7	19.8
Fortnightly rent	0.2	0.3
Monthly rent	86.9	88.7
Yearly rent	1.3	1.0
Quarterly rent	0.1	0.0

To compare rental price inflation in Ireland across the price distribution as well as across RPZ and non-RPZ areas, we present a number of comparisons. Figure 2 presents the mean and median price growth in the sample over the period 2007-2018. To contextual the price distribution, we also include the interquartile range and p10-p90 spread which provides insight into the degree of price dispersion and the variance in growth rates in the market. In the period 2007 through 2012, rental prices were falling rapidly as the Irish economy suffered an extreme financial and economic crisis, a major cause of which was imbalances in the housing and credit markets (Honohan et al. 2010, McCarthy & McQuinn 2017). In this period of deflation, and in particular in 2010 at the height of the crisis, it is noteworthy that even at the top end of the distribution, prices were not rising or only rising modestly. This highlights the scale of the downturn in the property market. Towards mid-2013, rental prices began to recover with both the mean and median growth rate turning positive.

From 2014 onwards, as the Irish economy began to grow rapidly, rental prices also recovered strongly and this precipitated a period of rapidly growing rents from 2015-2018. While the mean and median growth rates had been hovering around 6-9 per cent over the period 2014-2016, it is noteworthy that the share of rapidly growing rents had increased

(as noted by an expansion in the share of interquartile range and p10-p90 above the mean and median). Since the end of 2016, and the introduction of rent controls, the share of rents at the high end of the distribution has fallen.

Figure 2: Rent Inflation Growth Distributions - Trend 2007-2018

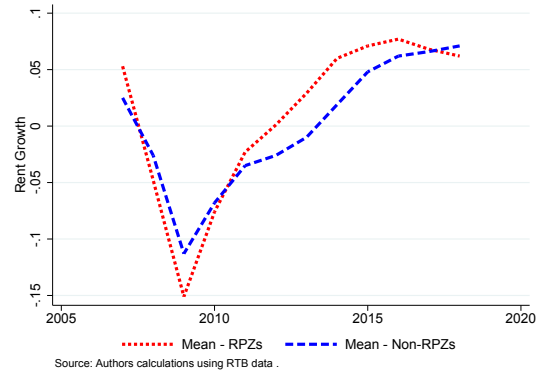


The first objective of this paper is to explore the impact of rent price regulation on the rental inflation rate. To set up this analysis, comparing price trends in the treated and control areas can provide important preliminary evidence as to how such rules impacted the market. To provide more granular insight into price developments and their interaction with the introduction of rent controls, in Figure 3 we present the mean and median rental growth rate for areas classified since 2016 as rent pressure zones and the non-classified areas.

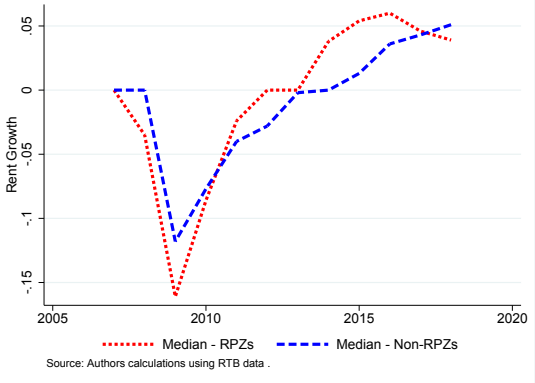
Figure 3 A presents the mean growth rates while Figure 3 B presents the median growth rates. The relative trend in the means appear to be similar across both RPZ and non-RPZ areas, up until 2016 when the regulations came into force. This includes a similar period of deflation and recovery. The recovery appears to be somewhat stronger in the RPZ areas which, to date, mainly cover the urban centres and commuting towns. Given the structure of the Irish economy, with rapidly growing urban economic activity, this is unsurprising. Since 2016, price inflation has moderated in the RPZ areas but continued to rise elsewhere. A similar picture emerges in the median inflation rate. These data appear to suggest a common path between the two areas, albeit with different levels of inflation. This common path breaks down at the same time as rent pressure zones were introduced suggesting a correlation between the rent controls and changing price dynamics. We formally test these dynamics in the next section.

Figure 3: Growth Rate Trends in Treatment and Control Areas

(a) Figure 3 A: Mean Comparison



(b) Figure 3 B: Median Comparison



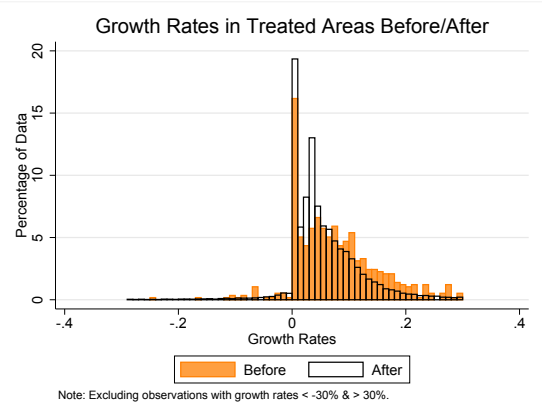
A second objective of this paper is to consider the impact of rent controls on the degree of nominal rigidity in rental prices, and in order to do so, we turn our attention to the price distribution. In this context, we define nominal rigidity as contracts where there is no change in the annualised rent as in previous studies. To illustrate the change in the rental price distribution before and after the introduction of RPZ legislation, Figure 4 presents the percentage of contracts across the price distribution for each 1 per cent of the growth distribution. We have censored the data at growth rates plus or minus 30 per cent for illustration. The time period presented is from Q2 2015 - Q3 2018 which is split into the periods before and after the introduction of rent controls. The classification is time varying so that, within the period Q2 2015 - Q3 2018, each observation is classified into the RPZ group at the point when each area was designated as an RPZ. Both the treated (RPZ) and non-treated (non-RPZ) areas are presented separately thus highlighting the temporal variation within each area. Figure 4 suggests that even before the introduction of the RPZ legislation, a high degree of nominal rigidity existed in the data with approximately 15 per cent of RPZ areas not changing their rental levels and 30 per cent in the non-RPZ areas. After the introduction of rent controls, the share of nominal rigidity rose in RPZ areas to just under 20 per cent with no discernible change in the non-RPZ areas. Of note also is the bunching at 4 per cent in the RPZ areas after the introduction of rent controls. This is the legislative allowable increase for contracts in these areas. Given the data, it could be the case that the 4 per cent is acting as an anchor effect which reinforces the point that the parameterisation matters: growth rates are drawn to this point. These patterns are not evident in the control areas. It is also noteworthy that the share of growth rates between 0 and 4 have increased after the legislation was introduced. As the Irish regulations are first generation rent controls, in the sense that no reset is allowed between tenants[3], this may have increased the share of landlords increasing rents to ensure they maintain real

[3]First generation rent controls refer to a situation where the property is covered by the regulations and even if a tenant changes, rent increases are linked to the previous rent. Second generation controls relate to the protection of the tenant from rent increases. These allow increases to market rates if the tenant changes.

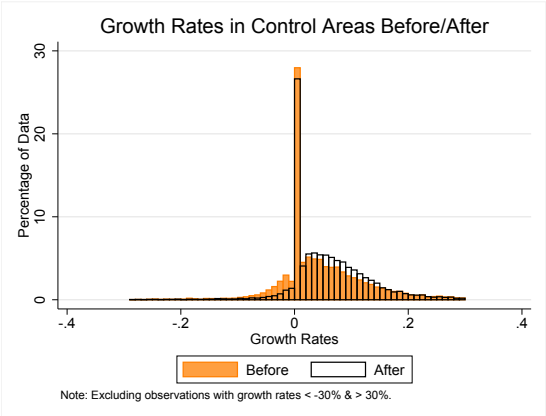
returns (setting the price growth as high above inflation as possible).

Figure 4: Growth Rate Distributions - Before and After RPZs

(a) Treated Group



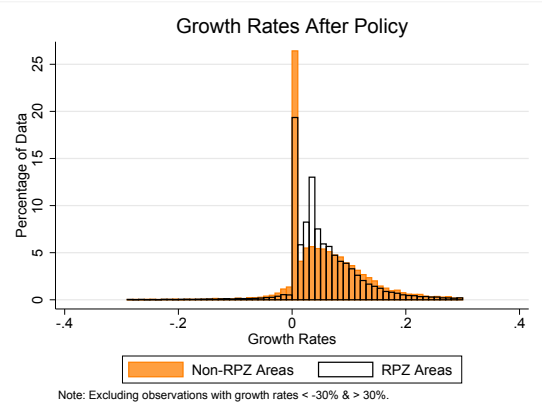
(b) Control Group



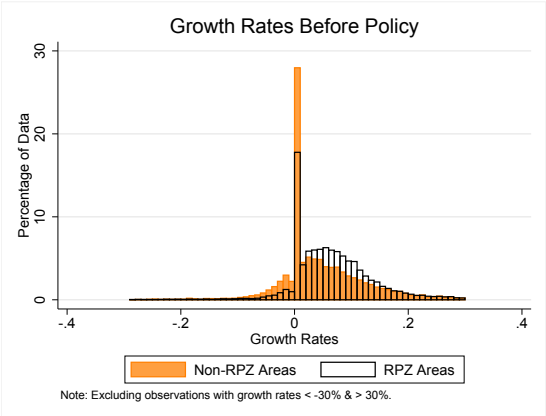
A final comparison that we present is the cross sectional variation for the two areas for each time point. Figure 5 presents the distribution for RPZ and non-RPZ areas separately. Before the treatment, the degree of nominal rigidity was higher in the non-RPZ areas and there were fewer incidences of rental growth at the high end of the distribution. However, in the post-treatment period there are now more high growth rents in the non-treated areas. We can again see the increase in rents in and around 4 per cent that was documented previously.

Figure 5: Growth Rate Distributions - Treatment and Control LEAs

(a) After 2017



(b) Before 2017



Figures 4 and 5 presented in this sub-section suggest that the introduction of rent controls in Ireland had different effects across the price distribution and potentially on the degree of nominal rigidity. We formally examine these patterns in the following sections.

4 How do Rent Controls Impact Inflation Rates?

We begin our empirical examination of the impact of rent controls on price inflation by exploring the direct effect of the treatment on the growth rate in the areas of Ireland that were declared RPZs. We first outline our identification strategy then present the results of our overall estimates and then subsequently undertake some estimates across the distribution of rental growth.

4.1 Identification Strategy

To identify the effects of rent controls on the level of rental inflation across the growth distribution, we test two different hypotheses. Our first *a priori* expectation is that the inflation rate should fall after the introduction of the rules. This is captured by the following hypothesis:

H1: The inflation rate will be lower in the designated areas after the introduction of the regulations.

To test this hypothesis, we use a standard difference-in-difference fixed effects model to test for the average treatment effect on the treated i.e. the change in the inflation rate following the introduction of rent controls. The specification is as follows;

$$\Delta R_{ijt} = \alpha + \beta RPZ_{jt} + \gamma LEA_j + \tau_t + \mathbf{x}'_{ijt}\delta + \epsilon_{ijt} \tag{2}$$

where ΔR_{ijt} is the annualised change in the rent of property i in time t in local electoral area j. This is determined as a function of an RPZ dummy, which is a time and LEA varying binary indicator which is 1 if an area has been classified as an RPZ and zero in other time periods. To saturate out the time varying effects and the area specific effects, we then include LEA level fixed effects, (LEA_j), and time fixed effects (τ_t).[4] Time fixed effects include month dummies and year dummies. We then include a vector of property-level control variables in a similar vein to a hedonic regression to standardise the growth rates across property types. The variables included in this vector are: the number of bedrooms, the number of tenants, the tenancy length, and the housing type (apartment, detached house, semi-detached house, terrace, other). As the dependent variable is a compound annual average growth rate, the periods across which the growth rates are potentially different. We therefore include three variables to capture the time gap between the observations in the panel. We include the log and level of the time gap and the time gap squared as control variables.[5] Given our specification, we would therefore expect that $\beta < 0$ and is statistically significant

[4] We also run additional specifications which include a property-level fixed effect and the results are identical to those with the higher level fixed effects. Results are available on request from the authors.

[5] The results are not sensitive to the functional form or the set of controls included for the time gap. Other specifications can be provided as requested from the authors.

The Irish rent control regulation limits annualised rent increases to 4 per cent, however there are several reasons as to why rent in certain properties might still be growing above the limit. First, the regulation allows a number of specific exemptions from the rent cap, as discussed previously, and landlords are allowed to raise prices on a pro-rata basis. Second, it is possible that non-compliance might be eroding rent inflation reductions enforced by the RPZs declaration. The property level dataset used in this analysis allows us to calculate the share of tenancy agreements with more than 4 per cent annual rent growth, and therefore provide insights into how many agreements are transacting in, around or above the 4 per cent legal threshold.

Our second *a priori* expectation is that the set up of the regulations should reduce the share of growth rates over 4 per cent:

H2: Share of properties with a growth rate above 4 per cent will decline

This hypothesis provides a direct test of how effective the regulations have been in meeting their central objective of reducing growth rates above the 4 per cent cap. To test this proposition, we define an indicator variable which takes the value of 1 if $\Delta R_{ijt} > 4\%$ and 0 otherwise. This variable is regressed as a function of the RPZ dummy as previously defined, LEA fixed effects, time fixed effects and the control vector:

$$Pr\left(\Delta R_{ijt} > 4\%\right) = f\left(\alpha + \beta RPZ_{jt} + \gamma LEA_j + \tau_t + \mathbf{x}'_{ijt}\delta\right) \tag{3}$$

Again, we would expect that $\beta < 0$.[6]

4.2 Testing for Average Effects

In this sub-section we empirically test H1. For this purpose, we estimated a series of rental growth regressions to determine the impact of the introduction of rent controls on the average rental growth rate, as presented in equation (4). We include the main RPZ_{jt} indicator which varies by LEA and time, picking up the changing classification over time of the different areas. We saturate the specifications with year, month and LEA fixed effects as well as time gap controls. These controls ensure that the common trends over time as well as the LEA specific time invariant heterogeneity is removed thus allowing the RPZ coefficient to pick up the average effect of RPZ status on the areas after classification. We also include variables capturing the duration of the tenancy, the number of tenants, the number of rooms in the property, the type of housing (with apartment being the omitted group) and a control for whether the lease was a new or renewal agreement. These variables should capture variation in the growth rates across different property types.

A standard challenge in impact studies such as these is determining the time window to be used before and after the policy. The measures in Ireland were introduced in late December 2016 and in effect began to operationally impact the Irish market from January

[6] As would be the marginal effect if a non-linear model is used in estimation.

2017 onwards. Taking the time period following the onset of the regulations for which we have data, this leaves a window of 7 quarters between Q1 2017 and Q3 2018. Our main comparison that we undertake is to use a symmetric time window thus 7 quarters before and after the policy intervention, Q2 2015-Q3 2018. However, to ensure that our estimates are not affected by the selection of the time window we also expand our analysis to cover the period Q1 2010 to Q3 2018 as a check. Another consideration is that the legislation in Ireland only applies to those properties which have a rent history for the past 24 months. We therefore limit our sample into two groups: the first are all properties and the second are those properties for which we have data to estimate a growth rate within the past two years. The latter should be more affected by the regulations. The results are presented in Table 2. In columns (1) and (2) we present the estimates for the full sample for the broad and short time windows. In columns (3) and (4) we present the estimates for the restricted sample where the properties were re-leased within a 24 month window.

Table 2: Testing for Average Effects

	(1)	(2)	(3)	(4)
$Tenants_{ijt}$	0.004***	0.002***	0.005***	0.003*
	(0.000)	(0.000)	(0.001)	(0.001)
$TenancyLength_{ijt}$	-0.000^{+}	-0.000*	-0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
$NoofRooms_{ijt}$	0.000	-0.001	-0.001*	-0.003
	(0.000)	(0.001)	(0.001)	(0.002)
$PT : Det_{ijt}$	-0.001	-0.005**	0.004*	0.004
	(0.001)	(0.002)	(0.002)	(0.004)
$PT : SemiDet_{ijt}$	-0.001	-0.002	0.004***	0.009*
	(0.001)	(0.002)	(0.001)	(0.004)
$PT : Terrace_{ijt}$	-0.002**	-0.003*	0.002*	0.006^{+}
	(0.001)	(0.001)	(0.001)	(0.003)
$PT : Other_{ijt}$	-0.000	0.001	0.002	0.004
	(0.002)	(0.002)	(0.002)	(0.004)
RPZ_{jt}	-0.026***	-0.019***	-0.043***	-0.029***
	(0.002)	(0.002)	(0.005)	(0.005)
Observations	362,391	149,884	169,704	52,296
From	Q1 2010	Q2 2015	Q1 2010	Q2 2015
To	Q3 2018	Q3 2018	Q3 2018	Q3 2018
Sample	All	All	<=24month	<=24month
LEA FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Time Gap Controls	Yes	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In all four specifications, the RPZ dummy is negative and significant at the 0.1 per cent level. These results indicate a statistically significant reduction in rent inflation after the introduction of the regulations. The magnitude of the effect varies across the specifications. In the shorter time window, the coefficient is circa -2 percentage points for the larger sample and -3 percentage points for the 24 month window sample. The wider time widow coefficients indicate effects of -2.6 and -4.3 percentage points respectively.

A critical question in terms of understanding the economic magnitude of these findings is to explore how large these estimates are given the prevailing inflation rates in the market prior to the onset of the regulations. Given that the regulations were introduced as a reaction to high rental inflation in the period 2015 and 2016, we consider the impact

for this time period. The results of simple calculations are presented in Table 3. The average inflation rate for all properties from Q2 2015 to the onset of the regulations in each LEA was approximately 7 per cent. The estimate coefficient of -0.02 suggest a 28 per cent reduction in the inflation rate from 7 per cent to approximately 5 per cent. The equivalent figures for this time period using the 24 month window sample are 10 per cent with a coefficient of -0.03 indicating again a 28 per cent moderation in the inflation rate. Both of these effects suggest a material reduction in the inflation rate following the introduction of rent controls.

Table 3: Impacts on Inflation Rate, Q3 2015-classification

	(1) All properties	(2) <= 24 month sample
$Mean\Delta R_{ijt}$	7%	10%
β	-2%	-3%
Effect = $\frac{\beta}{Mean\Delta R_{ijt}}$	-28%	-28%

4.3 Testing the Impact of Equilibrium Convergence

One issue that could be confounding our identification strategy relates to the fact that the specific areas where the regulations were introduced were set as rent pressure zones specifically due to the level of rents being high in these areas. In these areas, the rate of growth may have been slowing before the regulations solely due to the fact that in these markets the growth rates were converging to their local equilibrium (having potentially grown rapidly in the period prior to the introduction to the regulations). While an ideal way to control for this would be to find some source of exogenous variation which would allow us to purge the estimates of these biases, we have not been able to find such variation in our data. As an alternative, we run a range of robustness checks. First, we simply control for the level of rent (in lagged form) to test whether the effect of the RPZ dummy is dependent on the initial level of the rent. Second, we introduce a disequilibrium term into the rental growth regression which allows each specific rental growth price to be a function of how far the initial average is from the market average. The specification is as follows:

$$\Delta R_{ijt} = \alpha + \beta RPZ_{jt} + \gamma LEA_j + \tau_t + \mathbf{x}'_{ijt}\delta + \omega \left[R_{ijt-1} - \bar{R_{jt-1}}\right] + \epsilon_{ijt} \tag{4}$$

where R_{ijt-1} is the level of the rental contract i in LEA j in period t-1 and $\bar{R_{jt-1}}$ is the average inflation rate in LEA j in period t-1. Given our panel data are unbalanced, the lagged figure refers to the previous period in which that rental property is observed. The number of observations falls in this case. The parameter ω should capture the degree to which each rental growth rate is converging at a slower or faster rate due to how much it deviates from the local market conditions. For brevity, we run this specification for only the limited sample as in column (4) of table 3 which also ensure the lagged controls are within 24 months of the dependent variable. The results are presented in table **??**. Column

(1) reproduces the estimate without controls for comparison purposes. Columns (2) and (3) include the new proposed controls. It is clear across all the specifications that the main RPZ effect is negative, statistically significant and similar in magnitude regardless of the control. We are therefore reasonably confident that the findings are not affected by this specific source of potential bias. We therefore proceed without these controls for the rest of the analysis.[7]

Table 4: Controlling for Disequilibrium Effects

	(1)	(2)	(3)
RPZ_{jt}	-0.029***	-0.029***	-0.029***
	(0.003)	(0.003)	(0.003)
R_{ijt-1}		-0.161***	
		(0.004)	
$\left[R_{ijt-1} - \bar{R_{jt-1}}\right]$			-0.162***
			(0.004)
Observations	52296	39294	39294

Standard errors in parentheses

Property type controls and fixed effects included.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.4 Exploring Growth Rates Above 4%

The previous section documents a fall in the inflation rate following the introduction of the rent controls. Given the parameterisation of the regulations, this effect is likely to be driven by a reduction in the share of growth rates above the allowable 4 per cent increase in rents, as was proposed in H2. However, given the possibility for landlords to use exemptions or due to non-compliance, there are still cases where rental inflation above 4 per cent is allowable thus the actual impact is an empirical question. To test these dynamics, we estimate a linear probability model with the dependent variable set as 1 if the property level growth rate was greater than 4 per cent. We estimate the model for the four samples presented in Table 2, using differing time frames and lease change lengths. The estimates are presented in Table 5 in columns (1) through (4).

[7]Estimates including these data are available from the authors on request.

Table 5: Growth Rates Above 4 Per Cent, Linear Probability Model Estimates

	(1)	(2)	(3)	(4)
$Tenants_{ijt}$	0.012***	0.010***	0.011***	0.007**
	(0.001)	(0.002)	(0.002)	(0.003)
$TenancyLength_{ijt}$	-0.001***	-0.001***	-0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$NoofRooms_{ijt}$	-0.001	-0.006**	-0.007***	-0.017***
	(0.001)	(0.002)	(0.002)	(0.003)
$PT : Det_{ijt}$	-0.032***	-0.089***	-0.003	-0.048***
	(0.004)	(0.006)	(0.006)	(0.011)
$PT : SemiDet_{ijt}$	-0.027***	-0.066***	0.004	-0.014*
	(0.002)	(0.004)	(0.004)	(0.006)
$PT : Terrace_{ijt}$	-0.028***	-0.060***	-0.003	-0.024***
	(0.002)	(0.004)	(0.004)	(0.006)
$PT : Other_{ijt}$	-0.028***	-0.037***	-0.023***	-0.038***
	(0.004)	(0.006)	(0.005)	(0.010)
RPZ_{jt}	-0.150***	-0.164***	-0.267***	-0.229***
	(0.004)	(0.005)	(0.007)	(0.008)
Observations	362,391	149,884	169,704	52,296
From	Q1 2010	Q2 2015	Q1 2010	Q2 2015
To	Q3 2018	Q3 2018	Q3 2018	Q3 2018
Sample	All	All	<=24month	<=24month
LEA FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Time Gap Controls	Yes	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Across all specifications, the share of properties with growth rates above 4 per cent fell dramatically. Focusing on the findings in columns (2) and (4) covering the short time widow, we find that for all properties the impact is a 16 per cent reduction in the probability of having a rental growth rate above 4 per cent. The figure for the 24 month sample, the more appropriate comparison from a regulatory compliance perspective, is 22 per cent. Across all estimates, the coefficients are statistically significant at the 0. 1 per cent level. These findings indicate a strong impact of the regulations on the share of properties whose rent is growing at above 4 per cent. In relation to the other covariates, the findings suggest that the probability of having rental growth rates above 4 per cent is increasing with the number of tenants, decreasing with the number of bedrooms and

higher for apartments (the omitted group) than for other property types. The latter finding likely reflects the strong excess demand pressures in urban areas where the majority of apartment housing stock is located in Ireland.

4.5 So where did all the high growth rates go?

It is clear from the preceding sections that the rate of overall rental inflation moderated in the Irish market, driven by a reduction in growth rates above 4 per cent, following the introduction of tenancy rent controls. However, to understand the impact of the policies on the distribution of rental prices it is noteworthy to explore what price growth did landlords set after the policies, as it is not clear from Figure 4(a) that they all reduced to exactly the regulatory allowable maximum. Indeed, landlords price setting behaviour is likely to be affected by a number of factors such as profit maximising behaviour in maximise real returns (price growth above inflation), the probability of tenant turnover given the price increase and the ability to recoup the cost of turnover. Given the Irish regulations, and the fact that rents cannot be reset between tenancies except by the allowable 4 per cent per annum, the cost of tenant turnover becomes more difficult to recoup.

Within these parameters, landlords have the following pricing options after the regulations: 1) reduce rents; 2) leave rents unchanged; 3) increase rents by less than 4 per cent; or 4) increase rents by 4 per cent. To explore, which of these pricing points were chosen by landlords, we conduct an analysis where we separate out the rental growth distribution into 5 segments as defined by variable Y(R) in Table 6.

Table 6: Spliting the rental distribution

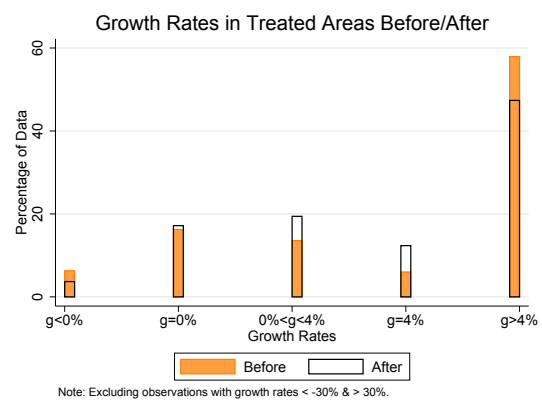
Y(R)	Rental Change Group
1	$\Delta R_{ijt} < 0$
2	$\Delta R_{ijt} = 0$
3	$0 < \Delta R_{ijt} < 4$
4	$\Delta R_{ijt} = 4$
5	$\Delta R_{ijt} > 4$

Splitting the distribution in this manner allows us to consider the rental changes in a multinomial sense. In other words, we can test the relative probability of a landlord choosing to price in other parts of the distribution, relative to the base case of above 4 per cent. The shares of growth rates split into these categories are presented in Figure 6 for the period Q2 2015 - Q3 2018, split out before and after the policies for the treatment and control groups. Focusing on the treated area, it is clear that there was a reduction in the share of growth rates above 4 per cent. This group is not eliminated completely as the regulations contain allowable exemptions for properties not previously rented or which underwent substantial renovation. There will also be some growth rate above 4 per cent if landlords did not increase the rent in the previous year as they are allowed accumulate

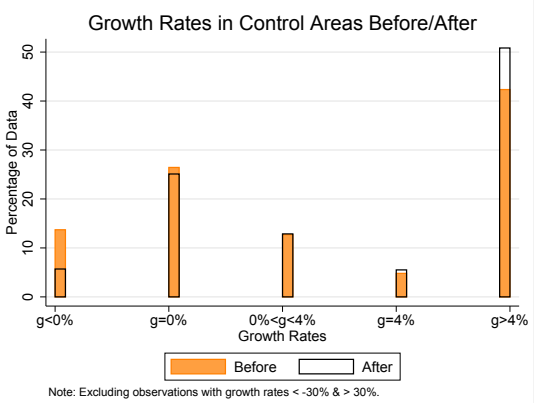
on a pro-rata basis. The fall in the share above 4 per cent is concurrent with a rise in growth rates at 0, between 0 and 4 and at 4 per cent suggesting that landlords have priced differently across the distribution due to the regulations being introduced.

Figure 6: Growth Rate Distributions - Treatment and Control LEAs

(a) Treated



(b) Control



4.5.1 A multinomial logit model across the distribution

To explore where across the price distribution landlords decided to set prices after the regulations, we use a multinomial logit model to explore the relative probability of pricing in each of the buckets as compared the above 4 per cent (our base category). Using a multinomial logit allows us to estimate relative risk ratios which provide the odds of any category relative to a base, and can be depicted in the following identity considering the relative probabilities as:

$$p_{ij} = \frac{exp(x_i\beta_j)}{\sum_{l=1}^{m} exp(x_i\beta_l)} .....j = 1, .., m. \tag{5}$$

where x_i are case specific regressors of which their are M cases. The model ensures that the sum of the probabilities across m cases is equal to 1, $\sum_{l=1}^{m} p_{ij} = 1$. The model is identified by setting a base case with 0 as parameters and each other category is compared to this case. In our model the explanatory variables will, as before, be:

$$\beta RPZ_{jt} + \gamma LEA_j + \tau_t + controls \tag{6}$$

where the controls are the time gap and hedonic regressors previously outlined.

The results are presented in Table 7. Two specifications are presented covering the period Q2 2015 - Q3 2018; the first includes all properties and the second only includes those properties whose we observe twice within a 24 month period. The latter are those who would certainly have a rent history and be in scope of the regulations. In each case, we present only the coefficient of the difference-in-difference interaction effect, RPZ_{jt}. All specifications include fixed effects for LEA, month and year as well as the time gap and

hedonic controls discussed earlier.[8] In column (1), all relative risk ratios are statistically significant at the 0.01 per cent level and positive. This suggests that landlords were more likely to price in all other points of the distribution relative to above 4 per cent after the regulations. While it is unsurprising that landlords are more likely to set prices at 4 per cent, it is somewhat surprising to see landlords are more likely to set 0 growth or lower rents relative to the above 4 per cent. Looking at column (2) which the relative odds of the growth rate being set at 4 per cent are seven times greater than above 4 per cent after the regulations. However, with a relative risk ratio of 1.87 (1.64) suggesting the odds are 86 per cent higher for this category than the above 4 per cent after the regulations. The findings from this section are clear: faced with a common, market-wide regulatory maximum, landlords react heterogeneously and set prices at different points across the distribution.

Table 7: Where have the high growth rates gone? MNL Relative Risk Ratios

All Relative Risk Ratios from Variable RPZ_{jt}

	(1)	(2)
$\Delta R_{ijt} < 0$	2.106***	1.644***
	(0.096)	(0.125)
$\Delta R_{ijt} = 0$	1.671***	1.876***
	(0.046)	(0.088)
$0 < \Delta R_{ijt} < 4$	2.133***	4.219***
	(0.068)	(0.343)
$\Delta R_{ijt} = 4$	2.475***	7.038***
	(0.108)	(0.611)
$\Delta R_{ijt} > 4$	Base	Base
	(.)	(.)
Observations	149,884	52,296
From	Q2 2015	Q2 2015
To	Q3 2018	Q3 2018
Sample	All	$<= 24 Months$
LEA FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
Time Gap Controls	Yes	Yes
Hedonic Controls	Yes	Yes

Exponentiated coefficients; Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[8] Results for these variables are available on request.

5 Rent Controls and the Degree of Nominal Rigidity

Having explored the effect of rent controls on price inflation in the Irish private rental sector, we now examine the degree to which rent controls impact nominal price rigidity in rental housing. The above section showed that some landlords were more likely to leave prices unchanged relative to having high growth rates after the regulations which suggests changed dynamics in relation to nominal rigidities. Given the multinomial estimates are relative probabilities, they do not however tell us whether there was a statistically significant change in the overall share of nominally rigid rents after the regulations. This overall level is of critical importance to market dynamics as well as the functioning of monetary policy.

5.1 Did Nominal Rigidity Change?

The impact of rent controls on the degree of price stickiness are potentially ambiguous from a theoretical point of view. Landlords' behaviour will depend on aspects such as the degree of excess demand or supply in the market, the parameters of the regulations or any exemptions that are allowable. The Irish regulations can be considered first generation rent controls, because they do not allow a reset of rent amounts between tenants (i.e. rents charged to new tenants must also comply with the 4 per cent growth cap). Given this feature, and the fact that the allowable increase in real terms is under 3 per cent[9], it may incentivise landlords who previously did not change rents to build in price increases to ensure the real return remains intact over time. Therefore it may reduce the share of nominal rigidity as landlords build in small but legal increases. Alternatively, landlords may choose not to increase rents, as the costs of tenant turnover (a key determinant of nominal ridigity as shown by Aysoy et al. (2014)) are not recoupable and therefore the risk of tenant exit is not compensated by the marginal increases. This leads to the specification of two alternative hypotheses that can be tested empirically:

H3a: Nominal rigidity declines after rent controls as landlords protect real returns by increasing rent to the regulatory limit allowed.

H3b: Nominal rigidity increases after rent controls as the cost of tenant turnover is not recoupable.

To test these hypotheses, we first explore changes in the share of zero growth rents before and after rent control implementation. Unchanged rents are assumed to be a proxy for increased nominal rigidity (i.e. if the share of unchanged contracts increases, nominal rigidity increased). We specify the following empirical model:

[9] At the time of writing the Irish CPI was increasing on an annual basis by 1.1 per cent, leaving the annual real allowable return at 2.9 per cent. See www.cso.ie for details.

$$Pr\left(\Delta R_{ijt} = 0\%\right) = f\left(\alpha + \beta RPZ_{jt} + \gamma LEA_j + \tau_{\mathbf{t}} + \mathbf{\Omega X_{ijt}}\right) \tag{7}$$

Where the dependent variable is a binary indicator which takes the value of 1 if the rental growth was zero on an annualised basis and zero otherwise (Shimizu et al. 2010). This variable is regressed on the RPZ dummy, LEA and time fixed effects, and the vector of property type, tenants and lease duration controls described in the previous section. The coefficient on the RPZ dummy will provide insight into whether nominal rigidity increased following the introduction of rent controls in Ireland. The results of estimating equation (7) by linear probability OLS is presented in Table 8. In column (1), we focus on the broader sample including all properties with the estimates for the narrow group of properties (<=24 months) presented in column (2). We find that the impact of the RPZ status on the probability of nominal rigidity is positive and significant. This means that the share of properties whose rent did not change increased following the introduction of the rental measures. This finding supports H3b, which proposes that nominal rigidity would increase following the intervention. One potential economic reason why this might be the case is that, given the cost of turning over tenants is not recoupable, this lowers the likelihood that a landlord will raise the rent and thus risk a potential tenant exit.

The magnitude of the coefficients suggest that being in a RPZ increases the probability of nominal rigidity by 2.1 or 3.7 percentage points. Given there were approximately 20 per cent of zero growth rents in treated areas before the policy intervention, the economic impact of the policies suggests an increase of about 11-18 percent which is sizeable.

Table 8: Probability of Nominal Rigidity - Marginal Effects

	(1)	(2)
RPZ_{jt}	0.021***	0.037***
	(0.004)	(0.007)
Observations	149,884	52,296
From	Q2 2015	Q2 2015
To	Q3 2018	Q3 2018
Sample	All	$<= 24 Months$
LEA FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
Time Gap Controls	Yes	Yes
Hedonic Controls	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 A Multinomial Approach and Changes to Nominal Rigidity

While we find that nominal rigidity went up after the introduction of the regulations, given heterogeneous responses to the regulations by landlords facing varying incentives, it could be the case that both H3a and H3b above are occurring. This situation would arise if some landlords are moving from no change in rents to small increases to protect real returns, while others are keeping rents static to reduce the cost of tenant loss. In this regard, Figure 5 showed that the share of landlords increasing rents by above 4 per cent fell and Section 4.5 suggested they were pricing right across the distribution.

To test the potential concurrence of both channels in more detail, we draw on the multinomial logit approach previously outlined. For this section, our approach is identical except that we set the base category to that of no change in rents (nominal rigidity) and compare each of the other categories to this base. In terms of coefficient interpretation, again, we present the exponentiated coefficients which can be interpreted as relative risk ratios (i.e. values of greater than one indicate a higher likelihood of being in a category than the base case and values lower than one indicate a lower risk). In terms of covariates, we include the full set of controls as per equation (4). This includes the LEA dummies, the time dummies and the critical RPZ indicator varying by LEA and time.

The multinomial logit estimates are presented in Table 9. Since our focus is on comparing the relative probabilities between groups before and after the treatment, Table 9 displays the estimated relative risk ratios for the RPZ difference-in-difference parameter only. Our findings are interpreted as the relative difference in the odds of being in a comparison group relative to the base group. Values less than one indicate a lower odds of being in the comparison group whereas values above one indicate a higher risk of being in the comparison group. Two specifications are presented for all properties and those within 24 months, as before.

Table 9: Multinomial Logit Model Estimates - Relative Risk Ratios

All Relative Risk Ratios from Variable RPZ_{jt}

	(1)	(2)
$\Delta R_{ijt} < 0$	1.260***	0.876
	(0.061)	(0.071)
$\Delta R_{ijt} = 0$	1.000	1.000
	(.)	(.)
$0 < \Delta R_{ijt} < 4$	1.276***	2.249***
	(0.046)	(0.199)
$\Delta R_{ijt} = 4$	1.481***	3.751***
	(0.070)	(0.351)
$\Delta R_{ijt} > 4$	0.598***	0.533***
	(0.017)	(0.025)
Observations	149,884	52,296
From	Q2 2015	Q2 2015
To	Q3 2018	Q3 2018
Sample	All	$<= 24 Months$
LEA FE	Yes	Yes
Month FE	Yes	Yes
Year FE	Yes	Yes
Time Gap Controls	Yes	Yes
Hedonic Controls	Yes	Yes

Exponentiated coefficients; Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We focus on the relative risk ratio for $\Delta R_{ijt} < 0$ which compares the likelihood of rents remaining constant relative to rents falling. For the RPZ dummy the relative risk ratio is greater than one in the broader specification and less than one, but statistically insignificant, in the second. As column (1) contains properties that are outside of the scope of the regulations, it is likely the estimates in column (2) are a more accurate measure of the effects. This suggests no statistical difference between the likelihood of having a reduction in rents relative to nominal rigidity after rent controls were introduced.

Focusing on the relative risk ratio for $0 < \Delta R_{ijt} < 4$, this statistic compares the probability of having a rent rise of just below 4 per cent relative to rents remaining constant in nominal terms. In this case the RPZ dummy is positive and statistically significant at the 0.1 per cent level. This suggests that after rent controls were introduced, rents were more likely to rise at rates below 4 per cent, relative to remaining unchanged in nominal terms. The coefficient magnitude indicates the relative risk as nearly 2.5 times higher after treatment (for the narrower specification). This finding is mirrored in estimates presented one row below which compares the relative risk of nominal rigidity versus an increase of 4

per cent, the maximum allowable under the rent restrictions. Again, in this specification the RPZ dummy is statistically significant and positive. The magnitude indicates that rents were 3.75 times more likely to increase at 4 per cent relative to being unchanged after the policy implementation. These two findings suggest that rent growth restrictions have had an inflationary effect, and have increased the likelihood that rents would rise at or below 4 per cent relative to remain unchanged post-treatment.

The final set of estimates displayed present the relative risk of a rent increase of above 4 per cent relative to no change. The coefficient is statistically significant at the 0.1 per cent level and is lower than one. With a relative risk ratio of 0.53, this suggests that rents are nearly twice as likely to remain unchanged relative to increasing at above 4 per cent after the regulations. This estimate is in line with our previous finding that the share of contracts with growth rates above 4 per cent decreased. This evidence suggests that at least some of these agreements that were growing at above 4 per cent annually correspond to cases where the rents stayed unchanged after rent controls were implemented.

Overall, the multinomial logit estimates present an interesting picture of the impacts of rent controls across the price distribution relative to nominal rigid prices. They indicate that, in line with estimates in Section 4.4, the share of high inflation rents above 4 per cent decreased post-implementation of rent controls, with unchanged rental agreements being more likely. This indicates an increase in the share of nominal rigidity at this region of the rent growth distribution. However, the estimates also show that, although the share of nominally rigid agreements (i.e. zero growth) increased post-implementation, the regulations have increased the share of contracts with inflation at or below the regulatory limit relative to no change. This may indicate that some landlords are more likely to increase, relative to leaving them unchanged, in an effort to protect the real value of contracts. This can be driven by their inability to reset rents outside the regulations in future. While the overall effect of the policies has been to reduce rent growth, they have also led to some inflationary pressure up to the regulatory maximum, which is consistent with a protection of real returns.

5.3 Exploring Heterogeneous Effects by Landlord Type and Initial Rent

Findings in previous sections point towards heterogeneous effects across different landlords, depending on their circumstances and the supply, demand dynamics in their local market and with their tenant. To provide a more detailed insight into the behaviour of landlords, we exploit the rich micro dataset to gain a better understanding of which landlords may react differently. Two characteristics that we exploit are 1) whether the landlord is a company or an individual household, and 2) the level of the initial rent prior to the regulations being introduced.

5.3.1 Do the Effects Differ by Landlord Type?

We begin our assessment of the heterogeneous effects by looking at the type of landlord. Our data provides information on whether the landlord is a company or an individual.[10] We use these data to test whether the impact on nominal rigidity, using the simple probability model and multinomial logit approach, differ for landlords relative to companies. In our data, as outlined in Table 10, approximately 13 per cent of the observations are accounted for by landlords (in Appendix B we present the data for the treatment and control groups separately).

Table 10: Data Split: Companies and Individual Households

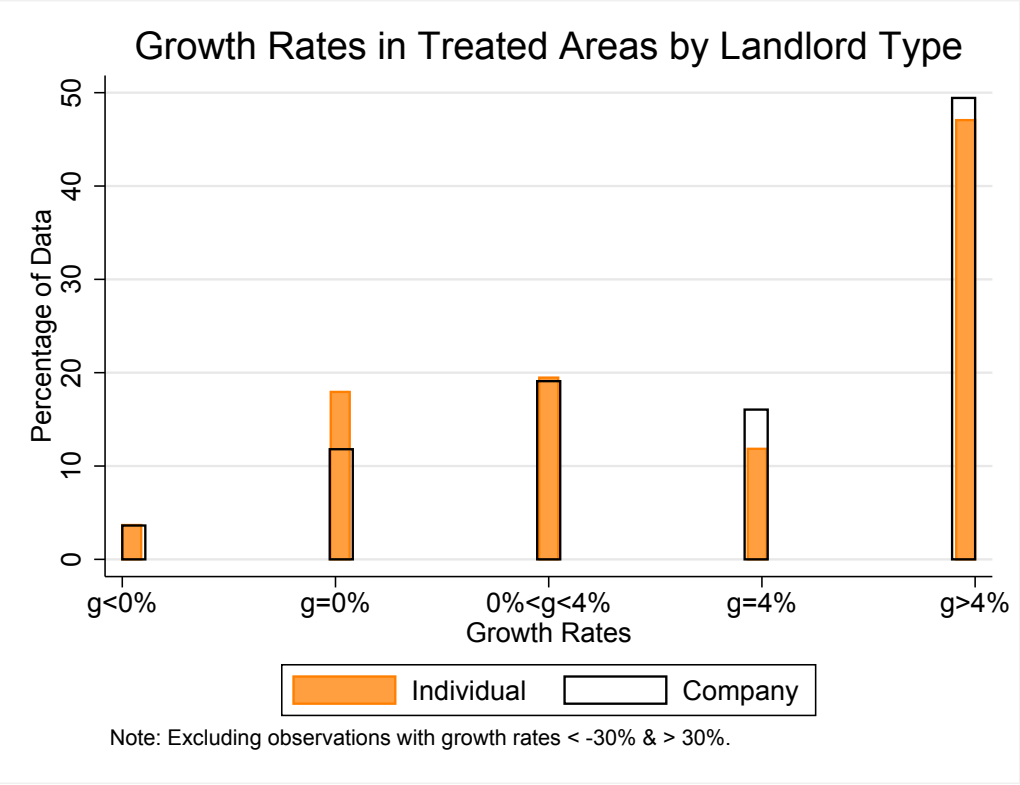
Landlord Type	Freq.	Percent	Cum.
Individual	45,400	87.39	87.39
Company	6,551	12.61	100.00
Total	51,951	100.00	

Note: Time period is Q2 2015-Q3 2018.

There are a number of reasons to think that companies might react differently. First, if the landlord is a private individual, they may be managing only a single (or at least limited) number of housing units. Therefore, it is more costly for them to carry the cost of changing tenants. They may also be have a lower level of financial knowledge and not be as well placed to make optimal financial decisions as compared to a professional company who are likely to have trained finance staff. Given this intuition, our *a priori* hypothesis is that companies are less likely to keep prices nominally rigid after the regulations, and more likely to price at the regulatory maximum as compared to individuals. Individuals may also have built up a personal relationship with the tenant and this may affect their pricing decisions.

[10] When registering with the RTB, the landlord is required to provide either a company registration number if they are a commercial operation or a personal household social security number. We can use these data to split the landlords between commercial companies and individual households.

Figure 7: Growth Rate Distributions - Treatment Areas by Landlord Type



Indeed, the histogram for the five growth categories across companies and individuals after rent controls were implemented provides suggestive evidence of differences. Individual landlords appear to have a higher share of nominal rigidity, while companies appear to have a higher share of growth rates at or above 4 per cent. We therefore explore whether these patterns hold in a difference-in-difference setting. We test the following two hypotheses:

H4a: Nominal rigidity increased more for individual landlords after the regulations.

H4b: Companies are more likely to set growth at the regulatory maximum than individual landlords.

To test these hypotheses, we first re-estimate the probit model outlined in equation 7 including both a dummy for company as well as an interaction effect between the RPZ difference-in-difference parameter and the company dummy. This allows us to identify whether the impact of the regulations differed between companies and individuals. The results are displayed in Table 11. We first present the overall RPZ difference-in-difference parameter and then its interaction with company. Secondly, we present the marginal effect at the mean of RPZ for individuals and companies separately. We find a statistically significant and positive overall effect with a magnitude of 0.04, as before. However, we also find the interaction is negative and significant with a magnitude of 0.03, indicating that while nominal rigidities increased after the regulations, the effect for companies was 3 percentage points lower than the overall effect. In fact looking at the marginal effect

at the means for each group, while individual landlords had a positive 4 percentage point increase in nominal rigidities, there was no statistically significant effect for companies. This suggests the increase in nominal rigidities after the regulations was driven by non-professional landlords, which supports hypothesis H4a.

Table 11: Impact on Nominal Rigidity by Landlord Type

	Coefficients from Interactions
RPZ_{jt}	0.041***
	(0.007)
RPZ_{jt} × Company	-0.030**
	(0.011)
	Marginal Effects for Groups (At Means)
MFX of RPZ_{jt} for:	
Individual	0.041***
	(0.007)
Company	0.011
	(0.011)
Observations	51,950

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We now present the multinomial logit estimates obtained after including the interaction between the difference-in-difference and the company indicator. Again, relative risk ratios are presented in Table 12. The interpretation of the new interaction term included is that it increases or lowers the overall effect captured by the main RPZ dummy (if less than one, the effect is lower, if greater than one, the effect is higher). The estimates indicate that there is no difference for companies and individuals between the nominal rigidity group and falling rents and rental growth between 0 and 4 per cent categories. However, companies are significantly more likely to set growth rates at the regulatory maximum of four per cent. This might be arising from professional investors following cash flow maximisation strategies, and therefore setting maximum rent increases allowed by the regulations where feasible. This finding appears to be in line with hypothesis H4b.

Table 12: Multinomial Logit Model Estimates - Relative Risk Ratios

	(1)
$\Delta R_{ijt} < 0$	
RPZ_{jt}	0.847*
	(0.071)
$RPZ_{jt}\times$ Company	1.241
	(0.181)
$\Delta R_{ijt} = 0$	
RPZ_{jt}	1.000
	(.)
$RPZ_{jt}\times$ Company	1.000
	(.)
$0 < \Delta R_{ijt} < 4$	
RPZ_{jt}	2.332***
	(0.212)
$RPZ_{jt}\times$ Company	0.861
	(0.110)
$\Delta R_{ijt} = 4$	
RPZ_{jt}	3.556***
	(0.341)
$RPZ_{jt}\times$ Company	1.490**
	(0.184)
$\Delta R_{ijt} > 4$	
RPZ_{jt}	0.524***
	(0.025)
$RPZ_{jt}\times$ Company	1.159+
	(0.099)
Observations	51,950
LEA FE	Yes
Month FE	Yes
Year FE	Yes
Time Gap Controls	Yes
Hedonic Controls	Yes

Exponentiated coefficients; Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To summarise, our estimates indicate that differences exist in the reaction to the regulations depending on whether the landlord is a company or an individual. We find that individual landlords are more likely to set prices unchanged after the regulations.

This behaviour might arise from these landlords being less likely to be able to carry tenant turnover costs, having an valued tenancy relationship with the occupier or being less financially sophisticated than a professional company. We also find that companies are more likely to set prices at the regulatory maximum (relative to no-change) which would be in line with professional cash flow management practises.

5.3.2 Did the Initial Rent Level Matter?

The final characteristic that we explore is whether the level of the initial rent matters for the price setting behaviour of landlords after the regulations. Our intuition behind using this split of the data is that some landlords who did not anticipate the regulations may have been setting rents at a below current market rate to keep a good tenant with a view to increase rents sharply when the tenant leaves. Once the regulations came into force, this is no longer an option and such landlords would have to increase by the maximum in an attempt to catch up.[11] In relation to our exploration of nominal rigidity, this suggests that landlords who change rents lower than the average in their area (hedonically controlling for property type) prior to the introduction of the regulations, should be less likely to keep prices nominally rigid and more likely to have higher growth rates at or below 4 per cent relative to those who charged higher rents. This can be summarised in the following hypotheses:

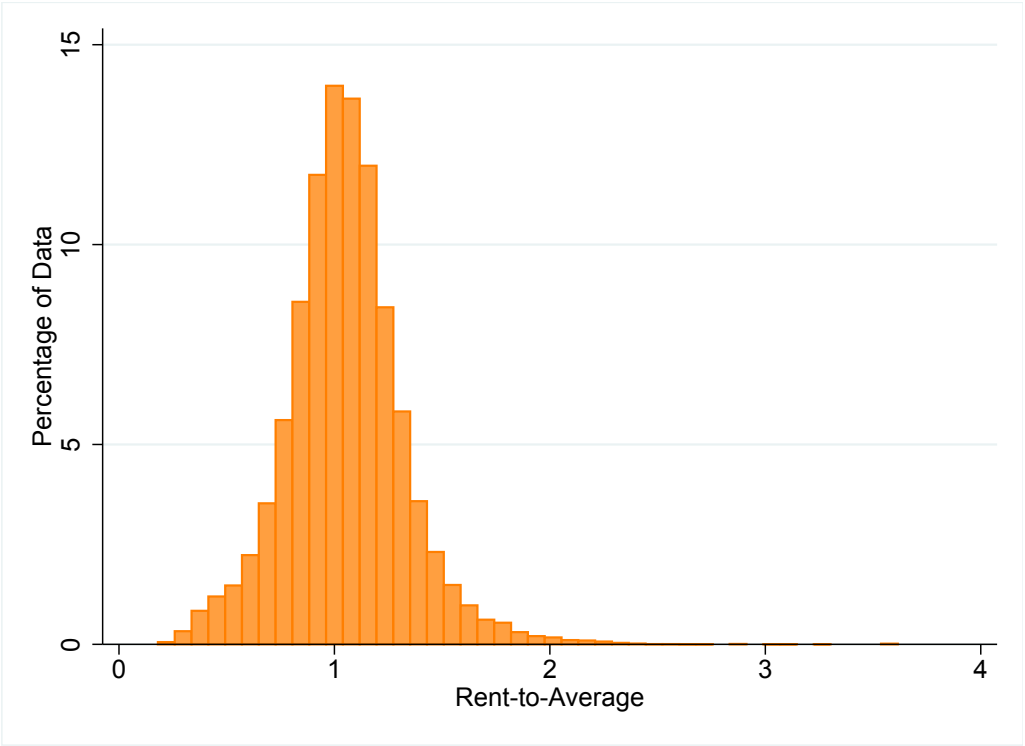
H5a: Nominal rigidity increases more for properties with above average rent levels.

H5b: Below average rental properties are more likely than above average rent properties to set growth at the regulatory maximum.

To test whether this is the case, we exploit the panel nature of our data. For each property, we compute the ratio of the rent in the period closest to (but before) the regulation implementation, and the average rent in the quarter the tenancy commenced in the local electoral area where it is located. A value of 1 for this ratio indicates the property rent equals the average in the local electoral area in that quarter. A histogram of these values is presented in Figure 8, which appears to be normally distributed. Using the values pre-implementation ensures that the ratio is not endogenous to the growth rate, from the perspective of simultaneity bias.

[11] Anecdotal information from the market in Ireland suggested this was a reasonably common phenomenon.

Figure 8: Growth Rate Distributions - Treatment Areas - By Rent Level



We then create a binary indicator which distinguishes rents that are below the average from those at or above the average. We then use this indicator and interact it with our main RPZ dummy. The results of the assessment of nominal rigidity are presented in Table 13. We find that the RPZ implementation effect is negative and significant and that the interaction is positive and significant. This suggests that all the increase in nominal rigidity after the regulations was driven by those landlords who had higher than average rents before the regulations were introduced. We posit that this group was likely to be more satisfied with the higher rent level they charged, whereas those landlords who set rents at lower than the average were more likely forced to increase rents to attempt to bring rents towards the average. The marginal effect would suggest these landlords are actually less likely to keep prices rigid after the regulations.

Table 13: Impact on Nominal Rigidity by Initial Rent Level

	(1)
RPZ_{jt}	-0.039***
	(0.008)
RPZ_{jt} × Above Average	0.121***
	(0.008)
MFX of RPZ_{jt} for:	
Below Average	-0.039***
	(0.008)
Above	0.083***
	(0.007)
Observations	52296

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In Table 14 we estimate the impacts, relative to nominal rigidity, across the price distribution, including again the interaction effect for those landlords who changed rents greater than the average. We find that landlords who charged above average rents were less likely to have positive growth rates across the distribution and more likely to have falling rents after the regulations.

Table 14: Multinomial Logit Model Estimates - Relative Risk Ratios

	(1)
$\Delta R_{ijt} < 0$	
RPZ_{jt}	0.792*
	(0.086)
RPZ_{jt} × Above Average	1.293*
	(0.141)
$\Delta R_{ijt} = 0$	
RPZ_{jt}	Base
	(.)
RPZ_{jt} × Above Average	Base
	(.)
$0 < \Delta R_{ijt} < 4$	
RPZ_{jt}	2.569***
	(0.276)
RPZ_{jt} × Above Average	0.816*
	(0.077)
$\Delta R_{ijt} = 4$	
RPZ_{jt}	4.482***
	(0.500)
RPZ_{jt} × Above Average	0.722***
	(0.066)
$\Delta R_{ijt} > 4$	
RPZ_{jt}	1.145*
	(0.071)
RPZ_{jt} × Above Average	0.290***
	(0.018)
Observations	52,296
LEA FE	Yes
Month FE	Yes
Year FE	Yes
Time Gap Controls	Yes
Hedonic Controls	Yes

Exponentiated coefficients; Standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our findings therefore suggest that the level of the initial rent did matter for landlords' response to the regulations. Those landlords with rents that were below their area's rents in the period before the regulations were less likely to keep growth rates nominally rigid

and also more likely to increase rents just below, at or above the 4 per cent cap. The lower rents may have been driven by good relationships with tenants or inertia with a view to increased rents in the future. However, the regulations are likely to have led to some such landlords pricing in the maximum allowable increases to compensate for previous low growth rates.

6 Conclusions and Policy Implications

This paper explores the impact of rent control regulations on rental price inflation, as well as on nominal rigidity in housing rents. Our research objective is therefore two-fold. First, using a difference-in-difference approach, we try to isolate the effect of the introduction of rent controls on rent inflation in Ireland. Given the exemptions allowed in the regulation, as well as potential non-compliance, we also analyse whether the regulations affected the share of rents growing above the 4 per cent cap imposed in the Irish legislation. Our second research objective focuses on analysing the effects of rent controls on the degree of nominal rigidity. In order to test these effects empirically, we focus first on changes in the share of zero growth rents. Afterwards, using a multinomial logit model, we explore the impacts across the price distribution.

A number of findings emerge. We find that overall rent controls had a deflationary impact, with the rental inflation rate dropping by approximately 2-3 percentage points after the introduction of the regulations. We also find a considerable fall in the share of rent price increases above the 4 per cent limit imposed by the regulatory framework. These findings indicate that the regulations have been effective to a certain extent in lowering the level of rental inflation in the areas of the country where rent controls were implemented.

In relation to the impact of rent controls on nominal rigidity, we find evidence pointing to both increases and decreases of rigidity. First, the share of zero growth contracts increased after the introduction of the measures. This might be consistent with the regulatory structure implemented in Ireland, which does not allow rent resets between tenants. Therefore, the increase in zero growth rent agreements may arise due to the risk of tenants leaving under a rent increase and such costs not being recoupable, resulting in increases in nominal rigidity. Second, the findings of the multinomial estimates present an more complete picture of the impacts of rent controls across the price distribution. The estimates indicate that rents were more likely to stay unadjusted after the implementation of rent controls, as opposed to increase above the 4 per cent threshold. However, the estimates also suggest that the regulations have increased the share of contracts with inflation at or below the regulatory limit. This indicates that many landlords may have increased the rents in an effort to profit maximise (maximise the real value of tenancies) given their inability to reset rents outside exceptional circumstances under the framework. Therefore, while the overall effect of the policies has been to dampen rents, they have also caused inflation at other points in the distribution consistent with a protection of real return by landlords.

We find differences by landlord type with non-professional investors (individual households) more likely to have nominally rigid rents and also less likely to have increases at, or below, the maximum allowable. This may be driven by the fact that such households are unable to absorb tenant turnover costs as easy as professional companies. We also find that landlords with lower than average rents before the regulations are less likely to leave rents unchanged and more likely to grow rents up to the regulatory maximum after the regulations. If such landlords had left rents low before, with a view to increasing the level when they brought a new tenant in, this is no longer allowed. They therefore set the price growth close to the maximum to compensate.

This research has interesting policy implications. First, our evidence suggests that while rent controls can be effective in dampening house price inflation, the effect is not uniform across the distribution. Indeed, some tenants, who previously enjoyed nominal rent freezes, may face rent rises up to the regulatory maximum allowance as landlords look to protect real returns. Two elements of the scheme calibration are therefore important to reflect upon. The Irish rent controls, which do not allow a rent change between tenancies, may be the reason landlords see the requirement to protect real returns. Rent restrictions which do not share this feature may not experience this inflationary impact. Second, the increase in the share of rent increases at the regulatory maximum (in this case 4 per cent) highlights the fact that the parameterisation of this element is considerably important. Policy makers should carefully consider the numerical parameter that is set as this will be essential in guiding behaviour. Regular reviews of this parameter based on granular data would be important, in particular, where rent control price allowances interact with inflation rates and Central Bank inflation targets.

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Appendices

A RPZ designation dates by LEA in Ireland

	Designation round	Date
County Dublin		
Dublin City Council	1	December/2016
Cabra-Finglas		
Ballymun		
North Inner City		
Beaumont-Donaghmede		
Clontarf		
Ballyfermot-Drimnagh		
Crumlin-Kimmage		
Rathgar-Rathmines		
Pembroke-South Dock		
South Dublin County Council	1	December/2016
Lucan		
Clondalkin		
Templeogue-Terenure		
Tallaght Central		
Tallaght South		
Rathfarnham		
Dun Laoghaire-Rathdown County Council	1	December/2016
Glencullen-Sandyford		
Dundrum		
Stillorgan		
Blackrock		
Dun Laoghaire		
Killiney-Shankill		
Fingal County Council	1	December/2016
Balbriggan		
Swords		
Castleknock		
Mulhuddart		
Howth - Malahide		
County Galway		
Galway city	2	January/2017
Galway City Central		
Galway City East		
Galway City West		
County Cork		
Cork City Council	1	December/2016
Cork City North-Central		
Cork City North-East		

Cork City North-West		
Cork City South-Central		
Cork City South-East		
Cork City South-West		
Ballincollig-Carrigaline	2	January/2017
Cobh	3	March/2017
County Kildare		
Maynooth	3	March/2017
Celbridge-Leixlip	2	January/2017
Naas	2	January/2017
Kildare-Newbridge	2	January/2017
County Meath		
Ashbourne	2	January/2017
Laytown-Bettystown	2	January/2017
Ratoath	2	January/2017
County Wicklow		
Bray	2	January/2017
Wicklow	2	January/2017
Greystones	4	September/2017
County Louth		
Drogheda	4	September/2017

B Additional Summary Statistics

Data Split: Landlord Type - Before and After Treatment

Landlord Type	Before	After	Total
Individual	34,122	11,278	45,400
Company	4,602	1,949	6,551
Total	38,724	13,227	51,951