The Spatial Analysis of the Employment Effect of the Minimum Wage in a Recession:

The Case of the UK 1999-2010.

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Abstract

This paper assesses the impact of the National Minimum Wage (NMW) on employment in the UK over the 1999-2010 period explicitly modelling the effect of the 2008-10 recession. Identification is facilitated by using variation in the bite of the NMW across local labour markets with the use of the 'incremental differences-in-differences' (IDiD) estimator. We explicitly take account of the spatial nature of local labour markets by using commuting patterns to weight our estimation. We find that, even controlling for clear regional recessionary factors, there are zero or small positive employment effects.

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I. INTRODUCTION

This paper builds on that small literature by examining the impact of the NMW in the UK over the period 1997-2010, comparing the period two years before its introduction with the subsequent history of the NMW and its up-ratings. This enables us to provide an additional insight by distinguishing effects between those in a NMW policy off period compared to each incremental up-rating of the NMW in subsequent years. Hence instead of using a simply policy on - policy off, difference-in-difference model, we examine a model in which each year's change in the NMW is considered as a separate interaction effect. This 'Incremental Diff-in-Diff' (IDiD) estimator (introduced in Dolton et al. 2011) is a logical corollary of the econometric model suggested by Wooldridge (2007) and Bertrand et al. (2004) in the sense that it introduces a yearly interaction for each up-rating of the NMW so that we may gauge the impact of each change in the NMW. We use this IDiD procedure to evaluate the year on year impact of the uprating of the NMW on employment.

There is a large literature on the employment effects of a Minimum Wage (see Brown et al. (1982) and Card and Krueger (1995) for extensive reviews of the literature). In recent years there is a growing literature which attempts to identify the effects of a MW on employment by using geographical variation in the bite of the MW in separate spatially separated markets (See Card (1992) or Neumark and Washer (1992) for the United States, Manacorda (2010) for Mexico, Stewart (2002) and Dolton et al. (2008, 2011) for the UK). This literature has not concerned itself with what happens to employment effects of the MW in times of macro-economic recession. This paper focuses on the modern era in the UK from 1997-2010 with the introduction of the NMW in 1999 and then leading into the Great Modern Recession of 2008-2010. Hence we focus on the important question of what is the impact of the MW in an era when the economy is contracting, unemployment is rising and real incomes are falling for many people in the economy.

A second feature of nearly all the literature on the MW to date which uses geographical variation to try and identify the impact of the MW is that it has made the assumption that the geographical units of observation are geographically separate and unrelated to one another. This assumption is unwarranted for many important reasons – we focus on just two motivations. Firstly, in reality a job vacancy rate is never posted with the condition that nobody outside the immediate geographical vicinity need apply. Clearly being able to travel to the job location is the problem of the individual and the resulting commute is never considered in whether someone gets the job. This means that labour markets are not neat, independent units of observation which bear no relation to one another. Economists frequently talk about local labour markets with the notion that if one considers a specific geographical area where most people both live and work in the same location then we can consider the modeling of all such areas as a set of independent, unrelated observations for our data. In reality, such a notion is false as all geographical areas have people who live in them but work in other locations. This pattern of commuting is then, in some sense, the realized form of all the subtle interrelationships between different geographical locations. A second flaw with treating such geographical units as independent is that spatially located phenomena like plant closures have an effect not just in the geographical location it occurred in but also in the immediate neighbouring areas. The degree of contiguity of neighbouring locations is therefore an important factor in the spread of unemployment, poverty, wage rises and other labour market phenomena. The extent of spillover effects from one location to another will depend on transport links, the spatial distribution of related industries and many other factors. It is well known that if we model an econometric relationship under the mistaken assumption that the units of observation are independent of one another – when in reality they are not - then we may get biased and inconsistent estimates of the resulting economic relationships. More specifically if we model these relationships under the assumption of a spherical set of disturbances when they were non-spherical we are likely to get estimates which are spuriously larger and more statistically significant than they should be. This means that if we estimate a model of the effects of the MW using geographical data under the assumption of non-spatially related units when they are indeed spatially related then we will get estimates of the effects which are biased, larger than they should be and also more statistically significant than they ought to be. Hence the assumption of spatial independence is a very important one in this context which should be tested. Most existing UK studies have focused on the impact of the introduction of the NMW, finding, broadly, that the aggregate employment effects of the introduction were negligible (Stewart, 2002, 2004a, 2004b). Aside from adjustment along other dimensions such as productivity, profits, hours or prices, or simply that the initial rate was too low in the wage distribution, another possible reasons for this, arguably counter-intuitive employment effect is that any long-run effects have not been captured by previous studies. Since in the short-run the costs of adjusting inputs tend to be high, the response of employment to NMW increases might not be immediate. As recently pointed out by Neumark and Washer (2007): "Most of the existing research on the United Kingdom has been limited to estimating short-run effects, and in our view, the question of the longer-run influences of the national minimum wage on UK employment has yet to be adequately addressed". In this paper we take a medium to long run look at the impact of the NMW in the UK and its up-ratings and try to assess whether this has had a differential impact across heterogeneous geographical areas. This paper is a logical follow up to the work of Dolton et al (2008, 2011) but this work only went up to 2007 (prior to the current recession) and did not consider the role of shocks to aggregate demand such as the current recession. In addition this work also treated the geographical units of statistical analysis as being independent and not spatially related. It is this clear deficiencies which this paper addresses.

In this paper we set the different estimates in the literature in some context as our econometric is more general that previously it is moot to consider the extent to which our findings can nest those of earlier contributions. Hence we make some effort to examine the robustness of our results with regard to the specification issues associated with: spatial dynamic specification to incorporate the lagged effects of previous employment on current employment, and time and interaction effects. In this testing of robustness we suggest that much of the previous literature is sometimes presented as if the results are in stark contrast to each other. Our take on this literature is that it often estimates fundamentally different parameters and that this explains a large degree of the differences in results.

The paper is organised as follows. Section II describes the datasets used and the characteristics of the data and contains a description of the maps of the incidence of the minimum wage and the measures of local area performance in each local area. Section III outlines the methodology for the analysis. The main results of the analysis are presented in section IV. Section V concludes.

II. DATA

The central idea of this paper is to see whether geographic variation in the "bite" of the minimum wage is associated with geographic variation in employment and other indicators of local market performance (wage inequality, unemployment, and hours of work). Geographical variation in wages in the UK is exploited in order to evaluate the impact of the NMW on a series of indicators of local area performance. The data used in this study are drawn primarily from three sources. Data on earnings, hours and a restricted number of covariates all disaggregated by geography is provided by the New Earnings Survey (NES) from 1997 to 2003 and by the Annual Survey of Hours and Earnings (ASHE), which replaced the NES in 2004. In both surveys, conducted in April of each year, employers are asked to provide information on hours and earnings of the selected employees. The geographic information collected for the full sample period used in the paper is based on workplace rather than residence. This is the only dataset that has hourly wage information from 1997 to 2007 at the various levels of geographical disaggregation used in this paper. Alongside the hourly wage, the ASHE data enable us to compute estimates of three different measures of wage inequality at the same geographic level, (the $50^{th}/5^{th}$, $50^{th}/10^{th}$, and $50^{th}/25^{th}$ percentiles of the wage distribution) and the average total hours worked by full-time and part-time employers.

Defining the level of Geography for our Analysis.

The geographic variation in wages will reflect the demographic and industrial composition of each local labour market. The changing industrial composition of an area and the extent to which industries are low and high paying will affect the changing incidence of the minimum wage working in a locality. Likewise the skill, age and gender composition of the local workforce. To a certain extent we can control for variation in these factors with a set of time varying local labour market control variables, drawn from either ASHE or matched in from complementary Labour Force Survey (LFS) data. Our analysis in this paper is conducted at travel to work areas level (TTWA) that are defined as areas in which 67% of people living and working in the same geography. Since TTWAs are not available for the entire period considered in this study the only option was to attempt to replicate our results for the most 'reasonable' definition of a TTWA that we could manually reconstruct from the data available[1]. This gave us 138 new geographical areas[2].

[1] The mechanics of how to do we this is available to interested readers upon request.

[2] Since the level of choosing the unit of geographical analysis is central we present main differences between different levels of analysis detailed in a more comprehensive paper for 140 and 406 regions. Thereby the 140 areas level is borne of administrative areas and consists of large counties and separate conurbations; the 406 areas is based on a much finer level of detail of areas which are much smaller and compact; and the 138 TTWAs are defined explicitly using the definition of a threshold of the fraction who live and work in the same area.

The Employment Variable.

We then match local area employment data from the LFS with the minimum wage covariates generated from ASHE. There is an important feature of the timing of data collection which we exploit in order to try and make sure that our employment variable is measured after the up-rating of the NMW. The ASHE and NES estimates for hourly earnings and therefore the minimum wage variables used in this paper are recorded in April of each year. Since the minimum wage was first introduced in April 1999 but then up-rated in October of each following year, the NMW variables are therefore generally recorded six months after each NMW up-rating. There are however two exceptions: April 1999 which is contemporaneous to the introduction of the minimum and April 2000, which is one year from the introduction of the minimum. To reduce simultaneity concerns, the wage data in April of year *t* is regarded as having absorbed any effect of the NMW upgrade in October of year *t-1*. This is in turn matched to employment data taken from June to August of year *t*, while data on unemployment is collected from May to September of year *t*. [3] This means that the estimated impact effect we identify is a mixture of the impact of the up-rating in year *t-1* and any changes from the already announced anticipation of the effect of the new NMW level in year *t*. As a robustness check we have varied our timing assumptions and our results suggest that any anticipation effect is negligible.[4]

Data on employment at these levels of aggregation derived from the LFS are available via NOMIS for yearly data for 1997 and 1998. For the period 1999 to 2005 we use employment rates calculated from the quarterly LFS local area data. For the years 2006 to 2010 we use the quarterly LFS Special License data to calculate the employment rate. According to the US literature, young workers are considered to be the most exposed to the possible negative effects

[3] For the pre-period 1997 and 1998, data on employment rates are collected from March 1997 to February 1998 and from March 1998 to February 1999. Quarterly data is not available for these two calendar years. Since LFS Local Area data is only available in seasonal quarters, it is only possible to use the quarter June-August and not a longer period (eg. from May to September) unlike say the monthly claimant count unemployment data.

[4] Swaffield (2008) shows that there is very little early upward adjustment in wages in the six months prior to October over several years of data.

of a uniform NMW. While the UK has always set a lower youth minimum, it seems worth looking for any differential effects of the NMW across age groups. Data availability means that we could do our analysis separately for different age groups – as we did in Dolton et al (2011). Here in the interests of simplifying the number of tables to be produced we estimated our model for the 16 to retirement group only. Testing on the other age groups in the earlier paper and for this work did not reveal significantly different conclusions. If anything all the MW employment effects are larger and more statistically significant for the young people when estimated separately.

Measuring the National Minimum Wage

The most widely used variables in the literature is the Kaitz index, defined as the ratio of the minimum wage to some measure of the average wage. We use the median wage in our study. The closer the Kaitz index to unity the "tougher" the bite of minimum wage legislation in any area. However the denominator can be influenced by factors other than the level of the NMW and so the median wage is arguably more endogenous in an employment regression For example, a positive correlation between the employment rate and the median wage might be generated by an exogenous labour demand shift. This will create a negative correlation between the Kaitz index and the employment rate. Although we have used alternative measures of the MW in previous work (see Dolton et al. 2011 where the fraction of people at or below the NMW and the Spike are used) we did not find that this definitional measure of the MW made much difference to our conclusions, hence we chose to use only the Kaitz index to again make the number of tables in this paper manageable. Our estimations with the other possible variables to represent the MW (not reported here) have not shown very different conclusions.

Modelling the Spatial Nature of Labour Markets.

One of the two main innovation in this paper comes from our attempt to capture the interconnectedness of local labour markets. The importance of the spatial nature of labour markets is now becoming widely recognized in the work of Patacchino and Zenou (2007), Moretti (2011) and many others. More specifically the suggestion that commuting patterns in UK are a way of representing this spatial interconnectedness are being used by others recently (e.g Manning and Petrongolo 2011). Where a given 'local labour market' begins and ends and the extent of interconnectedness of spatially located areas will depend on a multitude of factors, including: distances, rail networks, bus links, the availability of major arterial roads, house prices, commuting times, school quality, council tax levels, provision of amenities to name but a few. In some sense it is impossible to observe all these factors in determining how interconnected each labour market is to every other labour market. To this degree all these influences on the spatial nature of the location decision of where one lives and works has a huge number of unobservables in its determination. Our approach to this problem is to take the observed pattern of commuting behaviour as the empirical 'reduced form' of all these influences which we cannot possibly observe.

Measuring the Recession

The second innovation of this paper is to attempt to net out of our estimations any underlying movements in aggregate demand and more importantly the large potential effects of the current recession. This has rarely been attempted – indeed to our knowledge the only research on this topic has been our own previous attempts to tackle this issue (see Dolton et al. 2011, 2011b 2012 and Dickens and Dolton 2010). This analysis was rudimentary in that it relied on simple dummy indicators as the presence of a recession or not. The problems associated with this when the formal definition of a recession is two quarters of negative GDP growth are rehearsed in Dolton . (2011b). Here we adopt a more ambitious approach as we attempt to control for negative regional GDP growth shocks with a direct proxy for regional growth. The variable which we decided to use is the lagged level of Gross Valued Added on a regional basis which is available in Regional Trends. The definition of this variable is that it aggregates all firm revenues, profits and all wages on a regional basis to compute literally the gross value of goods and services in the regional economy. Hence, to all intents and purposes, this variable is a measure of GDP growth (per head) on a regional basis. This, in our view, is the closest one can get to a variable which measures in a continuous way the level of regional GDP growth changes over time and hence the closest to a variable which captures when negative aggregate demand shocks hit and when a recession occurs and how bad it is in different regions in different years.

III. METHODOLOGY AND IDENTIFICATION

As introduced in Dolton et al. 2011 we use an Incremental Difference-in-Difference estimator that is based on earlier studies by Neumark and Wascher (1992, 2004), Card (1992), and Stewart (2002):

The central idea is to see whether geographic variation in the "bite" of the minimum wage is associated with geographic variation in employment. However we also allow the effect of any treatment to vary over time, given the differential pattern of upratings that we observe in the data. This can be done by pooling over the eleven year period and letting the treatment be the measures of the "bite" of the NMW in each area at time *t*, P_{jt}, so that the model estimated is:

$$E_{jt} = \gamma_0 + J_j + \sum_{t=1999}^{2010} \gamma_t Y_t + \theta_0 P_{jt} + \sum_{t=1999}^{2010} \theta_t^{IDID} Y_t P_{jt} + \pi D_{jt} + \delta X_{jt} + \varepsilon_{jt} \qquad (5)$$

Where E_{jt} is a measure of area labour market performance in area j at time t, J_j are area effects, and Y_t is a set of year effects with $Y_t = 0$ for t=1997, 1998. The range t is indexed from 1999 (the year in which the NMW was introduced and subsequently up-rated). Area fixed effects are included to control for omitted variables that vary across local areas but not over time such as unmeasured economic conditions of local areas economies that give rise to persistently tight labour markets and high wages in particular areas independently of national labour market conditions. Time fixed effects control for omitted variables that are constant across local areas but evolve over time.

The Incremental Difference-in-Difference coefficients θ_t^{IDiD} on the interaction of the year dummies and the measure of the bite, capture the average effect of the up-rating of the NMW in each year, starting from the introduction of the policy in 1999 all relative to the 'off period' of 1997 and 1998, provided of course that the proportion in the area who are ‘low paid’, P_{jt} is a valid instrument for the endogenous wage change. The advantage of using the IDiD estimation procedure is that it facilitates the estimation of year on year incremental effects of each year’s up-rating. So even if the average effect over all years is insignificantly different from zero, this does not mean that the effect of any individual year's change in the NMW is also zero. Note that one cannot deduce the longer run effect of all the changes in the NMW by simply summing all the year-on-year IDiD coefficients.[5] The long run effect can only be measured in aggregate by using one DiD coefficient for the whole period. We therefore present both short run IDID and medium run DiD estimates in what follows.

Though we have 2 more years with observations compared to our previous work our time series remains quite short. To the best of our knowledge there is no statistical method that would find strong evidence for autocorrelation of a higher order in our panel data set. An additional concern, we also already mentioned in Dolton et al. (2011), is that spatially contiguous areas lead to heteroskedastic errors. Therefore in this work we explicitly model these spatial relations.

The idea is that an economic aggregate like employment in a certain region does not only depend on economic key figures in the same region but in other regions. To model these dependencies a class of spatial econometric models were developed that consider spatially autoregressive processes in the

[5] This is because some additional (untestable) assumption relating to independence of effects over time would be necessary. In addition, since we use a dummy variable interaction term, rather than a normalised metric on how large each increment was then this also makes aggregation of the individual interaction term estimates difficult.

dependent variables or in the error term. The first model is often called the Spatial Lag or Spatial Autoregressive Panel Model (SARP) and the second is called the Spatial Error Panel Model (SEMP, Elhorst 2010a).

In the following we extend our model in equation (5) with spatial lags. That means in the case of spatial lags of the dependent variable:

$$E_{jt} = \rho \sum_{i=1}^{n} w_{ij} E_{it} + \gamma_0 + J_j + \sum_{t}^{2010} \gamma_t Y_t + \theta_0 P_{jt} + \sum_{t}^{2010} \theta_t^{IDID} Y_t P_{jt} + \pi D_{jt} + \delta X_{jt} + \varepsilon_{jt} \qquad (6)$$

where ρ is the coefficient for the spatial lag term $\sum_{i=1}^{n} w_{ij} E_{it}$, a linear combination of values of the employment rate from regions *i* that are assumed to influence the observations in region *j* (Le Sage and Pace 2009). The weights w_{ij} contain zeros if there are no spatial lags and always for the case $j \neq i$ since the regions are not considered to influence themselves. The weights reflect the assumption about the relative strength of the spatial lag. In every case it is intended to identify the spatial dimension of economic or regional activity and to implement that in the model. A simple and intuitive assumption is that neighboured or nearby regions are more closely related than those that are more distant (Le Sage and Pace 2010). Here we use weights based on information about commuting. Möller and Aldashev (2007) underlined that commuting streams are good indicators for the intensity of regional labour market interdependencies. Particularly regarding to employment rates information about the number of commuters should reflect quite well the proximity of labour market regions. Therefore, we use the number of flows of commuters from the region *I* where the commuters live to the region *j* where they work. To form a spatial lag or a linear combination of values from the “nearby” regions, for each region *j* all weights w_{1j} to w_{nj} are normalized to the (row) sum of unity.

The dependent variable in equation (6) is on the right and the left side. To estimate the model equation (6) has to be rearranged for all regions *j=1,…,n.* The equation (6) in matrix notation is

$$\mathbf{E} = \rho \mathbf{W}_T \mathbf{E} + \gamma_0 \iota_{nT} + \mathbf{Y}_N \boldsymbol{\gamma}_t + \theta_0 \mathbf{P} + (\boldsymbol{\theta}_t^{IDID} \mathbf{Y}_N)' \mathbf{P} + \mathbf{X}\boldsymbol{\delta} + \boldsymbol{\varepsilon} \qquad (7)$$

Hereby **E** (**P**/ $\mathbf{Y_N}$/ **ε**) is the $nT \times 1$ vector containing the employment rates E_{jt} (the measures for the Kaitz index P_{jt} / the year effects variables Y_t with Y_t= 0 for t=1997, 1998 / the error term ε_{jt}), $\mathbf{W}_T$ is a $nT \times nT$ matrix containing all weights w_{ij} that are equal for all years. $\boldsymbol{\iota}_{nT}$ is a unity vector with dimension $nT \times 1$. The $nT \times 1$ vector $\boldsymbol{\gamma}_t$ contains the parameters for the year effects. The $nT \times k$ matrix **X** contains the *k* control variables including the aggregate demand shocks measure D, and the $k \times 1$ vector $\boldsymbol{\delta}$ the coefficients of the control variables δ.

Now we can solve equation (7) for **E** and get the regression equation for model considering spatial lags of the dependent variables:

$$\mathbf{E} = (1 - \rho \mathbf{W}_T)^{-1}(\gamma_0 \boldsymbol{\iota}_{nT} + \boldsymbol{\gamma}_t \mathbf{Y_N} + \theta_0 \mathbf{P} + (\boldsymbol{\theta}_t^{\mathbf{IDID}} \mathbf{Y_N})\mathbf{P} + \mathbf{X}\boldsymbol{\delta} + \boldsymbol{\varepsilon}) \tag{8}$$

The equation for the Spatial Error Panel Model in matrix notation is

$$\mathbf{E} = \gamma_0 \boldsymbol{\iota}_{nT} + \mathbf{Y_N}\boldsymbol{\gamma}_t + \theta_0 \mathbf{P} + (\boldsymbol{\theta}_t^{\mathbf{IDID}} \mathbf{Y_N})\mathbf{P} + \mathbf{X}\boldsymbol{\delta} + \mathbf{u} \tag{9}$$

with a spatially autoregressive process in the error term **u**

$$\mathbf{u} = \lambda \mathbf{W}_T \mathbf{u} + \boldsymbol{\varepsilon} \tag{10}$$

Finally solving (10) for **u** and implementing that in (9) leads to the SEMP model

$$\mathbf{E} = \gamma_0 \boldsymbol{\iota}_{nT} + \mathbf{Y_N}\boldsymbol{\gamma}_t + \theta_0 \mathbf{P} + (\boldsymbol{\theta}_t^{\mathbf{IDID}} \mathbf{Y_N})\mathbf{P} + \mathbf{X}\boldsymbol{\delta} + (1 - \lambda \mathbf{W}_T)^{-1}\boldsymbol{\varepsilon} \tag{11}$$

Since the regression equations in (8) and (9) are non-linear in their parameters maximum-likelihood approaches are used to estimate the parameters. We use estimators provided by Elhorst (2010b) that include a bias correction for both time and spatial fixed effects (for details compare Lee and Yu 2010).

The question which models should be preferred, the models without spatial dependencies or the models with either an autoregressive error term or the model with a spatial lag is crucial because misspecification would lead to biased estimates of the interesting coeffcients. Therefore we conduct Lagrange Multiplier Tests described and provided by Debarsy and Ertur (2010) that show us that spatial dependencies should not be neglected and there are indications that the SEMP approach should be preferred in the majority of specifications (all details can be in table 7). Nevertheless we present results for all presented specifications which mean non-spatial dependencies, spatial lags of the dependent variable and spatial autoregressive processes in the error terms.

IV. RESULTS.

We present estimates of the DID model (1) using (the log of) employment as the labour market outcome of interest to summarise the NMW effect on employment over the medium term, namely the average over 14 years since its introduction relative to the base period of 1997/98. We do this in this draft paper for the 138[6] regions. These are presented in Table 1. The second 4 columns in Tables 1 include the GVA lagged variable as a measure for the Recession. In each case this recession proxy is always positively significant suggesting that employment is always higher when there is higher economic growth (as measured by GVA lagged.) These estimates are reported as a simple benchmark for our more sophisticated models.

Table 2 augments the base model with the model specification of the IDiD estimator in equation (5) where again we do not model the spatial nature of the data.. For the Kaitz NMW toughness measure there are 4 columns. The first column is the estimate from a simple regression of the dependent variable on the NMW measure, effectively the establishing the correlation between the two variables. The estimates confirm the long-established fact that employment is lower in low wage areas. The addition of year specific time dummies makes little difference to the estimates, but the addition of area fixed effects removes the positive association between low wages and low employment. Since any effect is now identified of variations in the NMW bite over time across areas, this suggests no overall difference in employment growth rates between areas where the NMW bites most compared to areas where the NMW has less impact. The second 4 columns in Tables 2 again include the GVA lagged variable as a measure for the

[6] The authors provide all other results for 140 and 406 regions on request.

Recession. As expected the recessionary variable is again always positively significant suggesting the right sign of the impact of growth on employment. It should be noted that the addition of the GVA variable always attenuates downwards the size of the IDiD coefficients on the NMW variables for each year. Even in this benchmark model this indicates that modeling the employment effect of the MW without taking account of demand shocks and recessions is problematic and likely to overstate any measured MW effects on employment.

Tables 3 presents the results of the limited model in equation (1) but in the spatial context using the SARP model and Table 4 do the same for SEMP model. Again the logic of presenting these models is that they provide a benchmark of the base model estimated using the two different spatial model adjustments. In each of these tables the second set of 4 columns includes the GVA lagged variable. The final set of estimates is presented in Table 5 which estimates the 'full model' using the complete Incremental Diff-in-Diff structure but includes the spatial effects using the SARP model and Table 6 does the same for the SEMP model.

The main results from our estimations can be suggested by the patterns in these tables: firstly the recession, as captured by the GVA lagged variable plays an important role in the determination of employment but that the consequence of this variable's inclusion is that the NMW interaction effects are always attenuated. Likewise these estimated effects are further attenuated by the modelling which includes the spatial effects. The second dominant effect is that in most specifications there is an underlying negatively significant effect on employment of the presence of the NMW as reflected in the coefficient on the Kaitz index. This can be interpreted as the continuous, underlying effect of having a NMW in place rather than the effect of the size of the year on year up rating. This is a very important conclusion which may hold the key to understanding much of the controversy in the research literature. Indeed it could suggest that if our specification is correct then the source of much of the disagreement between the main protagonists, Card and Krueger (1994, 1995)or Neumark and Wascher (1994, 2004) has been misplaced due to equation misspecification..

For the 138 TTWA we see that there is evidence of positive significant interaction effects in the IDiD model for the years 2003 and 2004 (Tables 2, 5, and 6).[7] Turning to the models which reflect the specification of the spatial models we see that there is little difference between the SEMP and SARP specifications. This is reflected in the size of the coefficients relating to each regressor which are very similar and also in the size and significance of the lambda and rho ancillary parameters. These parameters are always of similar magnitude and statistical significance. This is not a surprising finding but one that is reassuring for the consistency of the model estimation.

Overall, where our NMW incremental effects are found significant it should be stressed that these point estimates effects are small in magnitude, but it is clear that they are masked if the simple DiD Policy-On Policy -Off variable is used. If the standard assumptions of Diff-in-Diff relating to the Stable Unit Treatment are applicable (namely that no other systematic factors are varying across geography and over time) then we can interpret this as a causal impact of the year on year up-ratings to the NMW which may cancel out the overall negative impact of the presence of the NMW as captured by the Kaitz variable. On this basis, if anything, employment rate appears to have risen more in areas where the NMW has more relevance.[8]

VI. CONCLUSIONS

[7] However, for the 140 geography we see that there are clearly positively significant interaction effects in the years 2003 to 2007 inclusive. Comparing these to the 406 geography we see that the size of the effects is attenuated but that the same years are all positively significant at the 10% level and very nearly significant at the 5% level. This is a consistent finding which directly relates to the extra variance introduced by having such a finer geographical set of areas with more variance in outcomes, more potential for measurement error and unobserved heterogeneity. Therefore, turning to the estimations and distinguishing between the results from the different geographies is instructive.

[8] One slight concern with the timing of the effects we have found is that the post 2003 period coincides with the change in the sampling frame of ASHE. Hence there is a residual doubt over whether there may be something intrinsically different about the data in ASHE and that in NES which causes this result. However, it would seem to us that there is no way to test this.

The conclusion from our estimates is that overall there are very small positive or zero incremental employment effects of up ratings to the MW in a year on year context.. In contrast the underlying effect of the presence of the NMW is reflected in the Kaitz Index coefficient in the Tables. This coefficient is nearly always negative and significant suggesting that the effective implementation of the NMW has an underlying negative impact on employment but that this is offset in a year on year context by the small positive effects of the NMW up ratings. It should be stressed that our measured marginal effects were consistently made smaller when we condition out for the presence and severity of the recession in the regional context. These findings are interesting as they rationalize why one might get negative impacts of the MW – i.e. due to the effect of the presence of the MW rather than its up rating. Our results are also consistent with much of the recent literature focusing on the introduction of the NMW (i.e. since they also get zero or small positive effects) but also because they explain why it may be possible to get both zero and positive effects.

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Table 1. Within Group and OLS Estimates of Minimum Wage Effects on Employment, 16 years to retirement age, 138 TTWA areas, 1997-2010,

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kaitz Index	-0.079***	-0.088***	-0.123***	-0.097**	-0.045***	-0.065***	-0.112***	-0.091**
	(0.015)	(0.017)	(0.042)	(0.038)	(0.016)	(0.018)	(0.042)	(0.038)
GVA					0.660***	1.785***	0.942***	0.726***
					(0.106)	(0.248)	(0.234)	(0.225)
age				2.522				2.153
				(2.515)				(2.604)
age2				-0.061				-0.052
				(0.062)				(0.064)
age3				0.000				0.000
				(0.001)				(0.001)
nvq4plusIMP				0.158***				0.148***
				(0.035)				(0.035)
total_female				-0.000				-0.013
				(0.063)				(0.062)
Year Effects	N	Y	Y	Y	N	Y	Y	Y
Area Effects	N	N	Y	Y	N	N	Y	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
R-squared	0.014	0.053	0.102	0.129	0.035	0.078	0.116	0.137

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. Incremental Difference in Differences Estimates of Minimum Wage Effects on Employment Rate 16 years to retirement age, 138 TTWA areas, 1997-2010, all estimations with area and year effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kaitz Index	-0.123***	-0.097**	-0.164***	-0.134***	-0.112***	-0.091**	-0.138***	-0.116**
	(0.042)	(0.038)	(0.050)	(0.047)	(0.042)	(0.038)	(0.050)	(0.047)
Kaitz*1999			0.007	0.008			0.007	0.009
			(0.052)	(0.052)			(0.053)	(0.053)
Kaitz*2000			0.040	0.039			0.037	0.037
			(0.044)	(0.042)			(0.045)	(0.043)
Kaitz*2001			-0.000	-0.012			-0.018	-0.024
			(0.037)	(0.037)			(0.038)	(0.038)
Kaitz*2002			0.046	0.035			0.019	0.016
			(0.034)	(0.032)			(0.036)	(0.034)
Kaitz*2003			0.119***	0.099**			0.094**	0.082*
			(0.040)	(0.043)			(0.040)	(0.042)
Kaitz*2004			0.125***	0.112**			0.100**	0.094*
			(0.048)	(0.048)			(0.048)	(0.049)
Kaitz*2005			0.047	0.041			0.025	0.026
			(0.053)	(0.049)			(0.053)	(0.050)
Kaitz*2006			0.020	0.004			-0.001	-0.009
			(0.059)	(0.059)			(0.057)	(0.057)
Kaitz*2007			0.043	0.053			0.028	0.040
			(0.056)	(0.055)			(0.056)	(0.055)
Kaitz*2008			0.090*	0.076			0.070	0.062
			(0.053)	(0.050)			(0.052)	(0.050)
Kaitz*2009			-0.009	-0.016			-0.032	-0.033
			(0.064)	(0.062)			(0.063)	(0.061)
Kaitz*2010			0.062	0.061			0.032	0.038
			(0.053)	(0.052)			(0.055)	(0.054)
GVA					0.942***	0.726***	0.900***	0.690***
					(0.234)	(0.225)	(0.250)	(0.238)
Control variables	N	Y	N	Y	N	Y	N	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
R-squared	0.102	0.129	0.110	0.136	0.116	0.137	0.122	0.143

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Within Group and Pooled Estimates of Minimum Wage Effects on Employment with Spatially Lagged Dependent Variable (SARP), 16 years to retirement age, 138 TTWA areas. 1997-2010, Kaitz index

	(1) Pooled	(2) Pooled	(3) FE	(4) FE	(1) Pooled	(2) Pooled	(3) FE	(4) FE
Constant	-0.142 ***	-0.177 ***			-0.145 ***	-0.199 ***		
	(0.012)	(0.014)			(0.012)			
Kaitz Index	-0.047 ***	-0.064 ***	-0.112 ***	-0.089 ***	-0.037 **	-0.053 ***	-0.106 ***	-0.085 **
	(0.014)	(0.015)	(0.033)	(0.034)	(0.014)	(0.015)	(0.033)	(0.034)
GVA					0.225 **	0.910 ***	0.816 ***	0.617 ***
					(0.096)	(0.016)	(0.178)	(0.180)
age				2.248				2.012
				(1.809)				(1.807)
age2				-0.055				-0.049
				(0.045)				(0.045)
age3				0.000				0.000
				(0.000)				(0.000)
NVQ4plus				0.154 ***				0.147 ***
				(0.028)				(0.028)
Share Female				-0.008				-0.017
				(0.047)				(0.047)
rho	0.581 ***	0.542 ***	0.181 ***	0.149 ***	0.559 ***	0.522 ***	0.121 ***	0.110 ***
	(0.028)	(0.030)	(0.038)	(0.038)	(0.029)	(0.013)	(0.039)	(0.039)
Year Effects	N	Y	Y	Y	N	Y	Y	Y
Area Effects	N	N	Y	Y	N	N	Y	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932

R-squared	0.178	0.185	0.633	0.643	0.178	0.189	0.636	0.644

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Within Group and Pooled Estimates of Minimum Wage Effects on Employment with Spatially Lagged Error Term (SEMP), 16 years to retirement age, 138 TTWA areas. 1997-2010

	(1) Pooled	(2) Pooled	(3) FE	(4) FE	(1) Pooled	(2) Pooled	(3) FE	(4) FE
Constant	-0.262 ***	-0.294 ***			-0.270 ***	-0.316 ***		
	(0.010)	(0.014)			(0.010)			
Kaitz Index	0.015	0.005	-0.111 ***	-0.088 **	0.017	0.002	-0.104 ***	-0.084 **
	(0.018)	(0.019)	(0.034)	(0.035)	(0.018)	(0.015)	(0.033)	(0.034)
GVA					0.590 ***	0.972 ***	0.891 ***	0.688 ***
					(0.195)	(0.019)	(0.193)	(0.192)
age				2.322				2.047
				(1.808)				(1.806)
age2				-0.057				-0.050
				(0.045)				(0.045)
age3				0.000				0.000
				(0.000)				(0.000)
NVQ4plus				0.154 ***				0.147 ***
				(0.028)				(0.028)
Share Female				-0.006				-0.015
				(0.047)				(0.047)
lambda	0.608 ***	0.565 ***	0.173 ***	0.139 ***	0.575 ***	0.519 ***	0.126 ***	0.105 ***
	(0.028)	(0.029)	(0.038)	(0.038)	(0.029)	(0.021)	(0.039)	(0.039)
Year Effects	N	Y	Y	Y	N	Y	Y	Y
Area Effects	N	N	Y	Y	N	N	Y	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
R-squared	-0.045	0.001	0.628	0.639	-0.007	0.031	0.634	0.643

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Incremental Difference in Differences Estimates of Minimum Wage Effects on Employment Rate with Spatially Lagged Dependent Variable (SARP), 16 years to retirement age, 138 TTWA areas, 1997-2010, all estimations with area and year effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kaitz Index	-0.112 ***	-0.089 ***	-0.150 ***	-0.122 ***	-0.106 ***	-0.085 **	-0.131 ***	-0.110 **
	(0.033)	(0.034)	(0.042)	(0.043)	(0.033)	(0.034)	(0.042)	(0.043)
GVA					0.816 ***	0.617 ***	0.782 ***	0.592 ***
					(0.178)	(0.180)	(0.181)	(0.182)
Kaitz*1999			0.005	0.007			0.006	0.008
			(0.049)	(0.048)			(0.048)	(0.048)
Kaitz*2000			0.037	0.037			0.035	0.035
			(0.049)	(0.048)			(0.049)	(0.048)
Kaitz*2001			-0.002	-0.012			-0.017	-0.022
			(0.047)	(0.047)			(0.047)	(0.047)
Kaitz*2002			0.039	0.029			0.017	0.014
			(0.047)	(0.046)			(0.047)	(0.046)
Kaitz*2003			0.108 **	0.090 *			0.089 *	0.078
			(0.048)	(0.048)			(0.048)	(0.048)
Kaitz*2004			0.115 **	0.104 **			0.096 **	0.090 *
			(0.049)	(0.048)			(0.049)	(0.048)
Kaitz*2005			0.038	0.034			0.022	0.023
			(0.050)	(0.050)			(0.050)	(0.050)
Kaitz*2006			0.011	-0.002			-0.004	-0.012
			(0.052)	(0.051)			(0.052)	(0.051)
Kaitz*2007			0.035	0.045			0.024	0.037
			(0.051)	(0.050)			(0.051)	(0.050)
Kaitz*2008			0.083 *	0.071			0.068	0.060
			(0.049)	(0.049)			(0.049)	(0.049)
Kaitz*2009			-0.011	-0.018			-0.030	-0.032
			(0.051)	(0.050)			(0.051)	(0.050)
Kaitz*2010			0.057	0.056			0.032	0.038
			(0.051)	(0.051)			(0.051)	(0.051)
rho	0.181 ***	0.149 ***	0.166 ***	0.141 ***	0.121 ***	0.110 ***	0.114 ***	0.101 ***
	(0.038)	(0.038)	(0.038)	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)
Control variables	N	Y	N	Y	N	Y	N	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
R-squared	0.633	0.643	0.635	0.645	0.636	0.644	0.638	0.646

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Incremental Difference in Differences Estimates of Minimum Wage Effects on Employment Rate with Spatially Lagged Error Term (SEMP), 16 years to retirement age, 138 TTWA areas, 1997-2010, all estimations with area and year effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kaitz Index	-0.111 ***	-0.088 **	-0.150 ***	-0.123 ***	-0.104 ***	-0.084 **	-0.132 ***	-0.110 **
	(0.034)	(0.035)	(0.044)	(0.044)	(0.033)	(0.034)	(0.043)	(0.044)
GVA					0.891 ***	0.688 ***	0.860 ***	0.661 ***
					(0.193)	(0.192)	(0.192)	(0.192)
Kaitz*1999			0.009	0.009			0.009	0.010
			(0.052)	(0.051)			(0.051)	(0.050)
Kaitz*2000			0.044	0.042			0.040	0.039
			(0.052)	(0.051)			(0.051)	(0.050)
Kaitz*2001			0.001	-0.010			-0.014	-0.021
			(0.051)	(0.050)			(0.049)	(0.049)
Kaitz*2002			0.040	0.029			0.020	0.015
			(0.050)	(0.049)			(0.049)	(0.048)
Kaitz*2003			0.108 **	0.090 *			0.091 *	0.078
			(0.052)	(0.051)			(0.051)	(0.050)
Kaitz*2004			0.119 **	0.106 **			0.099 **	0.092 *
			(0.052)	(0.051)			(0.051)	(0.050)
Kaitz*2005			0.035	0.030			0.020	0.020
			(0.054)	(0.052)			(0.053)	(0.052)
Kaitz*2006			0.004	-0.009			-0.008	-0.016
			(0.055)	(0.054)			(0.054)	(0.053)
Kaitz*2007			0.033	0.046			0.024	0.037
			(0.054)	(0.053)			(0.053)	(0.052)
Kaitz*2008			0.084	0.073			0.070	0.062
			(0.053)	(0.052)			(0.051)	(0.051)
Kaitz*2009			-0.011	-0.018			-0.028	-0.031
			(0.054)	(0.053)			(0.053)	(0.052)
Kaitz*2010			0.055	0.054			0.033	0.038
			(0.054)	(0.053)			(0.053)	(0.053)
lambda	0.173 ***	0.139 ***	0.154 ***	0.127 ***	0.126 ***	0.105 ***	0.108 ***	0.089 **
	(0.038)	(0.038)	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
Control variables	N	Y	N	Y	N	Y	N	Y
Observations	1,932	1,932	1,932	1,932	1,932	1,932	1,932	1,932
R-squared	0.628	0.639	0.631	0.642	0.634	0.643	0.636	0.645

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7. LM spatial specification tests, 16 years to retirement age, 138 TTWA areas, 1997-2010

	Specification of the model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specification of the model	Kaitz index				Y				
	Kaitz*Year effects	N	N	Y	Y	N	N	Y	Y
	Year effects				Y				
	Area effects				Y				
	Controls	N	Y	N	Y	N	Y	N	Y
	GVA	N	N	N	N	Y	Y	Y	Y
Null hypotheses					Test results				
No spatial autocorrelation of the error terms and no spatial lag of the dependent variables	LM statistics	14.715	17.054	17.900	19.451	5.658	6.297	7.213	7.990
	p	0.001	0.000	0.000	0.000	0.059	0.043	0.027	0.018
No spatial lag of the independent variable	LM statistics	12.602	8.905	10.814	7.574	5.284	4.348	4.600	3.731
	p	0.000	0.003	0.001	0.006	0.022	0.037	0.032	0.053
No spatial autocorrelation of the error terms	LM statistics	11.988	6.998	8.952	5.018	4.988	3.607	3.749	2.601
	p	0.001	0.008	0.003	0.025	0.026	0.058	0.053	0.107
No spatial lag of the dependend variable, given a spatial autocorrelation of the error terms	LM statistics	0.017	0.043	0.054	0.167	0.005	0.002	0.006	0.024
	p	0.895	0.836	0.673	0.683	0.944	0.961	0.936	0.878
No spatial autocorrelation of the error terms, given a spatial lag of the dependend variable	LM statistics	499.611	249.200	314.641	170.599	184.245	119.838	135.457	92.037
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Preferred model (p<0.10)		SEMP	SEMP	SEMP	SEMP	SEMP	SEMP	SEMP	SEMP
	Number of observations				1,938				