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SEGREGATION AND GENDER GAPS THROUGH THE UK'S GREAT RECESSION AND RECOVERY

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ABSTRACT

This article assesses the role of segregation in explaining gender employment gaps through the UK's Great Recession and its subsequent period of recovery and fiscal austerity. First, we re-affirm that UK gender gaps respond more generally to the business cycle. Although there are many potential explanations of this fact, we test the simplest. Is this because of the extent of segregation in work? Our counterfactual-type analysis accounts for the specific role of combined gender segregation across industry sectors and occupations that existed at the onset of the Great Recession. The results contradict the existing narrative that men's employment was more harshly affected than women's employment; segregation accounts for over two and a half times the actual fall in the gender gap between 2007 and 2011.

KEYWORDS

INTRODUCTION

The aim of this article is to assess the role of segregation across industries and occupations in explaining gender differences in the employment response to the Great Recession and its aftermath. Over the last four decades the employment rate gap between working-age men and women in the UK has narrowed by almost thirty percentage points. Figure 1 shows that this has been as much determined by falling employment amongst men as by a rising female rate. There is another prominent pattern alongside this longer-term trend. The employment rate gap is pro-cyclical. The jobs growth of men appears to be more sensitive to the economic

cycle than for women (Amado Peiro, Jorge Belaire-Franch and Maria Teresa Gonzalo, 2012, Giovanni Razzu and Carl Singleton, 2016). The Great Recession has certainly reminded us of the importance of understanding the behavior of labor markets over the economic cycle. It is not surprising then that significant attention has been paid to recent relative gender outcomes by policy makers and the media.[1] In this context, it is worth reflecting that greater reductions in male jobs growth during economic downturns have been common beyond the UK (see for examples Hilary Hoynes, Douglas Miller and Jessamyn Shaller, 2012, Yoonyong Cho and David Newhouse, 2013, Huayyong Zhi, Jikun Huang, Throng Huang, Scott Rozelle and Andrew Mason, 2013). One candidate to explain these changes in employment gaps, through periods of recession and recovery, is the degree of gender segregation in work.

[Figure 1 about here – half page]

Table 1 shows the extent of gender segregation across both industries and occupations at the onset of the Great Recession; more specifically, it shows the share of those employed in economic sectors (manufacturing, construction etc.) and occupation groups (managers and senior officials, professionals, elementary etc.) who were women. Regardless of occupation, women were relatively outnumbered by men in every sector except in the public administration, education and health sectors, where women held approximately seventy percent of the jobs, and to a lesser degree in the distribution, hotel and restaurant, and other services sectors. Those working in personal services, administrative and secretarial work and sales and customer service were far more likely to be female. This representation also demonstrates the extent of the segregation of work within industry and occupation types, and the notable heterogeneity of segregation across the two job characteristics; although only fourteen percent of those working in the construction sector in 2007 were female, eighty-four percent of the administrative and secretarial occupations in that sector were filled by women, a greater share than in any other sector. The employment types described here are broad, but

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nonetheless these definitions highlight the striking differences in where men and women find themselves in the labor market.

[Table 1 about here – half page]

We therefore ask: to what extent can short-term changes in the employment gap be explained by the industry sectors and occupations where men and women work? To answer this question, we construct a decomposition of changes in relative gaps in employment, accounting for the initial extent of segregation in work at the onset of the downturn. This is represented relative to a counterfactual, whereby both men and women were instead distributed across job types in identical proportions to their shares of the workforce as a whole. As such, this method accounts for a more complete role of segregation in the evolution of UK employment gaps than in existing studies (see for examples Jill Rubery and Anthony Rafferty, 2013, Helene Perivier, 2014). The shift-share analyses used in these studies do not capture the explicit role of there being initial differences in the distribution of work by gender at the start of a recession. Instead, they only capture a partial role that this could have in the evolution of the gender gap. Here we address this limitation. Moreover, we contribute to the previous literature by considering the role of segregation across both industry sectors and occupations, as well as their intersection. We find that this combined extent of segregation can account for all of the initial fall in the employment rate gap from 2008. However, by the end of 2011 it accounts for over two and a half times the gap's actual decline, with this contribution subsequently declining by the end of 2014. This suggests that the gender gap should have narrowed significantly further, if the reduction in jobs growth had been proportional for men and women to their industry-occupation shares. After accounting for where men and women work, the economic cycle still does not appear gender neutral, but it is women's employment instead which should be viewed as relatively more sensitive.

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From a feminist economics perspective this has some notable connotations, most evident being that our approach emphasizes the role of segregation by gender in "contributing to the economic crisis and shaping its distributional dynamics" (Sakiko Fukuda-Parr, James Heintz, and Stephanie Seguino, 2013). A full account of the impact of the most recent recession and recovery in the UK, including the gender-blind response of policy makers, could lead us to conclude that the initial "mancession" has become a "womancession" (Ailsa McKay et al., 2013). In this article, we show that careful consideration of gender segregation leads to results contradicting these existing narratives that have characterized the Great Recession as a "mancession" in the first place.

BACKGROUND

Evidence of a UK gender business cycle

Several studies have analyzed the possibility that the business cycle is not gender neutral.[2] The majority of these have described or estimated this indirectly, or with limited attention to the UK. Peiro et al. (2012) estimated directly a relationship between changes in unemployment rates and a cyclical component of Gross Domestic Product (GDP) for the UK and US, finding that the business cycle extends its influence on unemployment rates over several quarters, and does so more intensely for men than women. Razzu and Singleton (2016) extended this analysis further, decomposing a gendered output gap identity, and estimating an implied model comprising cyclical components of GDP and labor market outcomes for the US and UK, from 1948 and 1971 respectively. The cumulative response to the business cycle of the male unemployment rate has been significantly stronger in both countries over this period. Whilst the focus of these studies has mostly been on the unemployment rate, there has nonetheless been some recognition that there could be gender patterns in other aggregate labor market outcomes. As our main objective is to assess the role played by segregation, here we focus only on employment.

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We begin with the simplest identity relating output and employment in some time period t,

$$Y_t \equiv \left(\tfrac{Y}{E}\right)_t \left(\tfrac{E^m + E^f}{N^m + N^f}\right)_t N_t \,, \tag{1}$$

where Y is real GDP, Y/E is output per employee, N is the population level, and $\{m, f\}$ denote male and female values respectively. To express this as a tractable additive function of employment rates we take a first order log approximation around $t - 1$ values,

$$\Delta y_t \equiv \left(\tfrac{E^m}{E}\right)_{t-1} \Delta[e - n]_t^m + \left(\tfrac{E^f}{E}\right)_{t-1} \Delta[e - n]_t^f + v_t \,, \tag{2}$$

where lower case values represent the natural logarithm. Thus, $\Delta[e - n]_t^m$ gives the log change in the male employment rate between two periods, and v_t captures the contribution of changes in output per worker, population and an approximation error.[3] Equation (2) could also be re-written in terms of zero sample mean log point cyclical deviations if instead we approximated around some identifiable trend in the series.

Following (2), the cross-correlation statistics of log GDP and gender employment rate changes, with the latter weighted by their shares in total employment (shown in Table 1 in the online Supplementary Appendix) demonstrate that male employment rate changes are more strongly related to the business cycle than female changes (see Supplementary Appendix Table 1 for full results). Considering the correlation of employment rates ten quarters after a GDP change, there is also some suggestion that the female response is more persistent. Again using (2), we also account for how changes in employment rates have cumulatively contributed to recent recessions. Figure 2 uses forecast errors from an estimated VAR model to decompose deviations from trend GDP for the 1990 and 2008 UK recessions respectively (see Supplementary Appendix for discussion of the data and methodology used here). During the former, reduced male jobs growth accounted for approximately forty percent of the fall in

output. Female employment however accounted for less than twenty percent at the deepest point of the recession. In the most recent downturn, the male employment rate contributed less than twenty percent of the decline in output from trend, and the female rate nothing.

[Figure 2 about here – half page]

Theoretical explanations of the gender business cycle

There are several potential reasons why business cycles could lead to different aggregate labor market outcomes for men and women. For example, the extent to which female might substitute for male labor during recessions has been argued to depend on women's commitment to participation, as well as state policy and support for their employment (Jill Rubery 1988, Rubery and Rafferty 2013). Moreover, it could in some part be explained by gender related differences in individual economic agents' responses, both in the supply and demand of labor. For instance, discriminatory firms' negative perceptions of women's relative productivity might change during economic recessions, perhaps as a consequence of the increased need to minimize costs such as maternity leave, therefore leading to some substitution between men and women in work.

Various complex and interacting factors could theoretically account for a gendered response of labor supply decisions over the cycle: the level of attachment to the labor market and exposure to macroeconomic shocks, levels of job tenure and human capital accumulation, institutions, and how households pool resources, income and risk. One way in which these factors might theoretically manifest during a recession is the so-called added worker effect (AWE). An increase in labor supply might be prompted by the need to compensate for the loss of a partner's, and therefore household income. The evidence on the significance of the AWE is however mixed.[4] Most studies consider a micro-level analysis of married individuals' labor supply decision. Mark Bryan and Simonetta Longhi (2017), comparing the

UK Great Recession to the boom period before, found that both men and women substantially increased their job search activity from 2008-11 if their partner lost a job, compared with the years previously. This would imply that an AWE could be important in explaining gender patterns in employment over the cycle. However, the authors also found that this job search activity did not tend to increase the likelihood of these individuals moving into employment. Razzu and Singleton (2016) also considered the possibility of an AWE at the macro level, using labor market flows data for the UK, and concluded that there is scope for it to explain some of the gender pattern in outcomes. Using US time use survey data, Günseli Berik and Ebru Kongar (2013) also reported evidence consistent with an AWE. The 2007-09 recession narrowed the gender gap in both paid and unpaid work. Married mothers reduced their hours of time devoted to housework, shopping and childcare, replacing it with paid work. Fathers saw reduced paid hours but no additional unpaid work.

Another possibility is that female employment relationships simply differ from those of men. For example, male job tenure is typically longer (Alison Booth, Marco Francesconi, and Carlos Garcia-Serrano, 1999), and employees with relatively shorter tenures may be fired more quickly than those who have been with the firm longer and accumulated more experience, job specific skills or potential redundancy costs. Similarly, women more commonly work part-time or in temporary positions, and these forms of employment tend to be more sensitive to the economic cycle. However, Daniel Borowczyk-Martins and Etienne Lalé (2016) have documented that during the Great Recession part-time employment has been counter-cyclical, and that increases in this type of work tended to favor men. This increase though was driven by transitions within employment, both by movements from full-time work and lengthened spells in part-time work. As such, although this dampened the relative fall in the employment gap, it was nonetheless symptomatic of worsening relative outcomes for men. Carlos Carrillo-Tudela, Bart Hobijn, Powen She, and Ludo Visschers

(2016) focused on the role played by career changes, and found that job moves to different occupations or industries have been strongly pro-cyclical over the last two decades in the UK, and women were significantly more likely to make a career change upon a new hire, particularly in job to job transitions. It follows that when the economic climate restricts these movements, whether this be through risk aversion on the part of the employee or lack of opportunities, women are likely to be more adversely affected.

Before considering whether there are intrinsic and more complex differences in how men and women interact with labor markets over the business cycle, which are typically challenging to identify, we should be sure we are not more simply observing the effects of labor market composition. Can the patterns described above be accounted for by where men and women work, by their different concentrations in occupations and industry sectors? Although the observed cyclicality of aggregate gaps for the UK may be modest, it is possible that composition has an offsetting effect on the actual differences in gender responses, such that the business cycle is less gender neutral than it would at first appear. Of course, that means that some of the potential factors outlined above might also be related to the gender segregation of the labor market. Before we discuss our methodological approach to address this issue, we revisit the empirical evidence on gender segregation and employment outcomes since the Great Recession.

Gender segregation of work, the Great Recession and austerity

The gender segregation of work in the UK, and in many other countries, is a commonly reported fact (Robert Blackburn, Jennifer Jarman, and Bradley Brooks, 2000, Robert Blackburn, Jude Browne, Bradley Brooks, and Jennifer Jarman, 2002, Francesca Bettio and Alina Verashchagina, 2009). A large number of theoretical explanations have been proposed to explain it. Each tends to focus on one possible set of reasons. For instance, differences in human capital and education have been at the core of neo-classical economics approaches

and their focus on gender pay differences since the work of Jacob Mincer and Solomon Polachek (1974). Others have explained segregation in terms of patriarchy: the notion of male power and control in various spheres of life, resulting, in the exclusion of women from the best jobs, their dependency on men since female earnings are typically lower, and in the general exploitation of women both in work and the home (Sylvia Walby, 1986, 1990). Catherine Hakim (2000) places the emphasis on individuals' choices, with little room given to the fact that these choices might have been constrained. Finally, another approach rejects the application of external factors, such as rational choice or patriarchy, and argues that segregation is best understood through the examination of social reproduction and changing gender relations, recognizing the role of all aspects of social and technical change over time (Blackburn et al., 2002). However, it is beyond the scope of this paper to review these theoretical perspectives in detail. Here, we focus on empirical studies of whether or not segregation is relevant to the cyclical gender pattern.[5]

Rubery and Rafferty (2013) conducted a shift-share analysis of employment changes over the Great Recession, holding constant 2007 gender industry shares, finding that differences can mostly be accounted for by patterns of job loss and growth across sectors, rather than gender differences within. Overall and in some sectors women were disproportionately affected. Perivier (2014) undertook a similar study over the same period and concluded that female employment loss in the UK was relatively greater than male, after accounting for the initial industry segregation of the labor market. Relatedly, Stefania Albanesi and Ayşegül Şahin (2013) constructed a counterfactual employment rate change over past US recessions for women if they had the same distribution of work across industry sectors as men. Differences in the initial distribution of work before a recession accounted for around half of the greater male unemployment rate rise. Likewise, for employment changes,

the industry distribution accounted for over two-thirds of higher male employment losses in recent US recessions.

Philip Arestis, Aurélie Charles and Giuseppe Fontana (2013) have explored the possibility that the financialization of the US economy since the 1980s has created identity preference effects, by its linking of managerial and financial occupations to high earnings, and in turn high earnings to the dominant demographic group in the labor force, namely men. Individuals with a similar identity could develop these preferences in so far as they engage in behavior that reduces negative externalities generated by the identity of other individuals. For instance, a white male employer will consider certain jobs appropriate for white men only. So-called stratification effects of the Great Recession, through the declining importance of the financial services sector in the economy, could then in part be explained by the fact that the financialization of the economy in recent decades has not been gender neutral. In keeping with this observation, although where men and women work at the start of the recession is not strictly exogenous to other candidate explanations above, if segregation can account for changes in subsequent gaps it nonetheless shows that this is the likely channel through which men and women might have different labor market experiences during a recession. As such, factors that can explain the segregation of work, such as educational subject choices, would most likely explain why business cycles are not gender neutral, as opposed to other hypotheses, such as the added worker effect.

As pointed out by Fukuda-Parr et al. (2013) in relation to the causes, manifestations and consequences of the economic crises, "the emphasis on the immediate aftermath of the crisis does not provide a full portrait of the crisis' effects as they evolve over time". In fact, the 2008-09 UK recession, as in many other countries, resulted in increased output gaps and larger fiscal deficits, the latter as a consequence of increased social expenditures (automatic stabilizers) and decreased tax revenue. However, political concern for an increase in the

national debt resulted in the UK adopting significant fiscal consolidation thereafter, or so-called austerity, associated with large reductions in public expenditure. Christian Bredemeier, Falko Juessen and Roland Winkler (2015), using US data, have studied the effects of fiscal policy on the distribution of employment and found that fiscal expansions lead to a disproportionate increase in female employment relative to that of men. More specifically to the UK and fiscal policy, Maria Karamessini and Jill Rubery (2014) have demonstrated that austerity programs have gender specific consequences.[6] Segregation across industry sectors has been considered to play an important role in explaining why austerity programs are likely to have more severe effects on women's than men's employment. Those sectors most likely to be affected by public expenditure cuts, and therefore job cuts, are dominated by female employment. If not impacted on the extensive margin, the greater pressure at work might pose problems to work-life balance and therefore affect the intensive margin of women's labor supply. Perivier (2014) has reported a "seesaw" effect for the UK, whereby the austerity phase has led to a reduction in female dominated sectors and an increase (or relatively smaller reduction) in male dominated sectors. Figure 3 shows the share of male and female employment in the public sector, from 2002 to 2014. For both men and women, this peaked in 2010. From 2010 onwards, following the fiscal contraction imposed by the new coalition government, the share of both men and women working in the public sector has returned to the levels of the early 2000s.

[Figure 3 about here – half page]

DATA AND METHODOLOGY

To generate consistent quarterly time series of gender employment by industry, occupation and a measure of those working in the public or private sectors, from the period immediately before the Great Recession, we make use of the micro data from the Quarterly Labour Force

Survey (QLFS) for those aged sixteen and over (see Supplementary Appendix for a more detailed description of the data used here). By industry and occupation we generally refer to the SIC1997 classification of sectors and SOC2000 classification of major occupation groups respectively, as described in Table 1. For robustness we also consider results using the associated more detailed classifications of industry divisions and minor occupation groups.[7] Public or private sector employers are defined by survey respondents' own judgements.

We decompose employment rate changes as follows. Let E_i^j refer to the employment of gender j in some type of work i, whereby the total employment of men or women is given by $\sum_i E_i^j$. A first order approximation of the log quarterly change in the employment rate of gender j is given by

$$\Delta[e-n]_t^j \approx \sum_i \lambda_{i,t-1}^j \Delta e_{i,t}^j - \Delta n_t^j \,, \tag{3}$$

where $t-1$ denotes the previous quarter's value and $\lambda_i^j = (E_i/E)^j$, i.e. the share of all men or women in employment working in industry-occupation i. This equation highlights the principal difference between our method and the shift-share analysis typically used in the literature. For each gender, a small relative (or log) change in the employment level or rate is approximately equal to a weighted average of the relative change in employment in different job types, where the weights are the initial distribution of work over these job types. A shift-share analysis is silent about how this initial gendered distribution of work matters over the subsequent economic cycle, relative to some more equal alternative. Instead, "the sex sectoral segregation hypothesis of the gendered effect of the crisis on employment" (Perivier, 2014) in these analyses is captured only by holding constant over the cycle the share of workers in some job type who are men or women. Our approach should then be viewed as a way to further unpick the gendered effects of recessions.

We can also represent the quarterly change in the log employment rate gap as

$$\Delta EGap_t \approx \sum_i \left[\lambda_{t-1}^m \Delta e_t^m - \lambda_{t-1}^f \Delta e_t^f \right]_i , \qquad (4)$$

where differences in working-age population growth rates are approximately zero over short time periods. To consider the full extent of how work segregation might account for or hide the gendered effects of the business cycle, we construct a counterfactual change in the employment rate gap. This is determined only by the relative change in employment of men and women within each industry-occupation, and not by the differences in where they worked before the recession. This counterfactual is given by

$$\Delta \widehat{EGap}_t = \sum_i \hat{\lambda}_{i,t=2007q1} [\Delta e^m - \Delta e^f]_{i,t} , \qquad (5)$$

where $\hat{\lambda}_{i,t=2007q1}$ is the share of all non-gendered employment in each industry-occupation group in the first quarter of 2007. As such, if men and women were equally affected within an industry, occupation etc., through the downturn and the following period of austerity, this counterfactual would be zero; the actual change in the gender gap would be accounted for almost completely by the gender segregation of work. To see this more clearly, by adding and subtracting terms we can re-write (4) as

$$
\begin{array}{c}
\overbrace{\phantom{\Delta \widehat{EGap}_t}}^{\textit{counterfactual}} \quad \overbrace{\phantom{\sum_i \left[\left(\lambda^m - \hat{\lambda} \right)_{t=2007q1} \Delta e_t^m - \left(\lambda^f - \hat{\lambda} \right)_{t=2007q1} \Delta e_t^f \right]_i}}^{\textit{initial segregation}} \\
\Delta EGap_t \approx \Delta \widehat{EGap}_t \; + \; \sum_i \left[\left(\lambda^m - \hat{\lambda} \right)_{t=2007q1} \Delta e_t^m - \left(\lambda^f - \hat{\lambda} \right)_{t=2007q1} \Delta e_t^f \right]_i \\
+ \sum_i \underbrace{\left[\left(\lambda_{t-1}^m - \lambda_{t=2007q1}^m \right) \Delta e_t^m - \left(\lambda_{t-1}^f - \lambda_{t=2007q1}^f \right) \Delta e_t^f \right]_i}_{\textit{varying segregation}} . \qquad (6)
\end{array}
$$

The second term of (6) thus captures how much of the change in the employment gap can be explained by the degree of pre-recession segregation. The final term gives the additional contribution from employment shares evolving over time, which will only be significantly different from zero in the long-run. In the short-run, this decomposition captures three

potential explanations for a cyclical gender gap. First, it could be explained entirely by the counterfactual, through the different employment responses of men and women within job types. Second, it could be explained entirely by the extent of initial segregation in the labor market. Third, it could be explained by some combination of the first and second. Therefore, this decomposition differs from Rubery and Rafferty's (2013) or Perivier's (2014) shift-share analyses since it identifies more completely the role of segregation, relative to an economy where in the first place men and women would do the same work if employed, which is then testing a more extended version of Rubery's (1988) "sex segregation hypothesis".

RESULTS AND DISCUSSION

Table 2 summarizes results for the counterfactual decomposition described above by (6). We separately consider the role of segregation across industry sectors and divisions, minor and major occupation groups, and the public or private sector. We also consider the intersections of industry sectors, major occupation groups, and public sector status of employment. The final row is a robustness check considering only workers aged 25-55 as opposed to 16+. For each decomposition of the cumulative change in the logarithmic gender employment rate gap we detail two sub-periods: the initial downturn between the final quarters of 2007 and 2010, and the period of shallow economic recovery and fiscal austerity thereafter. So, for instance, the first line of results in Table 2 describes the role of segregation across nine industry sectors for the former period. The actual employment gap decreased by approximately 2.7 percent from 2007 to the end 2010. The remaining columns give the contributions of the three factors in the decomposition described above. The *counterfactual* is one whereby men and women were assumed to have been identically distributed across industry sectors at the beginning of 2007, taking as given the true non-gender specific distribution of employment. As such, the positive *counterfactual* contribution tells us that the weighted average of the relative fall in female employment within those nine sectors was greater than the male fall, with those

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weights being each sector's 2007 share in total employment. The *initial segregation* contribution shows that the actual fall in the gender gap was more than explained by the differences in female and male employment shares across sectors before the start of the downturn. The final column, *varying segregation*, shows the small additional contribution from allowing these gendered sector employment shares to change as actually observed since 2007. In some sense this final column can be seen as a residual of the approximation, and we should not expect it to be large when studying only a short time period. These results are discussed more fully in the following sections and figures. However, still focusing on only the first row, we see that if employment had not been segregated across the industry sectors, the actual relative changes in male and female employment within sectors would have resulted in an increased gender gap.

[Table 2 about here – half page]

Industry segregation

As shown by Figure 4a, when accounting for industry segregation alone, the contribution from the different distribution of men and women across sectors pre-recession, labeled *Initial segregation*, is approximately twice as great as the actual fall in the employment rate gap. Under our counterfactual, the employment rate gap would in fact have widened substantially. In the downturn, jobs losses and reduced growth were more prominent in sectors where men dominate the labor force, such as construction and manufacturing, particularly at the start of the downturn, and vice versa in female dominated sectors such as public administration and health and social work activities. The initial fall in the gap has largely persisted since 2011, as has the extent to which this can be explained by the industry segregation of work. This suggests that any subsequent economic recovery has not favored jobs growth in sectors that were hardest hit during the downturn. Given that segregation more than accounts for the fall in the employment rate gap, a simplistic interpretation of this result would be that within

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industry sectors, women's employment was more harshly affected by the recession.[8] The nine

industry sectors defined here are broad. However, when we consider the role of segregation

across sixty industry divisions, these patterns not only remain but become more pronounced

(see also Supplementary Appendix Figure 4). Nonetheless, this still does not account for the

heterogeneity and segregation of work within specific industry sectors, particularly by

occupation.

[Figure 4 about here – full page]

Occupation segregation

Segregation across major occupation groups alone accounts for the majority, around seventy-

five percent, of the fall in the log employment rate gap by the end of 2010 (see Figure 4b).

Those working in skilled trades for example, who are more likely to be male, experienced

relatively worse employment changes than those in administrative and secretarial work, who

are more likely to be female. When considering these broad occupational groups, there is no

indication that women were more severely affected by the downturn. From 2010, some of the

jobs recovery did tend to favor the same male dominated occupations that were initially

hardest hit. However, these occupation groups are broad and unlikely to reveal the true extent

of gender segregation in the workforce. Therefore we consider a more detailed classification

of minor occupation groups. After doing so, we find that the segregation can account for all

of the initial fall in the gender gap, and by 2011 female employment within these eighty-two

occupations on average experienced a relatively greater decline, although this contribution is

less persistent from 2011 onwards than observed within industries (see Supplementary

Appendix Figure 5).

Public vs. private sector

During the initial downturn to 2010, we might expect some part of the relative difference in gender outcomes to be explained by the concentration of female work in the public sector, which was typically insulated from the employment losses seen elsewhere in the economy. However, as seen in Figure 4c, this segregation can account for a third of the fall in the employment rate gap. Male employment, independent of whether it was private sector or not, fell relatively more than female. It would appear as though the public-private dimension of employment was far less significant in explaining differences in relative outcomes than industry or occupation. Nonetheless, in these results there is some evidence of the burden of austerity on women. From 2011 onwards, whilst the employment rate gap remained persistently low compared to pre-recession, the counterfactual contribution decreased, indicating that that the employment gap would have reduced even further. Recalling that the counterfactual here measures the cumulative change since 2007 in the gap caused only by differences in the relative changes in employment of men and women within the public and private sectors, this result implies that although male employment grew at a lower rate than female within sectors, the concentration of women in the public sector, where employment fell sharply (see Figure 3), worked to offset this. In other words, the contraction in public sector employment did not lead to a widening in the actual gender gap only because it coincided with slower male jobs growth more generally throughout the economy.

Industry & Occupation

Thus far we have only considered separately the role of industry or occupational segregation in explaining relative employment patterns through the Great Recession. Now we consider both together. Employment types are defined by industry-occupation, and we consider in effect the segregation of the labor market represented in Table 1. Under our no segregation counterfactual the employment gap change is close to zero throughout most of

2007-10, and as such the segregation of work must account for the majority of the relative changes in employment initially (see Figure 5). By the end of 2011, the segregation of work accounts for over two and a half times the actual fall in the employment rate gap. This suggests that the gap should have narrowed significantly further if the reduction in jobs growth had been equally shared by men and women within each industry-occupation. Therefore, there is scope to suggest that women's employment, after accounting for segregation, was more severely affected by the downturn than men's. By the end of 2011, in a scenario where it is only segregation that affects the relative changes in gender employment rates, the gap would have narrowed further than it actually did. In fact, under our counterfactual, the gender employment rate gap would have risen by around a quarter. However, from 2011, although the observed decline in the gender gap is persistent, the role of segregation diminishes by 2014. Thus, accounting for where men and women work still demonstrates that the business cycle has not been gender neutral, but we might conclude differently now that, at least so far as the UK Great Recession is concerned, women in employment were disproportionately affected at the height of the downturn. Figure 6 demonstrates this in terms of the levels of the gender employment rates. The counterfactual female rate falls further than the male during 2010-11. These patterns are unchanged when we consider public sector segregation alongside industry-occupation, suggesting the latter mostly accounts for the concentration of women in some public sector job roles (see Supplementary Appendix Figure 6). Further, the results remain largely unchanged when we consider employment amongst those aged 25-55 instead of 16+ (see Supplementary Appendix Figure 7).[11]

[Figure 5 about here – half page]

[Figure 6 about here – half page]

From the graphical representations of the decomposition results, three distinct phases can be identified from a gender perspective. From 2007 to the beginning of 2010, male employment was more negatively impacted than female employment, but this can be mostly explained by where men and women work in the economy, especially with regards to the construction and skilled trades sectors and, to a lesser degree, the finance sector. Then, from 2010 to 2011, the pre-recession segregation of work continued to imply a narrowing employment gap, but this was increasingly offset by relatively worse employment changes for women than men within sectors and occupations. This represents the effect of those who had been displaced from male dominated sectors finding new employment in those previously dominated by women. We can see this more clearly when we identify the specific industry-occupation types which contributed most to the positive increase in our counterfactual gender gap: sales and customer service in Distribution, Hotels & Restaurants, and personal service in Public Administration, Education & Health (see Supplementary Appendix Tables 3 & 4). This also coincided with a substantial increase in part-time work for men, mostly involuntary (Borowczyk-Martins and Lalé 2016), and the greatest incidence of part-time work in the economy also coincides with these industry-occupations. From 2011 onwards, the role of the segregation of work reverses, increasing the employment rate gap. Partly this reflects the recovery of those male dominated sectors hardest hit by the recession, but also female dominance of the public sector.

Comparison with a shift-share analysis

As a sense check, we also compare one set of results to what would have been obtained from a shift-share type analysis in the spirit of Rubery and Rafferty (2013). Focusing on industry sectors alone, we decompose the absolute change in the employment gap in levels over subsequent three-year periods from 2004 (Table 4). The *segregation* effect here represents the change in the gap that would have occurred if the male and female shares within each

sector had remained constant throughout the period. Thus, unlike under our counterfactual type decomposition above, it is not only the initial difference in employment shares which is accounted for, but also an assumption that male and female employment changes within types were equal. Between 2004 and 2007, during which time the employment gap increased by only twenty-four thousand, the segregation effect contributed virtually nothing. However, between 2007 and the end of 2010, when the gap decreased by around four hundred thousand, the segregation effect for industry sectors accounts for a fall of eight hundred thousand. Thus the different distribution of work within industries accounts for over twice the fall in the gap. Although the two methods are only indirectly comparable, the magnitude of industry segregation's role during the Great Recession accounted for here is similar to that found above using our alternative approach.

CONCLUDING REMARKS

This article considers the role of gender segregation in work in determining the impact of the Great Recession on the labor market outcomes of men and women in the UK. The existing literature suggests that men's and women's experiences of the economic cycle could differ substantively, and that most recently men's outcomes were disproportionately affected. Although various explanations have been put forward to potentially explain these cyclical gender differences, observed not only in the UK, the most common of these is also perhaps the simplest: men and women work in different industries and occupations, and jobs dominated by men are more sensitive to the cycle.

Our analysis, by adding substantially to the current literature, contradicts the existing narrative that men's employment was more harshly affected by the recession than women's employment. First, we robustly confirm the gender dimension of the UK business cycle. We look at the role of gender segregation in a comprehensive way, using an approach that can account for the full extent of pre-recession segregation, and by studying the role of

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segregation across industry and occupation combined. We also assess the composition of public and private sectors, which is especially relevant to the recent period of UK austerity. Gender segregation across industry sectors accounts for more than twice the fall in the employment rate gap from 2007 to 2010. The pre-recession extent of segregation across both industry sectors and occupations combined can explain over two and a half times the gap's actual decline. As such, if segregation were the only factor affecting gender outcomes over the cycle, the gap ought to have declined significantly further than observed during this period. Although differences between men and women that determine the segregation of work, such as educational subject choices, must account for the pro-cyclical employment rate gap overall, there is nonetheless room for more cycle specific factors, such as the discriminatory firm practices theorized by Rubery (1988), to explain why within industry sectors and occupations women could be more severely affected. These results would also suggest that a cyclical added worker effect, which would tend to relatively increase female participation, is not a significant aggregate factor since we find that segregation alone more than accounts for the fall in the employment gap since 2007. This is consistent with other recent evidence that suggests the UK added worker effect is specifically an unemployment issue (Bryan and Longhi, 2013).

The results here suggest three distinct phases of relative gender employment dynamics through the recent recession and recovery. During the first, from 2007 to early 2010, in the immediate aftermath of the downturn, segregation can completely account for relative gender employment changes. In the second, from 2010 to 2011, the labor market stabilized through relatively stronger jobs growth for men than women within industry-occupations, especially those previously dominated by women. In the final phase, the effects of fiscal austerity from 2011 affected women's employment more severely through its

concentration in the public sector, but this was offset in the aggregate by the relatively worse performance for men within industry-occupations.

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ACKNOWLEDGEMENTS

NOTES

[1] Polly Toynbee, Guardian columnist: "My fear is that we will look back on this time of the deepest recession since the war, and see it as a period when women's lives took a step backward, at home and at work" (10/2014). In two years of economic recovery, women lost jobs, men found them, Pew Research Centre (7/2011). Are women bearing the brunt of the recession? Fawcett Society, (3/09). The Impact of Austerity on Women, Fawcett Society, (3/12). Alisa McKay, Jim Campbell, Emily Thomson, and Susanne Ross (2013) however have argued that these studies have been "marginalized" and focused too exclusively on the world of paid work and unemployment.

² See for examples Kim Clark & Lawrence Summers (1980), Rebecca Blank (1989), Ghazala Azmat, Maia Güell, and Alan Manning (2006), Herve Queneau and Amit Sen (2008, 2009), Hoynes et al. (2012). A business cycle includes periods of economic recession and recovery in sequence. This therefore overlaps with economic policies, such as fiscal expansion and contraction, or austerity.

³ For small changes the difference in natural logs is approximately the percentage change. This transformation allows us to create more tractable objects within an empirical application.

⁴ See Melvin Stephens (2002) for a detailed overview of the earlier literature.

⁵ This is a different question from one that assesses the impact of the business cycle on occupational segregation, which has been widely studied (see Cynthia Bansak, Mary Graham and Allan Zebedee, 2012, Donald Tomaskovic-Devey, Catherine Zimmer, Kevin Stainback, Corre Robinson, Tiffany Taylor and Tricia Mctague, 2006).

⁶ Jill Rubery (2015) provides an interesting and negative assessment of the impact of austerity policies in Europe on gender equality and its future.

⁷ From 2009 and 2011 onwards respectively, individuals' jobs were classified using updated SIC2007 and SOC2010 classifications. As such, we make use of conversions provided by the UK's Office for National Statistics. However, as shown in the appendix, using instead these latter classifications for the analysis does not qualitatively affect the results here.

⁸ See Supplementary Appendix online for a demonstration that these results are qualitatively unchanged when using ONS Labour Market Statistics and SIC2007 classification of industries for the decomposition instead of our estimates from the QLFS and SIC1992 equivalents.

⁹ Unfortunately, due to the sample size of the QLFS and ensuing small cell sizes when interacting industry-occupation, it would not be robust to report results for narrower age groups. There is also some similarity between the results when accounting for minor occupation groups only. Although there is correlation between these minor groups and the intersection of sectors and major groups, nonetheless, there is still sufficient difference to imply the two sets of results capture different versions of gender segregation.

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TABLES

Table 1 Gender segregation in the UK, 2007: the shares in industry-occupation groups who are women

		Occ. groups (SOC2000)
		1	2	3	4	5	6	7	8	9	Total
	A-B	0.26	0.39	0.55	0.81	0.13	0.78	0.52	0.08	0.19	0.28
	C-E	0.24	0.18	0.29	0.71	0.02	0.80	0.55	0.01	0.17	0.25
	D	0.23	0.15	0.35	0.77	0.05	0.68	0.60	0.22	0.28	0.26
Ind. sectors	F	0.15	0.11	0.22	0.84	0.01	0.36	0.63	0.01	0.05	0.14
(SIC1997)	G-H	0.36	0.37	0.53	0.74	0.17	0.82	0.70	0.15	0.52	0.52
	I	0.27	0.15	0.28	0.65	0.03	0.67	0.59	0.04	0.17	0.26
	J-K	0.34	0.26	0.44	0.78	0.05	0.65	0.59	0.14	0.43	0.46
	L-N	0.57	0.63	0.64	0.81	0.36	0.87	0.76	0.19	0.74	0.70
	O-Q	0.41	0.41	0.43	0.79	0.09	0.76	0.67	0.08	0.47	0.52
	Total	0.35	0.45	0.52	0.78	0.08	0.84	0.68	0.14	0.45	

Notes: SOC2000: 1. Managers and senior officials, 2. Professional occupations, 3. Associate professionals & technical occupations, 4. Administrative and secretarial occupations, 5. Skilled trades occupations, 6. Personal service occupations, 7. Sales and customer service occupations, 8. Process, plant and machine operatives, 9. Elementary occupations. SIC1997: A-B. Agriculture, forestry and fishing, C, E. Energy & water, D. Manufacturing, F. Construction, G-H. Distribution, hotels & restaurants, I. Transport & communication, J-K. Banking, finance & insurance etc., L-N. Public admin., education & health, O-Q. Other services.

Source: Author calculations using UK Annual Population Survey, January-December 2007.

Table 2 Decompositions of the change in the log gender employment rate gap (log points x100)

			Contribution to change in log gender gap		
		Total	Counterfactual	Initial segregation	Varying segregation
Industry					
Sectors *(9)*[†]	2007q4-2010q4	-2.7	2.3	-5.3	0.2
	2010q4-2014q3	-0.2	-1.6	0.9	0.5
Divisions *(60)*	2007q4-2010q4	-2.7	3.2	-6.4	0.4
	2010q4-2014q3	-0.2	-0.9	0.2	0.4
Occupation					
Major *(9)*	2007q4-2010q4	-2.9	-0.5	-2.2	-0.2
	2010q4-2014q3	-0.2	-0.9	1.1	-0.4
Minor *(82)*	2007q4-2010q4	-2.9	1.7	-4.5	-0.1
	2010q4-2014q3	-0.2	-2.9	2.9	-0.2
Public or private sector	2007q4-2010q4	-2.8	-1.6	-1.2	0.0
	2010q4-2014q3	-0.2	-2.6	2.4	0.0
Industry-occupation					
Ages 16+ *(72)*	2007q4-2010q4	-2.7	2.0	-4.8	0.1
	2010q4-2014q3	-0.2	-4.7	4.6	-0.1
& public or private *(144)*	2007q4-2010q4	-2.8	3.1	-5.9	0.0
	2010q4-2014q3	-0.1	-5.4	5.3	-0.1
Ages 25-55 only *(72)*	2007q4-2010q4	-2.9	2.2	-5.2	0.0
	2010q4-2014q3	0.8	-4.7	5.3	0.2

Notes: Gender gap given by male minus female. Columns may not sum to total due to approximation error and rounding. See Supplementary Appendix for details of data and methodology.

Source: Author calculations using Quarterly Labour Force Survey

† Values in parentheses give the number of types or categories of work accounted for in the decomposition.

Table 3 Industry sections shift-share decomposition of changes in the gender employment gap (absolute 000s)

| | | Contribution to change in gender gap | | |
	Total	Segregation	Shares	Interaction
2004q2-07q2	24	3	34	-13
2007q2-10q4	-394	-807	426	-13
2010q4-14q3	39	53	-23	9

Note: Gender gap given by male minus female. See Supplementary Appendix for details of data and methodology.

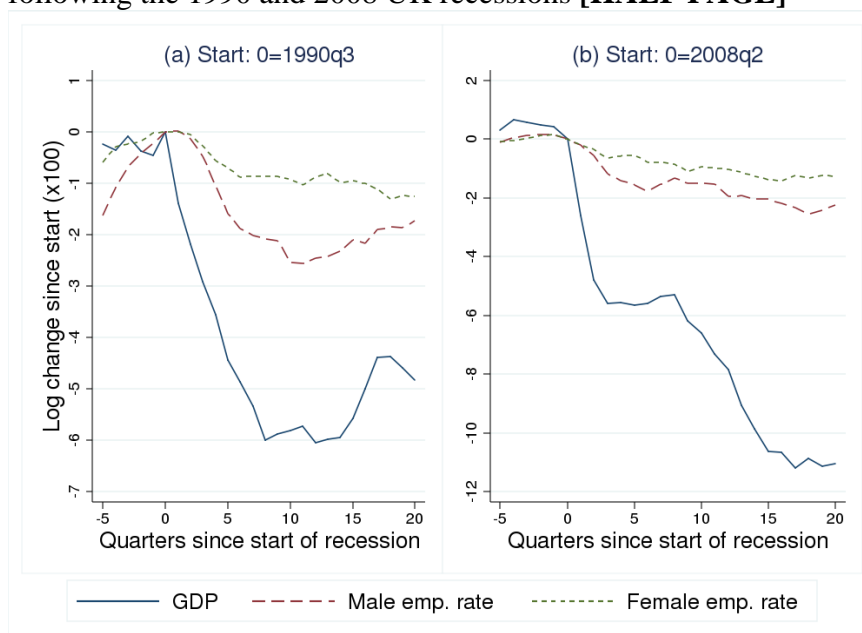Source: Author calculations using ONS Labour Market Statistics

Figure 1 Employment rates by gender, 16-64, SA, 1971-2014   **[HALF PAGE]**
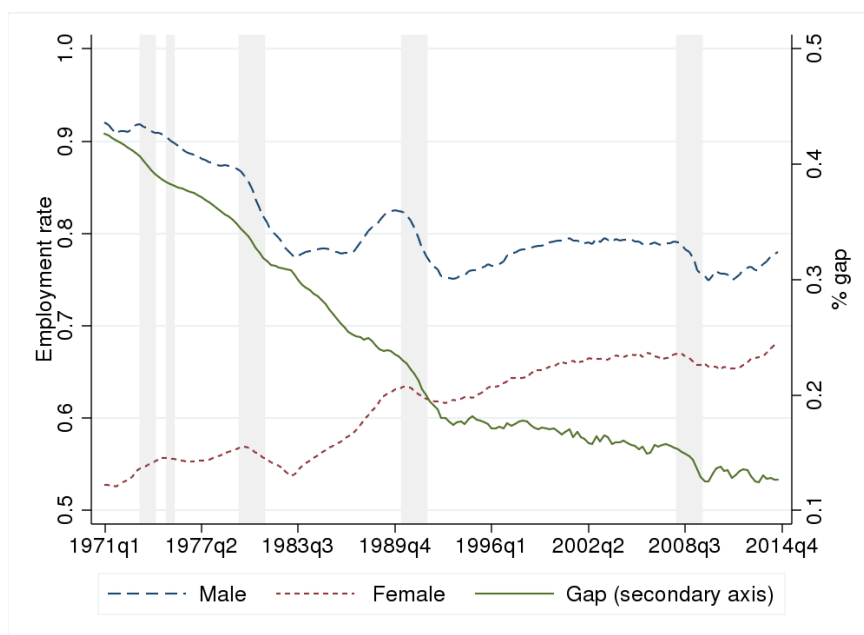
Notes: Gap measured as male minus female rate, relative to male. Shaded segments represent UK recessions defined as at least two consecutive quarters of negative real GDP growth.

Source: ONS Labour Market Statistics, accessed 02/2015

Figure 2 Cumulative change in GDP and contributions from gender employment rates following the 1990 and 2008 UK recessions **[HALF PAGE]**
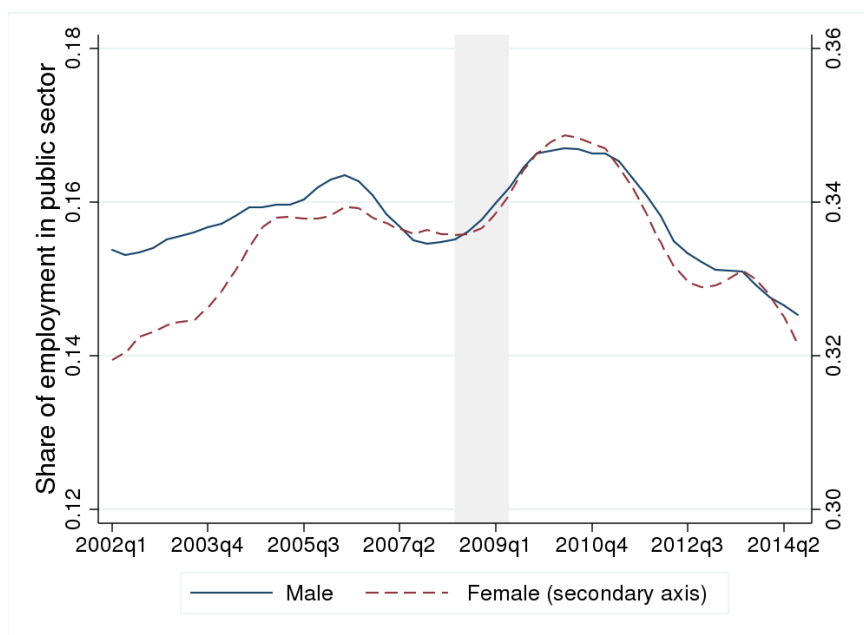

Notes: Indexed to zero in the quarter before the start of each recessionary period. Estimated using ten step ahead forecast errors from a VAR model. See Supplementary Appendix for more details.

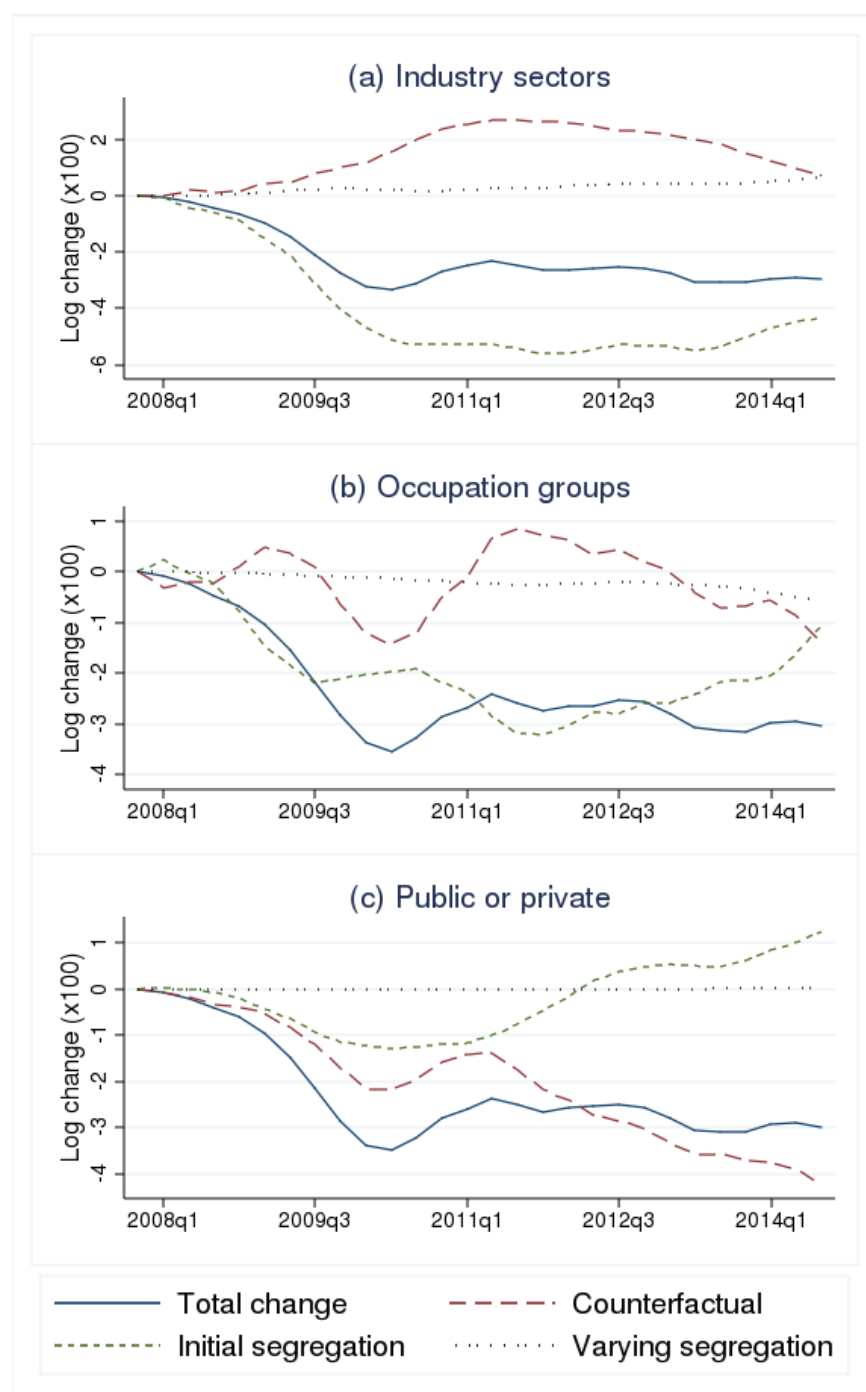*Source:* Author calculations using ONS data & definition of UK recessions.

Figure 3 Share of all in employment who work in the public sector, 2002-2014
[HALF PAGE]

Notes: ONS defines private sector employment as the total minus estimates for the public sector. Series here take non-seasonally adjusted data and are smoothed with a four quarter moving average.

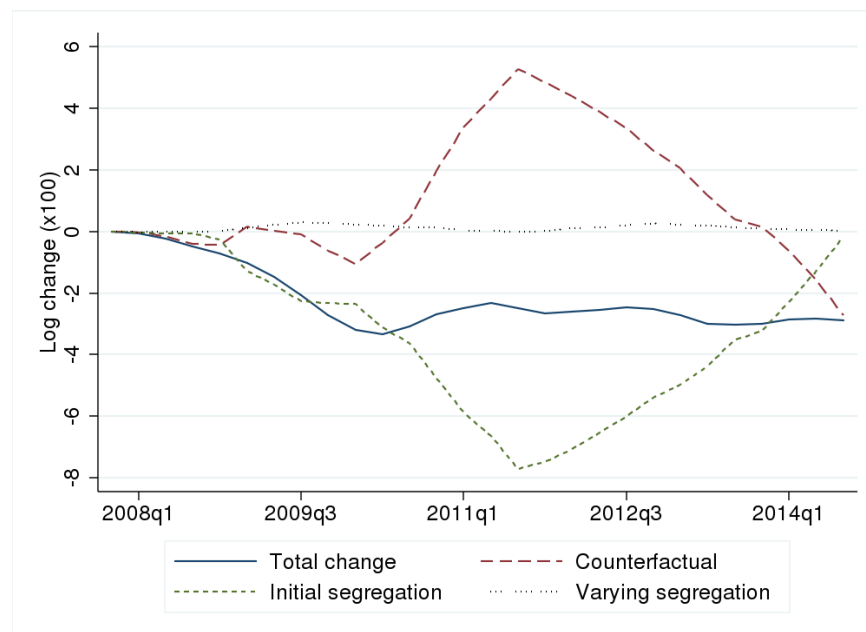*Source:* ONS Labour Market Statistics, accessed 02/2015

Figure 4 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across industry sectors, major occupation groups, and public or private sector   **[FULL PAGE]**

Notes: Gender employment rate gap stated as male minus female. All series are indexed to zero in the final quarter of 2007. See text for interpretation.

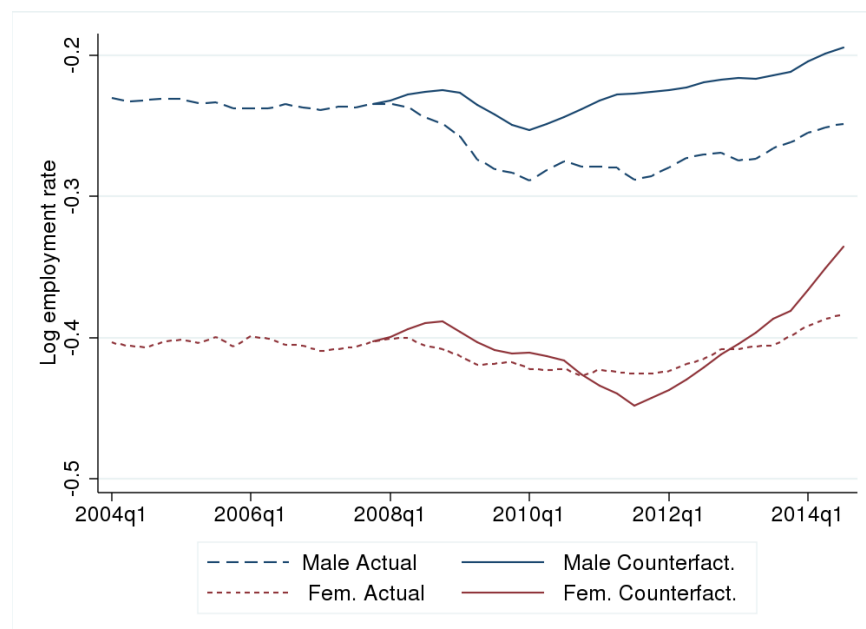*Source:* Author calculations using the Quarterly Labour Force Survey

Figure 5 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across industry-occupation groups   **[HALF PAGE]**

Notes: Gender employment rate gap stated as male minus female. All series indexed to zero in the final quarter of 2007.

Source: Author calculations using the Quarterly Labour Force Survey

Figure 6 Actual vs. counterfactual male and female log employment rates from 2007: segregation across industry-occupation groups   **[HALF PAGE]**

Notes: The cumulative change in the gender gap under the counterfactual (dashed) in Figure 5 is equivalent to the narrowing/widening of the counterfactual series (solid) here.

Source: Author calculations using ONS Labour Market Statistics, accessed 02/2015, and the Quarterly Labour Force Survey

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SEGREGATION AND GENDER GAPS THROUGH THE UK'S GREAT RECESSION

SUPPLEMENTARY APPENDIX

Data & methodology

Table 3 and Figures 4-5

For employment status we make use of editions of the Quarterly Labour Force Survey (QLFS) for all individuals aged sixteen and over. An indicative reference for the January to March 2007 edition used is as follows: Office for National Statistics. Social and Vital Statistics Division, Northern Ireland Statistics and Research Agency. Central Survey Unit. (2015). Quarterly Labour Force Survey, January - March, 2007. [data collection]. 6th Edition. UK Data Service. SN: 5657. We use the SIC1992 classification of industry sectors where available. However, from 2008 onwards, interviewers in the Labour Force Survey would classify occupations using the SIC2007. Details of how this differs from previous classifications can be found on the ONS website. To generate a consistent time series of employment by industry sector we make use of the conversion variable *in0792em*. This was created by the ONS by matching a SIC2007 sub-class to a higher level of aggregation, i.e. division, in SIC1992. We use the SOC2000 classification for occupation groups and a conversion from SOC2000. The LFS SOC2010-SOC2000 mapping available in the QLFS is probability-based (on an individual respondent basis), with the relative probabilities being based on the results of two dual-coded LFS datasets and a one percent economically active sub-sample of the 2001 Census. Using the estimated frequency distributions for the two classifications, the probability of a SOC2000 code occurring given a SOC2010 code at the 4-digit unit group level could be calculated. The qualitative results we find using these classifications however are not altered were we to use the SIC2007 and SOC2010 classifications as our basis (see below). To account for some small sample cell sizes, for the counterfactual decompositions of industry-occupation types we combine the smaller primary sectors *A-B* and *C,E*. Likewise, to handle the few empty cells, if a frequency for some industry-occupation returns zero in any period we exclude this case from the decomposition in all periods for each gender in turn. For the self-reported public or private sector description of employment we use *publicr*. We use the latest version of QLFS population weights. To account for seasonality we apply a backward looking four quarter moving average on the derived employment levels, i.e. $\hat{E}_{i,t}^{j} = \left(1/4\sum_{k=0}^{4}E_{i,t-k}^{j}\right)$. As such, and since the aggregate employment levels only include main jobs, and do not include those whose main job could not be assigned to one of the nine major occupation groups, industry sectors or private/public sector, the derived change in the employment gap will not match exactly with that which one can readily obtain from national statistics.

Table 4

As part of the monthly Labour Market Statistics (LMS) release by the ONS, a longer non-seasonally adjusted series for employment at the industry section (one letter) and at the major occupation group level are published by gender, for those aged sixteen and over, classified using SIC2007 and SOC2010, with the back series derived using the reverse of the methods described above. Using again a moving average to reduce seasonality, we use these series, as published in the January 2015 LMS release, to consider over the longer term which employment types tend to explain variation in the gender employment rate gap. We can also use these series to check that results for the employment decomposition using the QLFS were not dependent on the use of the SIC1992 and SOC2000 classifications and their conversions. SA Figure 1 below shows qualitatively that we would have obtained the same results had we used these published statistics and alternative classifications.

Similarly as in Rubery (1988) a shift-share decomposition of the difference in employment change between men and women can be described as

$$\Delta(E_t^m - E_t^f) = \underbrace{\sum_i (1 - 2\alpha_{i,t-1})\Delta E_{i,t}}_{\text{Segregation effect}} + \underbrace{\sum_i -2E_{i,t-1}\Delta\alpha_{i,t}}_{\text{Share effect}} + \underbrace{\sum_i -2E_{i,t-1}(1 - 2\alpha_{i,t-1})\Delta E_{i,t}\Delta\alpha_{i,t}}_{\text{Interaction effect}}, \quad (1)$$

where i denotes mutually exclusive finite employment types. $\alpha_{i,t}$ gives the share of workers of type i who are female in period t. The first sum on the RHS represents the employment or 'segregation' effect: this gives the change in the employment gap had the gender share within industries or occupations remained constant, and both men and women experienced the same change in employment within that type of work. The second term is the 'share' effect, and accounts for the changing composition of work within industries and occupations. Finally, the third term is the so-called 'interaction' effect, which is by design small and has no relevant interpretation. For ease of replication of these results, and so as to match National Statistics for this exercise, since it is a precise decomposition method, we use the published Labour Market Statistics series.

Equation 2 and Figure 2

Cross-correlation statistics of log GDP and gender employment rate changes, weighted by their shares in total employment, are computed using equation 2 in the main paper. These are shown in SA Table 1. It displays two types of results. The first, named *Unconditional*, shows cross-correlations statistics for log changes (first column) or deviations from trend (second column). The second, named *Conditional* addresses the fact that the unconditional results do not control for the behaviour of other variables in the output identity and, therefore, ignore potentially valuable information. The unconditional results are computed using the model of Den Haan (2000), which provides a workable solution without restrictive assumptions on the data generating process. The only requirement of the estimated VAR model in applying the result of Den Haan (2000) is that the error term for each equation is serially uncorrelated, which is achieved through inclusion of sufficient lags. One advantage of this method is that it is robust even for non-stationary variables, which is not the case for the unconditional statistics. In particular,

SA Figure 1 Decomposition of cumulative change in log gender employment rate gap from 2007 using SIC2007 and SOC2010 classifications

(a) Industry

(b) Occupation
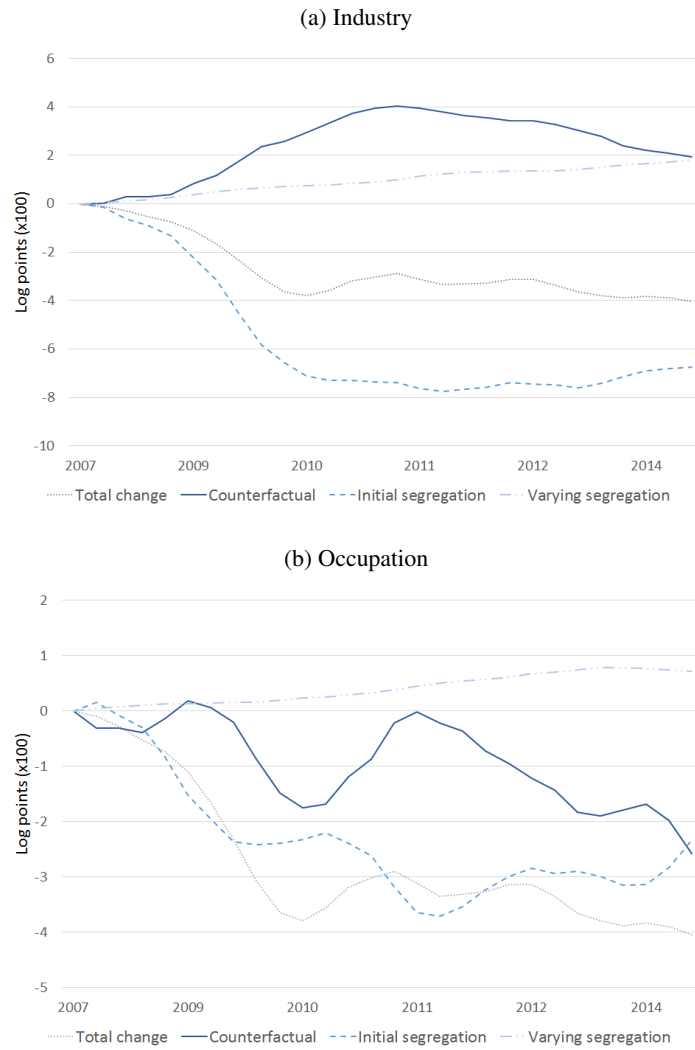
Notes: Gender employment rate gap stated as male minus female. Indexed to zero in final quarter of 2007.
Source: Author calculations using UK Labour Market Statistics & Labour Force Survey.

since the forecast errors themselves are in effect the outcome of a trend-cycle decomposition, we need not focus on the question of how best to estimate cyclical components of the time series. Even so, in what follows we retain the implicit restrictions in (2) that the series are likely to be $I(1)$, as this potentially increases the efficiency of forecasts in a finite sample setting. Thus, we estimate

$$A_t = \alpha + \beta t + \gamma t^2 + \delta t^3 + B(L)A_{t-1} + \varepsilon_t, \tag{2}$$

where A_t is a 3x1 vector containing the first three terms of (2), $\alpha, \beta, \gamma, \delta$ are 3x1 vectors, $B(L)$ is 3x3, and each i, j th element is the lag polynomial $b_{ij}(L) = (\beta_{i,j,0}L^0 + \beta_{i,j,1}L^1 + \cdots + \beta_{i,j,p}L^p)$. The lag length p is sufficient that (2) is correctly specified; i.e. the 3x1 white noise process ε_t is not integrated.[1] Using

the estimated VAR we then derive the $K \in [1,20]$ period ahead forecast errors for each variable using the maximum possible sample period. For each value of K we can then construct the conditional cross-correlation statistics for the variables in the model.

To construct the cross-correlation statistics we use quarterly and seasonally adjusted measures of GDP and employment rates for those aged 16-64 from 1971 to the third quarter of 2014.[2] For the sake of robustness, we estimated (2) under alternate specifications (see SA Table 2), though here we focus on a model with no trend terms, thirteen lags, and a sample period of 1971q2-2014q3.

Table 1: *SA Table 1:* Correlation statistics of quarterly log changes or trend deviations in GDP, for the period 1981q3-2009q3, with forward employment rates

| | *Unconditional* | | | | | | *Conditional* | | |
| | Time changes | | | HP-1600 | | | 10 step fcast err. | | |
Forward qtrs	0	Max.[†]	10	0	Max.	10	0	Max.	10
Male	0.44	0.58	0.07	0.67	0.85	0.01	0.44	0.49	0.13
		(2)			*(2)*			*(2)*	
Female	0.44	0.46	0.17	0.56	0.75	0.12	0.40	0.42	0.11
		(1)			*(3)*			*(1)*	

Notes.- Trend deviations for log GDP and employment are obtained using the Hodrick-Prescott filter with a standard parameter of 1600 for quarterly data. Ten step ahead forecast errors are obtained by estimating the VAR model described below, with no trend terms, thirteen lags and a sample period of 1971q2-2014q3. The male and female employment rate log changes/deviations from trend used to calculate the statistics here are weighted by their shares in total employment.

† Values in parentheses give the number of forward quarters for the employment rate value with the highest cross-correlation statistic.

SA Table 2: Description of VAR models estimated

Sample period	No. lags	Trend
1971q2 - 2014q3	13	
1971q2 - 2014q3	13	cubic
1971q2 - 2005q4	7	cubic
1980q1 - 2014q3	13	cubic

SA Figure 2 compares the unconditional cross-correlation statistics of both log time changes and deviations from logarithmic trend in GDP and forward gender employment rates with equivalent statistics obtained using the ten step ahead forecast errors from the VAR estimation. The pattern is consistent across all three measures, that the UK business cycle is more strongly positively correlated with lagged changes in male employment than female, in at least the following four quarters.

This suggests that the immediate greater effect of the business cycle on male employment outcomes drives the UK gender cycle, and that cumulatively a recessionary period will have a larger negative effect

on male outcomes (see also Razzu & Singleton, 2016). In SA Figure 3 we compare the results using forecast errors at a ten quarter horizon, from our main specification, with estimations using restricted sample periods. We see that excluding data form the Great Recession or the 1970s from the estimation does not qualitatively affect the gender patterns we observe.

We could also show how the cross-correlation results with specific lagged and forward employment rates might differ while varying the forecast horizon. To calculate these we use in each case the maximum possible sample period, and thus when we compare with the unconditional measures we also adjust the sample period accordingly, meaning that these latter measures also vary. Although for brevity we exclude these results here, unsurprisingly, given what we know about the frequency of the business cycle, the patterns we discuss above tend to disappear at shorter forecast horizons. However, once we look beyond a frequency which is able to extract business cycle features of the data (approximately a five quarter forecast horizon), the pattern we describe above, of male outcomes being initially more sensitive to the cycle, is consistent as we increase the forecast horizon. This is also the case with regards the lack of gender difference in persistence.

SA Figure 2 Comparison of conditional and unconditional cross-correlation statistics for changes/deviations from trend in log output and gender employment rates

(a) Male

(b) Female
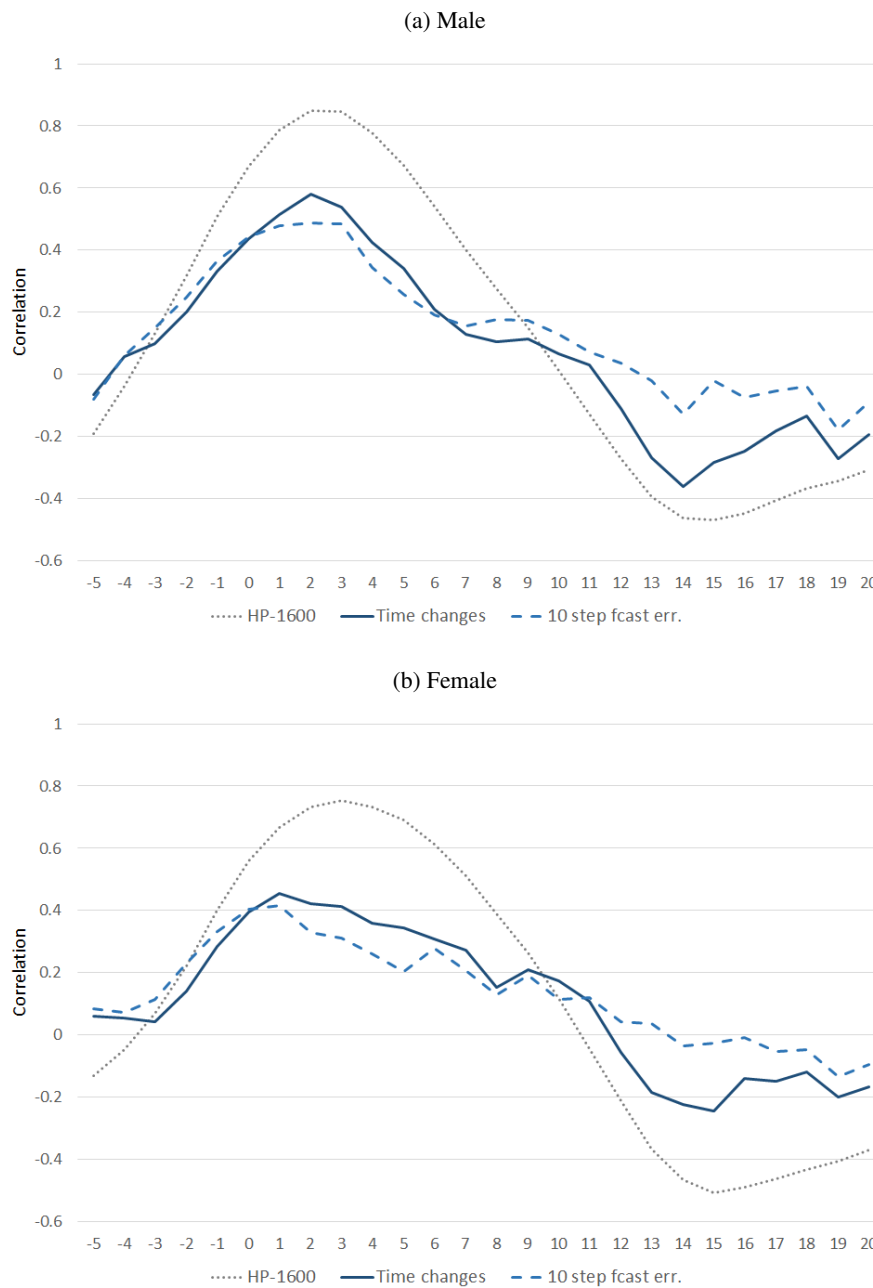
Notes: Forecast errors are from specification over full sample without trend terms, and correlation period is for GDP fixed at 1981q3-2009q3

SA Figure 3 Conditional cross-correlation statistics for changes in log output and gender employment rates with alternate specifications of VAR model

(a) Male

(b) Female
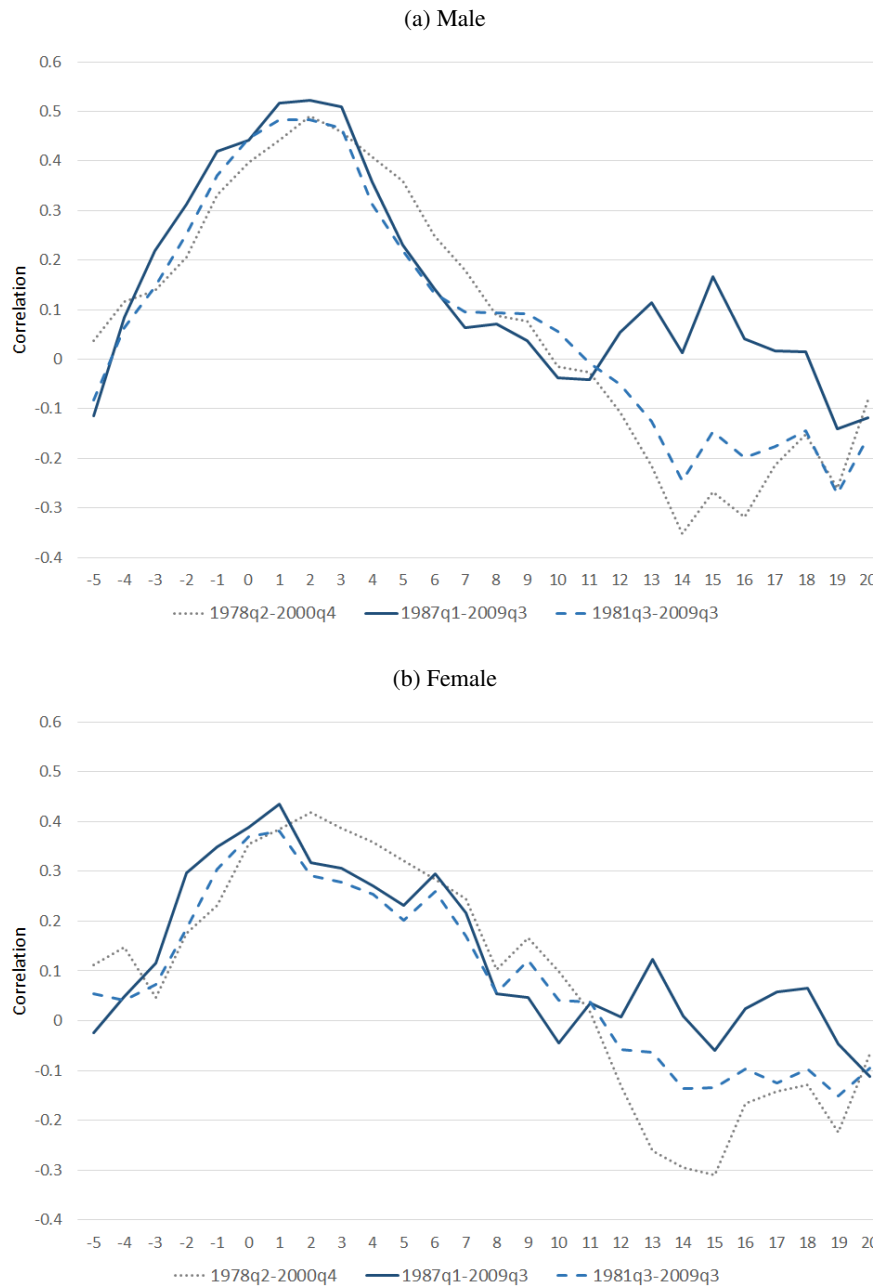
Notes: Forecast errors are from specifications with trends and restricted or full estimation windows as per SA Table 2. Series labels denote the time periods of GDP changes (fixed) at which the correlation statistics are calculated.
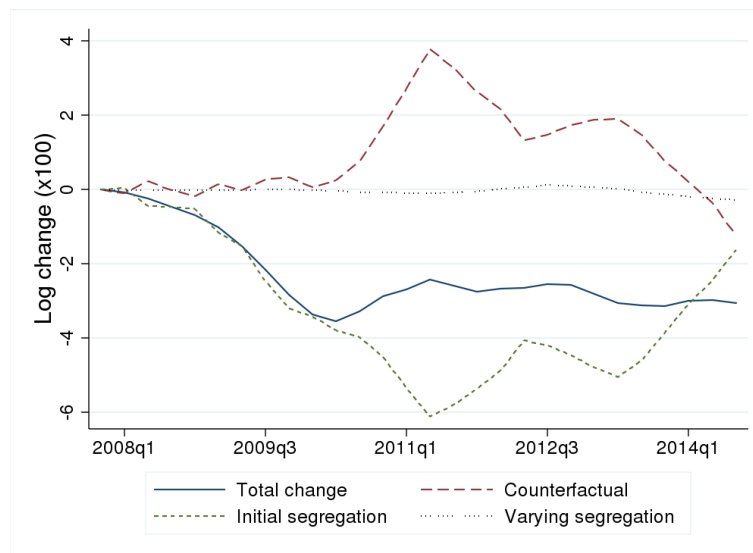
SA Figure 4 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across industry divisions
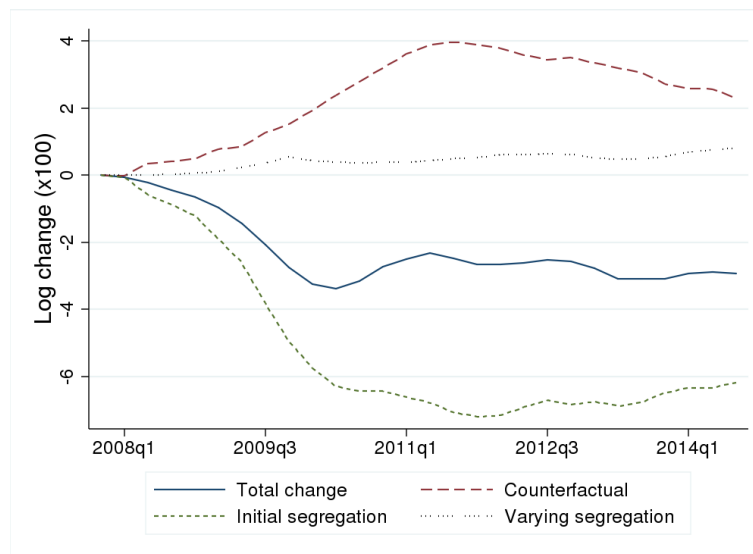
Notes: Gender employment rate gap stated as male minus female. All series are indexed to zero in the final quarter of 2007. See main text for interpretation.
Source: Author calculations using Quarterly Labour Force Survey

SA Figure 5 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across minor occupation groups

Notes: Gender employment rate gap stated as male minus female. All series are indexed to zero in the final quarter of 2007. See main text for interpretation.
Source: Author calculations using Quarterly Labour Force Survey

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SA Figure 6 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across industry-occupation-public/private groups

Notes: Gender employment rate gap stated as male minus female. All series are indexed to zero in the final quarter of 2007. See main text for interpretation.
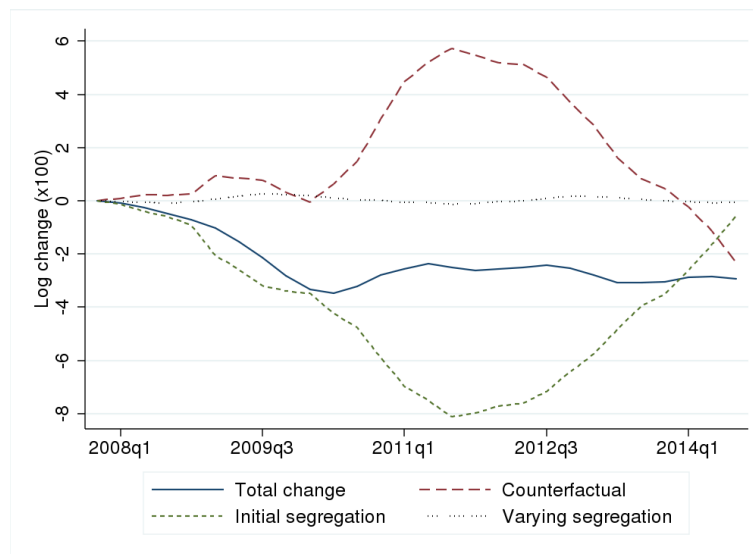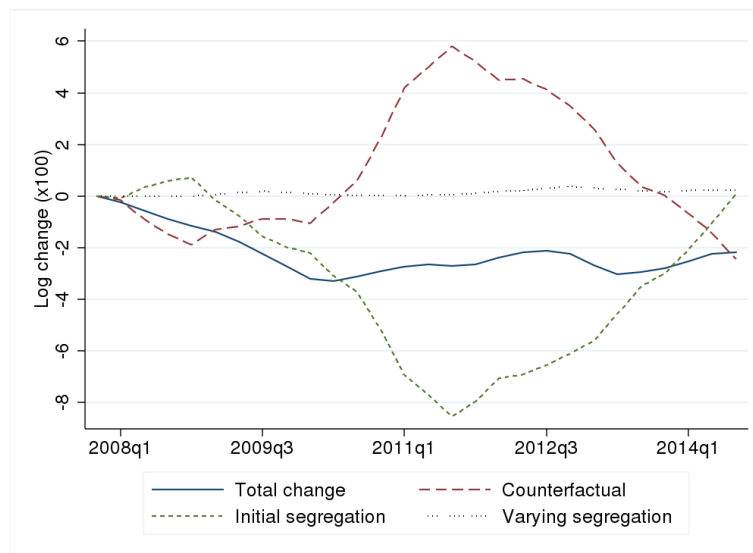*Source:* Author calculations using Quarterly Labour Force Survey

SA Figure 7 Decomposition of the cumulative change in the log gender employment rate gap from 2007: segregation across industry-occupation groups, ages 25-55 only

Notes: Gender employment rate gap stated as male minus female. All series are indexed to zero in the final quarter of 2007. See main text for interpretation.
Source: Author calculations using Quarterly Labour Force Survey

SA Table 3: Largest and smallest contributions of industry-occupations to cumulative change in counterfactual log gender employment rate gap, 2007q4-2010q4, (log points x 100)

	$\hat{\lambda}_{2007q1}$	λ^m_{2007q1}	λ^f_{2007q1}	$\sum_{t=2008q1}^{2010q4} \hat{\lambda}_{2007q1} \Delta \left[e^m - e^f \right]_{i,t}$
Largest				
7,G-H	0.06	0.03	0.09	0.77
6,L-N	0.06	0.01	0.11	0.72
5,F	0.04	0.08	0.00	0.65
3,J-K	0.03	0.03	0.03	0.44
8,D	0.03	0.04	0.01	0.37
4,L-N	0.04	0.02	0.08	0.26
4,G-H	0.01	0.01	0.02	0.22
1,D	0.02	0.04	0.01	0.20
2,A-C,E	0.00	0.00	0.00	0.20
5,G-H	0.02	0.03	0.01	0.20
Smallest				
9,A-C,E	0.00	0.00	0.00	-0.12
5,O-Q	0.00	0.01	0.00	-0.15
6,O-Q	0.01	0.01	0.02	-0.17
1,G-H	0.04	0.05	0.03	-0.18
9,J-K	0.01	0.02	0.01	-0.18
4,A-C,E	0.02	0.04	0.00	-0.28
1,J-K	0.03	0.04	0.02	-0.29
1,F	0.01	0.02	0.00	-0.30
5,D	0.03	0.04	0.00	-0.43
2,L-N	0.07	0.05	0.09	-0.46
Total (all work types)				2

Notes: Interpretation: Values in final column are positive where in an industry-occupation the change in male employment was relatively greater than female, i.e. the no-segregation gender gap would have increased. SOC2000: 1. Managers and senior officials, 2. Professional occupations, 3. Associate professionals & technical occupations, 4. Administrative and secretarial occupations, 5. Skilled trades occupations, 6. Personal service occupations, 7. Sales and customer service occupations, 8. Process, plant and machine operatives, 9. Elementary occupations. SIC1997: A-C,E. Agriculture, forestry and fishing, Energy & water, D. Manufacturing, F. Construction, G-H. Distribution, hotels & restaurants, I. Transport & communication, J-K. Banking, finance & insurance etc, L-N. Public admin., education & health, O-Q. Other services.

Source: Author calculations using Quarterly Labour Force Survey

SA Table 4: Largest and smallest contributions of industry-occupations to cumulative change in counterfactual log gender employment rate gap, 2010q4-2014q3, (log points x 100)

	$\hat{\lambda}_{2007q1}$	λ^m_{2007q1}	λ^f_{2007q1}	$\sum^{2014q3}_{t=2011q1} \hat{\lambda}_{2007q1}\Delta\left[e^m - e^f\right]_{i,t}$
Largest				
4,J-K	0.03	0.01	0.06	0.72
4,D	0.01	0.00	0.02	0.32
4,O-Q	0.01	0.00	0.01	0.31
7,J-K	0.01	0.01	0.01	0.30
6,I	0.00	0.00	0.01	0.21
6,L-N	0.06	0.01	0.11	0.20
6,O-Q	0.01	0.01	0.02	0.19
1,J-K	0.03	0.04	0.02	0.17
3,O-Q	0.01	0.01	0.01	0.16
9,O-Q	0.01	0.01	0.01	0.16
Smallest				
5,A-C,E	0.01	0.01	0.00	-0.20
5,D	0.03	0.04	0.00	-0.29
1,G-H	0.04	0.05	0.03	-0.32
9,F	0.01	0.01	0.00	-0.33
8,D	0.03	0.04	0.01	-0.38
2,F	0.00	0.01	0.00	-0.38
2,L-N	0.07	0.05	0.09	-0.44
3,L-N	0.06	0.04	0.09	-0.63
1,D	0.02	0.04	0.01	-0.67
5,F	0.04	0.08	0.00	-2.49
Total (all work types)				-3.7

Notes: Interpretation: Values in final column are positive where in an industry-occupation the change in male employment was relatively greater than female, i.e. the no-segregation gender gap would have increased. SOC2000: 1. Managers and senior officials, 2. Professional occupations, 3. Associate professionals & technical occupations, 4. Administrative and secretarial occupations, 5. Skilled trades occupations, 6. Personal service occupations, 7. Sales and customer service occupations, 8. Process, plant and machine operatives, 9. Elementary occupations. SIC1997: A-C,E. Agriculture, forestry and fishing, Energy & water, D. Manufacturing, F. Construction, G-H. Distribution, hotels & restaurants, I. Transport & communication, J-K. Banking, finance & insurance etc, L-N. Public admin., education & health, O-Q. Other services.
Source: Author calculations using Quarterly Labour Force Survey

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