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Residual Wage Inequality and Immigration in the US and the UK

Cinzia Rienzo†

Abstract

Over the last few decades, immigration has increased significantly in both the US and the UK; both countries have also experienced notable increases in the degree of wage inequality.

Unlike previous studies, this paper focuses on the effects of immigration on the residual wage inequality in the UK and US between 1994 and 2008. It seeks to assess whether and to what degree immigration contributed, along with technology, institutions and traditional explanations, to widening inequality. To answer these questions, this work reassesses Lemieux's hypothesis (i.e., composition effects exert an upward mechanical force on the residual wage inequality) by adding the immigration dimension to the original analysis.

The empirical analysis reveals that residual wage inequality is higher among immigrants than among natives. However, such differences do not contribute (much) to the increasing residual wage inequality observed in the two countries.

Keywords: wage inequality, immigration, composition effects, residual
JEL No. J31, J61

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1. Introduction

Over the last few decades, immigration has increased significantly in both the US and the UK; both countries have also experienced notable increases in the degree of wage inequality. Overall, the increase in wage inequality has been stronger in the upper tail than the lower tail of the wage distribution (Machin and Van Reenen, 2008) moreover a significant share of the overall rise in US and UK wage inequality is attributable to increases in residual wage inequality - wage dispersion among workers with the same education and experience (Katz and Autor, 1999; Card, 2009; Lemieux, 2006, 2008; Machin and Van Reenen, 2008).

The existing literature investigating the effect of immigration on native-born workers' wages has only addressed the role of immigration on the between-group¹, while less attention has been devoted to the effect of immigration on the within-group or residual. Lemieux (2006) demonstrates that a large fraction of the 1973-2003 growth in residual wage inequality in the US is due to compositional changes (education and experience) of the labour force; however this influential contribution does not consider immigration as another factor affecting compositional changes of the labour force and therefore does not address whether immigration may have played a role in the process of increasing residual wage inequality. This paper aims to do so.

Immigration has been changing not only in size but also in the composition (Card, 2009), with immigrants being nowadays not only more educated than the past but also being on average better educated than natives born (Dustmann, Fabbri, Preston 2005; Dustmann, Frattini and Preston 2008; Manacorda, Manning and Wadsworth 2007 (MMW hereafter); Schmitt and Wadsworth 2007; Wadsworth 2010, Boudarbat and Lemieux 2010). The increasing share of immigrants in the labour force, along with their increasing educational attainment, may represent another factor that could mechanically increase the dispersion in the residual wage due to the increasing heterogeneity linked not only to differences in the formal education but also to differences in cognitive skills, abilities, motivations, connections with the labour market that are usually not captured by formal education. The quality of foreign-acquired qualifications can be considered as another unobservable aspect of human capital (Nielsen, 2011) that could also increase the dispersion in the residual; similarly immigrants' work experiences earned in the sending countries may be valued (downgraded) differently in the receiving countries contributing therefore to the growth in the dispersion of residual wages even for workers within the same level of education. Ottaviano and

¹ Manacorda, Manning and Wadsworth (2007) show that a 10% rise in the population share of immigrants in the UK is estimated to increase native-migrant wage differential by 2%.

Peri (2006) claim that the difference in unobserved characteristics of immigrants and natives may be one of the reasons behind their imperfect substitutability².

There are many reasons to believe that immigrants and natives with similar observable skills may differ in unobservable skills that are relevant in the labour market. Immigrants constitute a particular subgroup of their original population with motivations and tastes that may distinguish them from natives (Ottaviano and Peri, 2006). In manual and intellectual work, they have culture-specific skills as well as limits (language) that might translate into advantages or disadvantages (Peri and Sparber 2008); foreign-born workers have different abilities pertaining to language, quantitative skills, and relational skills, so they choose occupations differently from natives, even within the same education and experience group.

Card (2009) has recently offered an overview of the present understanding of the relationship between immigration and within group inequality; focusing on cross-city comparisons in the US he demonstrates that although immigrants tend to have higher residual inequality than natives, the effect of immigrants account only for 5% of the increase in US wage inequality between 1980 and 2000.

The current paper contributes to the existing debate on the effect of immigration on the labour market outcomes of the receiving countries by investigating the relationship between immigration and residual wage inequality and by assessing whether and to what degree immigration contributed, along with the traditional explanations, to widening within-group wage inequality in the UK and the US between 1994 and 2008. To do so, this work reassesses Lemieux's hypothesis (i.e. that composition effects exert an upward mechanical force on the residual wage inequality) by adding the immigration dimension to the original analysis, adopting the same reweighting methodology that allows now to control also for the share of immigrants in the labour force.

This work differs from that of Card (2009) in several ways: first, it uses a different methodology (reweighting approach) to assess the effect of immigration on the within group inequality; it differs in the sample period analysed since Card focuses on the 1980, 1990, 2000 Census and 2005/2006 American Community Survey while this work proposes an analysis from 1994 to 2008; additionally while the analysis performed by Card is restricted to college-equivalent and high school workers, this research also includes workers with lower level of education; finally the current research presents a comparison by gender between the UK and the US and illustrates

² As proven by Ottaviano and Peri (2006) for the US and MMW (2007) for the UK natives' wage loss from immigration is mitigated by the incomplete substitutability of immigrants and natives within age and education groups.

the evolution of the upper- and lower-tail distributions when controlling for both composition effects and the increasing supply of immigrants.

The next section provides an explanation of why unobservable components might be crucial in analysing the impact of immigrants on natives' wage inequality and what the plausible link is between the increased educational attainment of the labour force and the increase of the residual; part three presents the econometric methodology; part four describes the two datasets used in this paper; part five discusses the results; and the final section concludes.

2. Immigrants and Natives: Imperfect Substitutability, Unobserved Skills and Composition Effect

The lack of any negative effect of immigration on wages of natives in the US and the UK reported respectively by Ottaviano and Peri (2006) and MMW (2007) is based on the evidence that immigrants do not fully compete and substitute with natives, even within a given education-experience group. The imperfect substitution between immigrants and natives may be due, among other reasons, to differences in unobservable skills that are relevant in the labour market (Ottaviano and Peri, 2006) and that could affect not only occupational choices of both natives and immigrants, but also the dispersion in wages.

There are many reasons to believe that immigrants and natives, within the same education group, have different unobserved skills. Immigrants are a particular group of their native country's original population with motivation and tastes that may differentiate them from natives of the host country. In manual and intellectual work, their culture-specific skills and limitations (e.g. language) might translate into advantages or disadvantages; foreign-born workers have different abilities pertaining to language, quantitative skills, and relational skills, so they choose occupations differently from natives, even within the same education and experience group. Gould and Moav³ (2008) argue that unobservable skills of immigrants include, along with some "general skills" easily transferrable to other countries, some "country-specific" skills that cannot be easily transported to another country such as personal connections, knowledge of the local labour market, language-specific communication skills, and success in the labour market.

³ They show that a higher ratio of individuals with a higher transferability rate of unobservable skills exists in the middle of the distribution of total unobservable skills. They argue that those at the bottom of the unobservable skills distribution have little of both types of skills, while those at the top have high levels of both. Individuals are more likely to have high levels of unobservable general skills versus country-specific skills if they are in the middle of the distribution rather than on the tails.

Given the high variation in unobservable skills, the increasing share of immigrants in the labour force is likely to introduce more dispersion in labour market outcomes (e.g. wages) of the receiving country.

The idea that there might be a crucial unobservable skills component in the immigration process is consistent with a recent consensus of the wage inequality literature: unobservable skills, that are not captured by formal education and that can be measured by the residual of a Mincer equation, explain most of the growth in the observed increasing wage inequality (Acemoglu 2002; Juhn et al.1993; Katz and Autor 1999; Autor et al., 2005, 2008; Lemieux 2006).

Lemieux (2006) documents that a large fraction of the 1973-2003 growth in residual wage inequality in the US is due to composition effects, affecting both the upper and lower tails of the wage distribution. In particular, he demonstrates that the increase in within-group wage inequality is a spurious consequence of the fact that workforces became older and more educated over time; in other words, the increases in educational level and experience act as a mechanical force on the residual. Specifically when the level of education of the labour force increases, more and more “marginal“ workers are added to the group of highly educated workers; while this will benefit those workers with more unobserved skills, it will also generate more unobserved heterogeneity in that group increasing therefore within-group inequality. This phenomenon means that changes in the education and experience characteristics of the workforce determine more variation in wages due to unmeasured aspects of human capital. Holding market prices constant, changes in labour force composition can mechanically raise (lower) residual earnings dispersion simply altering the employment share of worker groups that have more (less) dispersed earnings.

This influential contribution does not consider immigration as another factor affecting compositional changes of the labour force⁴ and introducing more heterogeneity, and therefore does not address whether immigration may have played a role in the process of increasing residual wage inequality.

As pointed out by Card (2009) there is no theoretical model explaining how the increasing supply of immigration could affect changes in the residual wage inequality of the labour force; however as explained above because immigrants are likely to be characterised by higher level of unobserved skills compared to natives, when more foreign-born workers are added in the labour force, this will create more unobserved heterogeneity and increasing the within-group inequality. This implies that the increasing share of immigrants in the labour force may mechanically raise the

⁴ It is relevant to point out that Lemieux’s original analysis starts from 1973 when the share of immigrants in the US was very low compared to the beginning of the 1990s.

within-group wage inequality due to the higher heterogeneity that characterises immigrants and due to their higher earnings dispersion.

There is little existing research on the overall impact of immigration on native workers' within-group inequality. To the best of our knowledge the only contribution has recently been provided by Card (2009) who suggests that immigration has a relatively small causal effect on within-group wage variation.

The remaining part of this research investigates the relationship between immigration and residual wage inequality and aims to assess whether and to what degree immigration contributed, along with and the traditional explanations, to widening within-group wage inequality in the UK and the US between 1994 and 2008. To do so, this work reassesses Lemieux's hypothesis (i.e. that composition effects exert an upward mechanical force on the residual wage inequality) by adding the immigration dimension to the original analysis, adopting the same reweighting methodology that controls for the increasing immigration in the labour force, by holding the share of foreign-born workers fix at a base year.

3. Econometric methodology

Because this work mainly seeks to test Lemieux's findings in the immigration context, the methodology and the identification strategy largely adhere to his original work, although some modifications and adjustments to data sets have been necessary. The econometric methodology of this work is based on two simple steps: the analysis of inequality in the residual and a reweighting approach to control for both composition effects and increasing supply of immigration in both the US and the UK.

The residuals are obtained from a standard OLS regression with the following specification:

$$(1) \quad y_{it} = X_{it}B_t + \varepsilon_{it}$$

Where y_{it} is the log hourly wage of individual i in year t , X_{it} is a vector of observed individual characteristics (education, age and a set of interaction terms between education and age), B_t is a vector of estimated returns to observable characteristics at time t , and ε_{it} is the log wage residual depending on unmeasurable skills.

Given the orthogonality of the predicted values and the residuals in an OLS regression, the variance of y_{it} can be written as:

$$(2) \quad \text{Var}(y_{it}) = \text{Var}(X_{it}B_t) + \text{Var}(\varepsilon_{it}).$$

In other words, the change in the variance of log wages can be decomposed into the change in the variance of the predicted values (between-group inequality), reflecting the contribution of observable prices and quantities, and the change in the residual variance (within-group inequality) measuring the role of unobserved skills.

Changes in the residual variance can be attributed to changes in prices for unobserved skills (p_t^2) and changes in unobservable skills ($\text{var } e_{it}$); if $\varepsilon_{it} = p_t e_{it}$, then

$$(3) \quad \text{var}(\varepsilon_{it}) = p_t^2 \text{var}(e_{it}).$$

This dispersion can be disaggregated across time and education and experience groups. Because the information and structure of the data sets used in this work (ORG/CPS, LFS) are somewhat comparable, it is possible to divide workers into 12 education and experience cells based on a group of 3 (similar) education categories (lower, intermediate and high) and 4 potential experience categories: 1-10, 11-20, 21-30 and 31+ years.

To control for composition effects, i.e., to assess if and to what degree changes in the education and experience of the labour force account for the increase in wage inequality for the whole labour force as well as for natives and immigrants separately, the variance of the residual is recomputed, assigning workers observed in the actual year the same characteristics of workers observed at a given base year. In other words, the technique holds the skill composition of the workforce (θ_{jt}) constant over time to reflect the distribution of characteristics of the labour force in a given year.

Assuming⁵ that observed skills, x_{jt} , can be divided into a finite number of education-experience groups j , the (unconditional) variance of the residual $\text{Var}(e_{it})$ is directly affected by changes in θ_{jt} (share of workers in experience-education group j at time t) and is linked to the conditional variance σ_{jt}^2 by the following equation:

$$(4) \quad \text{var}(e_{it}) = \sum \theta_{jt} \sigma_{jt}^2$$

where σ_{jt}^2 represents the conditional variance ($\text{Var}(e_{it}|x_{it})$) so that changes in the education-experience cell shares will correspond to changes in the residual variance. Because the conditional variance in wages V_{it} is linked to the conditional variance of unobserved skills by the following equation:

$$(5) \quad V_{it} = p_t^2 \sigma_{jt}^2$$

⁵ This part follows Lemieux (2006).

where p_t captures the returns to unobserved skills (e_{it}), it follows that σ_{jt}^2 also increases as a function of experience and education. Only when the variance of unobserved skills remains constant over time can changes in residual variance be interpreted as evidence of changing skill prices p_t .

Holding the characteristics of the labour force constant at a base year can be done by constructing a counterfactual weight, expressed as $(1-\omega_i)/\omega_i$, where ω_i is the predicted probability for each worker observed at time t to be in the base year s . This probability is obtained by applying a logit model conditioning on the characteristics (education and age) of the workers. The magnitude of the weight therefore depends on the characteristics of workers observed in year t compared to the characteristics of workers observed in a given base year s . For example, the predicted probability of less educated workers observed in a year characterised by a higher level of education of the workforce will be small; therefore, the counterfactual weight $(1-\omega_i)/\omega_i$ will give more to less educated workers in the later years. Similarly, less weight will be given to observations of more educated individuals in the later sample years.

In this way, by holding the distribution of skills constant over time, it is possible to compute a counterfactual variance, i.e., the variance of the residual that would prevail if the distribution of skills of workers remained constant at its base year value. The difference between the counterfactual variance and the actual variance indicates the extent to which the composition of the labour force accounts for the evolution of the observed residual. By applying this methodology only to natives, the counterfactual variance will not only take into account changes in characteristics of the labour force but also consider what would have happened had immigration not taken place.

Formally, the residual variance needs to be written as a function of the variance of wages, V_{jt} , within each skill group j :

$$(6) \quad \text{Var}(\varepsilon_{it}) = \Sigma \theta_{jt} V_{jt}$$

Holding constant the skill distribution of workers (θ_{jt}^*), the counterfactual residual variance can be written as:

$$(7) \quad V_t^* = \Sigma \theta_j^* V_{jt}$$

Working in this way will indicate whether the composition effect is driving changes in the residual variance; in particular, when the composition of the workforce is held constant, any increase in the residual variance can be interpreted as an increase in skill prices p_t .

If one assumes that the causal effect of increased immigration depends on the fraction of immigrants in the labour market, controlling for the increasing supply of this share should help to disentangle the effect of immigrants on the residual wage inequality.

Defining δ_m as the fraction of immigrants in the labour force and assuming it is orthogonal to returns to various skills, the residual variance defined in (6) can be re-written as:

$$(8) \quad \text{Var}(\epsilon_{it}) = \sum \delta_{mt} V_{jt}$$

where the residual variance is now a function of the variances of wages accounting not only for the skill characteristics of the labour force but also for the share of immigrants in the labour force. In a similar vein to (9), by holding fixed the share of immigrants in the labour force (δ_{mt}^*), the counterfactual residual variance can be written as:

$$(9) \quad V_t^* = \sum \delta_{mt}^* V_{jt}$$

Working in this way will indicate whether the increasing share of immigrants in the labour force can help to account for the increasing residual wage inequality observed. This also implies that we should expect the effect of immigration on the residual dispersion to be larger (smaller), the larger (smaller) is the share of foreign-born in the labour force.

Controlling for the increasing supply of immigration can be done by following the same methodology, constructing a weight that, in the spirit of DiNardo et al. (1996), adds a dummy variables for the state of immigration as well as interaction terms. This would allow the construction of another counterfactual: “what would have happened to the residual wage inequality of the labour force had the share of immigrants remained constant at a base year

4. Data

The analysis is based on two pooled time series cross-sectional micro data sets: the Outgoing Rotation Group (ORG CPS) for the US and the Labour Force Survey (LFS) for the UK. Both data sets cover the same period (1994 to 2008), contain similar information relevant to labour market characteristics, wages and immigration, and are sufficiently large to analyse minority populations.

The CPS is a monthly household survey conducted by the Bureau of Labour Statistics to measure labour force participation and employment. The survey provides individual data for about 30,000 individuals per month. Every household that enters the CPS is interviewed each month for four months, then ignored for eight months, then interviewed again for four more months. Standard weekly hours/earnings questions are asked only during a household’s fourth and eighth interviews. These outgoing interviews are the only ones included in the extracts. New households enter each month, so one fourth of the households are in an outgoing rotation each month.

One of the main advantages of the ORG CPS is that it provides point-in-time measures of usual hourly wage for 60 percent of the sample; the remaining non-hourly wage can easily be calculated as the ratio of earnings to hours. We kept real hourly wage between \$1 and \$100. One of the main issues encountered when working with the ORG CPS dataset relates to the top-coded earnings. In the data released to the public, the Census Bureau restricts the top of the earnings distribution to \$99,999 a year. This restriction means that all earnings above that level appear in the CPS public dataset as \$99,999, whatever the actual earnings are. This artificial ceiling can lead to bias in the measurement of trends in earnings inequality if the proportion of earnings so affected changes over time; in particular, it will lower the mean and the variance of the wage data relative to the true mean and variance. We adjust for the top-coding issue by using the log-normal approach recommended by Schmitt (2003). In contrast⁶ to the procedure that is usually applied, the log-normal procedure models the entire distribution, not just the top portion of interest, under the assumption that the entire distribution of earnings is log-normally distributed. The properties of the log-normal distribution allow for the straightforward estimation of the mean and variance of the “true” distribution, even though the estimates of the mean above the top-code are consistently below those generated by these versions of the pareto approach.⁷

The LFS is very similar to the US Current Population Survey in terms of its purpose (measuring labour market activity and unemployment in a timely fashion), sample size and because, similar to CPS, LFS provides point-in-time hourly wages for a large majority of the sample.

The (LFS) is the largest survey of households living at private addresses and in NHS accommodations in the UK and is conducted by the Office for National Statistics (ONS). Information is recorded in four quarters; each quarter’s LFS sample of 53,000 UK households consists of five “waves”, each of approximately 11,000 private households. Each wave is interviewed in five successive quarters, and earnings information is only recorded in waves 1 and 5. A single-stage sample of addresses with a random start and constant interval is drawn from the Postcode Address File (PAF) sorted by postcode. To limit the effects of outliers, following the existing literature in the UK (MMW 2007), only observations with an hourly wage between 1 and 100 pounds in 2008 pounds are kept. In the same manner as for the CPS, for individuals whose

⁶A large part of the existing literature on wage inequality (Lemieux 2006, Autor and Autor, 1999, Autor et al.2005,2008) addresses the top-coding issue by multiplying top-coded wages by a factor of 1.3 or 1.4, which is believed to provide estimates of the mean and the variance that are closer to their true values.

⁷ For details, see John Schmitt (2003): “Creating a consistent hourly wage series from the Current Population Survey’s Outgoing Rotation Group, 1979-2002”.

wage is only recorded weekly, hourly wage is derived by dividing weekly wage by the usual amount of paid hours worked per week.

Real wages for the UK are obtained by deflating nominal wages by the Retail Price Index. For the sake of comparability with the UK, wages measures for the US are inflated using the Consumer Price Index.

The samples used for the estimations consist of men and women in the labour force, considered separately, meaning men and women aged 16-64 for the US and aged 16-59 and 16-64, respectively, for the UK. We limit the analysis to workers who are full-time employees,⁸ considering only their main job. We define as an immigrant someone who was born outside of the US and UK irrespective of the time of age on arrival.

All results are derived from separate regressions for men and women, respectively, for all workers, natives, and immigrants by applying the log hourly wage to a set of dummies for age, education and interactions between education and age squared.

One of the main issues arising when aggregating immigrants and natives based on level of education is that, due to the heterogeneity of educational systems, there is not a one-to-one correspondence in years of schooling⁹. In the ORG/CPS data, education is reported in years for all workers, meaning that immigrants report their level of education in terms of years of schooling. One problem arising for LFS is that foreign educational qualifications are classified in the “other” category. As explained by MMW (2007), there is good reason to believe that many immigrants in the “other” category actually have quite high levels of education. The LFS employs an alternative definition of educational level, namely, the age at which the individual left full-time education. To create comparable educational categories for the UK data, we combined information on “age left school” and “other”. The similarity between the US and UK schooling systems allowed us to create three educational categories that are broadly comparable.

The lower education group includes workers who have completed compulsory education, i.e., less than a lower secondary education; for both the US and the UK, this group corresponds to 0 to 11 years of schooling. The intermediate category includes workers with qualifications that exceed those of a high-school dropout but do not reach those of a college-degree holder (both excluded). In both countries analysed, this corresponds to any individual with years of schooling at least 12 and at most 15 years of schooling. The high education group refers either to individuals with graduate or

⁸ The use of only full-time workers is meant to eliminate variation in hours worked per week or weeks worked per year (Katz and Murphy, 1992; Card and Lemieux 2001).

⁹ Preliminary runs indicated that changes in the years of schooling as a measure of education would not produce substantial changes in the results.

postgraduate education, corresponding to 16 or more years of schooling. Preliminary analyses showed that using years of education in the regression rather than level of qualifications would not affect the results.

The years of potential labour market experience variable is conventionally derived as age – years of completed education- the age at which children start school. Workers are aggregated into four-year experience intervals (0-10; 11-20; 21-30; 31+). Based on the three education categories (lower, intermediate and high) and the four experience categories, workers can be classified into one of twelve skill groups¹⁰.

5. Results

5.1 Educational Characteristics of Immigrants and Natives

Table 1 compares the educational characteristics of natives and immigrants in the labour force for men and women in the US and UK. A couple of findings immediately emerge from the table: compared to the UK, the US labour force is on average characterised by the lowest share of low-educated workers. Considering natives in 2008, only 5% and 4% for men and women, respectively, were classified in the low-education group; while for the UK counterparts, these shares increase to 27% (men) and 31% (women). More differences arise in the US when comparing less educated natives with equivalent immigrants: as the existing literature documents, most immigrants to the US are relatively less educated. In 2008, 29% of male immigrants in the US had a lower level of education; this share is 13% higher than the share of male immigrants in the UK. The situation is better for female immigrants in the US; in fact, 18% of them have a low level of education. This result is very similar for female immigrants in the UK (0.16).

In contrast, the mix of immigrants to the UK has become much more educated over time compared not only to immigrants in the US, but also to natives UK. In 2008, almost half of the immigrants, both men and women, to the UK were highly educated, compared to 25 and 32 percent for male and female natives, respectively. This gap is less evident when comparing higher educated natives and immigrants in the US, where 33% of native males have a degree or postgraduate degree compared to 29% of immigrants; there is even less of a difference between native and immigrant women.

¹⁰ In the original data, Lemieux defines 20 education and experience groups based on 5 education groups and 4 experience groups. The education groups are dropout; high school graduates; some college; college graduates; postgraduate. These 5 groups have been clustered into 3 to generate 3 educational groups consistent through the three countries. The substantial results do not change: the residual increases for more-educated workers and decreases for less-educated ones.

5.2 Wage Dispersion for Immigrants and Natives

The patterns and the evolution of wage dispersion in the two countries are shown in Tables 2a together with Figures 1a to 2d.

Tables 2a summarise different measures of wage dispersion, their changes and main trends over time by comparing the standard deviation, the 90-50 and 50-10 gaps together with the changes over 1994 and 2008 for the US and UK, considering men, women, all workers, natives and immigrants separately.

The 90-50 log hourly wage gap in the US increases over the sample period for all workers and for both men and women; similarly, for workers located on the lower tail of the wage distribution, wage dispersion decreased from 1994 to 2008, but immigrants experienced the largest decrease. Female workers located on the lower tail of the wage distribution did not display a decrease in wage dispersion; in fact, there was a slight increase, which was higher for female immigrants. For the UK, the 90-50 log hourly wage gap has a different sign for men versus women; the former experience an increase in wage dispersion, which is larger for immigrants; the latter are instead affected by an overall decrease in wage inequality, except for the increase for female immigrants. More similarities are displayed for workers located in the lower tail of the wage distribution: in all cases, wage dispersion decreases, and the largest decrease is found for male immigrants.

The top panel reports wage dispersion for men in both countries. In 1994, wage inequality for all male workers was 0.547, and this value increased to 0.569 in 2008. Similarly, in the UK, standard deviation increased from 0.547 to 0.559; the standard deviation of wages was higher for immigrants in the UK in 1994 (0.612) than for those in the US (0.600). However, at the end of the sample period, immigrants in the UK experienced a decrease to 0.608 while, following the trend for all workers, wage dispersion for immigrants in the US increased. The trends go in opposite directions for females in the two countries; in the US, wage inequality increased for all female workers (from 0.509 to 0.525) and immigrants (0.552 to 0.580), while it decreased for both all workers (from 0.542 to 0.504) and immigrants (0.578 to 0.531) in the UK.

The same table also shows what happens to wage dispersion when foreign-born workers are not counted in the sample: when considering natives only, in all cases, the level of wage inequality is slightly lower, though still increasing; this means essentially that the presence of immigrants in the labour force does not strongly affect the level and the trend of wage inequality experienced by the countries.

The same table also reports a measure of dispersion by looking at workers located in the upper and lower tails of the wage distribution. In general, wage dispersion for workers located in the upper tail of the wage distribution increased over time for all natives and immigrants, both male and female, with the exception of females in the UK: in this case, dispersion of workers in the upper tail of the wage distribution decreased for both natives and immigrants, though the latter suffer from more inequality.

A more uniform pattern is observed when considering workers located in the lower tail of the wage distribution: in all cases (men and women, immigrants and natives in the US and the UK), wage dispersion has decreased over time. Looking at the changes over time immigrants located in the lower tail of the wage distribution experience the largest decrease in wage dispersion; this corresponds to a 0.1 log percentage point decrease for male immigrants in the US and 0.147 in the UK. Similar trends of smaller magnitudes occur for female immigrants.

Figure 1a to 1d plot the kernel distribution of log hourly wages for natives and immigrants in both countries for the years 1994 and 2008. The figures clearly show the difference in the wage distributions between natives and immigrants. Particularly in the US and for male workers, the density of log hourly wage for immigrants is left-shifted compared to natives. The two plots for women in the U.S. are qualitatively similar, though the gap in the density distribution is smaller in 2008. Results for the UK show a substantial overlap in wage densities for women in 2008, while in 1994 the density for women born abroad appears to be slightly right-shifted compared to natives. This pattern is similar for male workers in the UK in 1994, though the mean log hourly wage for natives is higher than for immigrants; in 2008, consistent with the US, the wage density of immigrants in the UK is left-shifted compared to their native counterparts.

Figures 3a and 3b plot levels and trends using as a measure of dispersion the variance of the residual¹¹ hourly wage for men and women in the US and the UK. The residual variance has been calculated separately from three different regressions, respectively, for the whole labour force, natives and immigrants. Confirming previous results, these graphs show that the dispersion in the wages of immigrants is higher¹² than it is for natives, especially for the UK, with the bulk of the increase for foreign-born immigrants working in the UK occurring at the end of the 2000s.

¹¹Wage residuals are obtained from a series of regression models fit separately by gender, immigrant status and year. The models include controls for education, experience, and interaction terms. When including a control for country of origin, the main results do not change too much. On average, the residual obtained when adding the control for area of origin is 0.002 lower than the one obtained when controlling for human capital variables only.

¹² One concern related to the increase in the share of immigrants is the area of origin; particularly, the UK dispersion in residual could also be due to different inflows of immigrants. To address this issue, I also control for area of origin both

This is particularly true for males, while there is more of a convergence in level and pattern for males in the US: starting in 2002, there is not much difference in residual dispersion between immigrants and natives. More variation remains for immigrant females in the US, and even more for the UK.

When treating immigrants and natives as two separate groups, interesting differences arise: in all cases, the level of wage dispersion in the residual for natives decreases, but the trends do not change that much, suggesting that had immigration not occurred, the residual wage inequality of natives in both countries would have increased anyway, albeit at a slightly lower level. This description supports existing results; i.e., the presence of immigrants cannot be considered to be even partially responsible for the increasing level of residual wage inequality in both the US and the UK. In a similar vein to the recent interpretation of Card (2009), this suggests that immigration can be said to have contributed to the increase of inequality in the workforce, albeit for only a small share, and it has no effect on the inequality of native wages.

Figures 2a to 2b plot the 90-50 residual of log wages for all workers (men and women, respectively) together with the share of immigrants in the labour force over the sample years. Both in the US and UK, the share of immigrants has been constantly increasing; this is taking place at a faster pace for the UK, although the share of immigrants is higher in the US. The results are qualitatively similar for women, except that female immigrants in the UK are more numerous than males and even more numerous than those in the US. As has been shown in previous studies, an increase in wage inequality occurred particularly on the upper tail of the wage distribution. The correlation between changes in the residual and changes in the share of immigrants in the labour force between 1994 and 2008 is quite high; in the US, it is equal to 0.762 and 0.936, respectively, for men and women; in the UK, the correlation of changes is 0.880 for men and 0.962 for women, suggesting a possible positive relationship between the increased number of immigrants in the labour force and the increase in residual wage inequality.

5.3 Residual Inequality, the Composition Effect and the Increase in Immigration

Table 2b presents the decomposition of total wage variation into different components (between- and within-variance), analysing all workers, natives and immigrants separately and by presenting the results for natives and all workers when holding fixed the characteristics of workers

in the original regression and in the logit model; the residual variance decreases a bit, mainly for immigrants, while results for all workers and natives do not change significantly. Nevertheless, the distance between residual variance of immigrants and natives still remains.

as well as the share of immigrants in the labour force. On average, when the characteristics of the labour force are held fixed at their 1994 levels, the level of residual wage inequality decreases on average for both men and women in the US and UK, confirming the main results of Lemieux. However, when the share of immigrants remains fixed at the level of the base year (1994) in addition to fixing the characteristics of the labour force, an additional decrease in the residual wage inequality occurs.

Figures 4a to 7b present the results of the counterfactual reweighting approach proposed by Lemieux that helps to account for the roles of composition effects and the share of immigrants in changes in residual wage inequality. The figures compare, for each country, for men and women separately, the actual residual variance from 1994 to 2008 to the counterfactual variance that would have existed if the distribution of skills had remained at the same level of the initial (1994) or the final (2008) year. The composition effect is represented in the figures by the distance between the actual variance and the counterfactual variance (residual holding skills constant at its 1994 or 2008 level).

As displayed in Figures 4a and 4b, when the distribution of skills characteristics of the labour force is held fixed at its 1994 level the remaining growth of the residual variance accounts for a small share. The results hold both for men and women in the US and the UK. This evidence confirms the findings of Lemieux (2006) when analysing natives and the whole labour force separately. However, the role of this component becomes less significant once the share of immigrants is also held fixed at its 1994 level. In general, once both the distribution of skills and the share of immigrants are held fixed at their 1994 levels, the role of the residual components ranges from 0.0002 to 0.009 for natives and up to 0.008 for all workers. Although the composition effects still explain most of the growth in the residual for natives and the total labour force, the results also suggest that the presence of immigrants plays a role in explaining the growth in the residual variance observed, albeit a very small share¹³. On average, the effect of immigration on residual variance is around 0.1 percent consistent with Card (2009) the effect is small but not causal.

The results are consistent with Lemieux (2006), confirming that the labour force is becoming increasingly educated and older, which will increase the role of workers' unobservable skills. If the 2008 workforce had the characteristics of the 1994 workforce, the level of the residual would have been lower, suggesting that composition effects exerted an upward force on residual inequality.

¹³ Additional specifications restricting the analysis to natives only, show an almost zero effect of the supply of immigrants on the within-group of natives. Results are available on request from the author.

5.4 Residual Wage Inequality: Upper and Lower Wage Gaps

During the 1990s, wage inequality occurred mainly in the upper tail of the wage distribution. This section examines alternative measures of wage inequality, specifically the 90-50 and 50-10 residual gaps, comparing the actual residual to the computed residual holding distribution of skills and share of immigrants at their 1994 levels to understand how much change in the residual and composition affect the labour force at each tail of the distribution.

Looking at the evolution of the 90-50 gap, Figures 6a to 7b show that residual wage dispersion for workers located on the upper tail of the wage distribution increased for the workforce in both countries for both men and women. When, in addition to holding fixed the characteristics of workers in the labour force, the share of immigrants is held constant at its 1994 level, the role of the residual component in the upper tail of the wage distribution decreases even more. Results are qualitatively similar for women.

Looking at the lower tail of the wage distribution, the evolution of the residual variance is similar between the two countries; in fact, the 50-10 residual gap is characterised by a general decrease over time. Consistent with the results of the previous section, the effects of composition appear to be more important: changes in the share of foreign-born workers exert almost no effect. This suggests that the presence of immigrants in the labour force not only has little effect on the change in and level of residual wage inequality, but it also does not have a large effect on the distribution of wages in both the US and UK.

6. Conclusion

This paper addressed empirically the question of whether increasing immigration in the US and the UK could have been associated with the rising residual wage inequality observed between 1994 and 2008. By applying Lemieux's methodology (2006), this paper controls for changing characteristics of workers and adds the immigration dimension to control for the increasing presence of foreign-born workers in the labour force. In line with Card's recent findings, the results show that the presence of immigrants does not have a causal relation with the increase in residual inequality. Even when treating natives and immigrants as two separate groups, the trend of residual variance inequality for natives does not significantly change, suggesting that inequality of the UK and US labour force is not substantially due to increasing heterogeneity introduced by immigrants.

However, when the share of immigrants in the labour force is held fixed at its value in the base year, the role of the residual components ranges from 0.002 to 0.009 for natives and up to

0.008 for all workers. Although the composition effect still explains most of the growth in the residual for natives and the whole labour force, the results also suggest that the presence of immigrants plays a role in explaining the growth in the residual variance observed, albeit a very small share. On average, the non-causal effect of immigration on residual variance ranges between 0.1% and 0.5% of the observed change between 1994 and 2008. The small effect could be related to the fact that despite increasing over time, the share of immigrants in the labour force only ranges between 7 to 12 %.

This finding suggests that the presence of immigrants in the labour force not only has little effect on the change and level of residual wage inequality, but it also does not affect the distribution of wages in either the US or the UK. In terms of public policy, the results imply that the inflow of workers from abroad has no negative effect on natives' wages in the receiving countries, confirming that the effect of immigration on wages should not be a concern in the public policy agenda.

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Table 1: Educational Attainment of Natives and Immigrants, US and UK

Level of Education	Natives		Immigrants	
	Men	Women	Men	Women
A. US				
Lower				
1994	0.08	0.06	0.30	0.22
2008	0.05	0.04	0.29	0.18
Intermediate				
1994	0.64	0.67	0.43	0.51
2008	0.62	0.60	0.42	0.47
Higher				
1994	0.28	0.27	0.27	0.27
2008	0.33	0.36	0.29	0.35
B. UK				
Lower				
1994	0.28	0.43	0.21	0.24
2008	0.27	0.31	0.16	0.16
Intermediate				
1994	0.55	0.30	0.37	0.34
2008	0.48	0.37	0.24	0.25
Higher				
1994	0.17	0.17	0.42	0.41
2008	0.25	0.32	0.56	0.59

The table shows the educational characteristics of natives and immigrants in the US and UK labour force. The lower education group includes workers who have completed compulsory education, i.e., less than a lower secondary education (from 0 to 11 years of schooling). The intermediate category includes workers with qualifications that exceed those of a high-school dropout but do not reach those of a college-degree holder (both excluded), this corresponds to any individual with years of schooling at least 12 and at most 15 years of schooling. The higher education group refers either to individuals with graduate or postgraduate education, corresponding to 16 or more years of schooling.

Table 2a: Wage Dispersion and Changes in the US and UK, 1994-2008

US	UK					
	Standard deviation	90-50	50-10	Standard deviation	90-50	50-10
<i>Males</i>						
A. All workers						
1994	0.547	0.684	0.721	0.545	0.706	0.630
2008	0.569	0.765	0.687	0.559	0.751	0.620
1994-2008 changes	0.022	0.081	-0.034	0.014	0.045	-0.010
B. Natives						
1994	0.537	0.674	0.697	0.541	0.703	0.627
2008	0.556	0.754	0.693	0.552	0.730	0.617
1994-2008 changes	0.019	0.080	-0.004	0.011	0.027	-0.010
C. Immigrants						
1994	0.600	0.876	0.693	0.612	0.770	0.783
2008	0.613	0.976	0.593	0.608	0.861	0.636
1994-2008 changes	0.013	0.100	-0.100	-0.004	0.091	-0.147
<i>Females</i>						
A. All workers						
1994	0.509	0.693	0.598	0.542	0.689	0.598
2008	0.525	0.722	0.597	0.504	0.671	0.558
1994-2008 changes	0.016	0.029	-0.001	-0.038	-0.018	-0.040
B. Natives						
1994	0.503	0.683	0.591	0.522	0.681	0.601
2008	0.513	0.701	0.607	0.500	0.667	0.554
1994-2008 changes	0.010	0.018	0.016	-0.022	-0.014	-0.047
C. Immigrants						
1994	0.552	0.787	0.580	0.578	0.690	0.661
2008	0.580	0.896	0.568	0.531	0.714	0.592
1994-2008 changes	0.028	0.109	-0.012	-0.047	0.024	-0.069

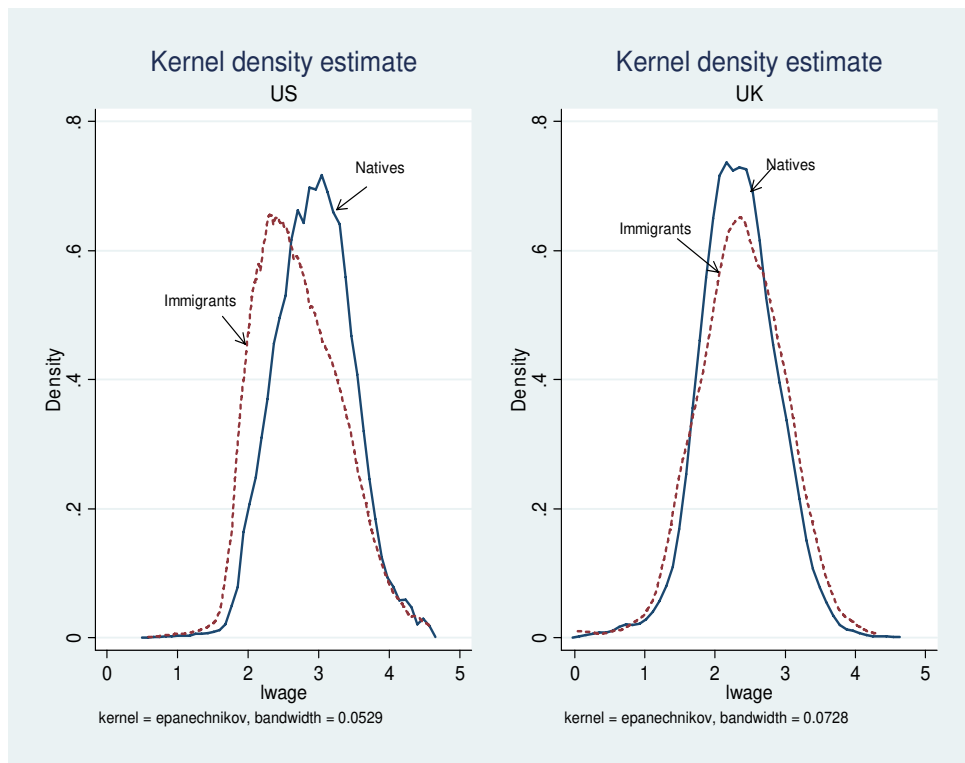
Notes: The table shows changes in wage dispersion for the log hourly wage of male and natives, natives and immigrants, in the US and the UK between 1994 and 2008

Table 2b: Wage Decomposition for Natives and all Workers

	UK 1994-2008		US 1994-2008	
	Natives	All workers	Natives	All workers
A. Men				
Actual Residual	0.021	0.028	0.018	0.017
Skills in 1994	0.006	0.006	0.010	0.009
Skills and Share of Immigrants in 1994	0.006	0.009	0.009	0.008
Predicted Value	-0.012	-0.012	0.002	0.007
Total wage variance	0.012	0.016	0.020	0.024
B. Women				
Actual Residual	0.003	0.010	0.008	0.009
Skills in 1994	-0.009	-0.005	-0.002	-0.0003
Skills and share of Immigrants in 1994	-0.009	-0.006	0.0002	-0.001
Predicted value	-0.025	-0.025	0.004	0.007
Total wage variance	-0.018	-0.015	0.012	0.016

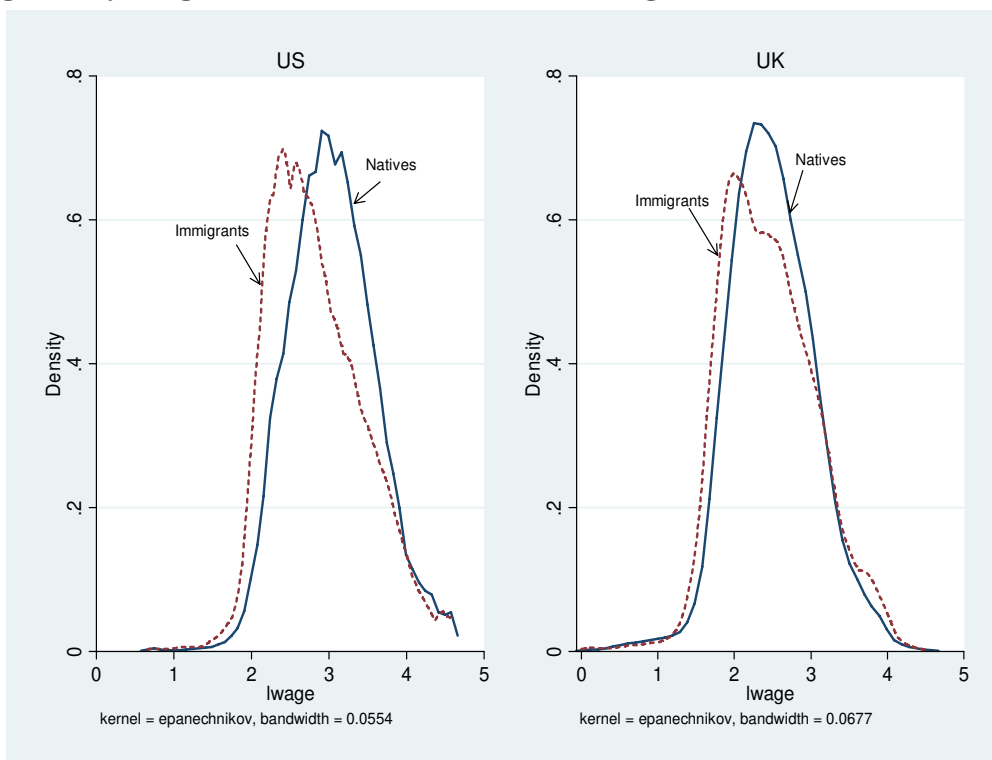
Notes: Based on ORG/CPS and LFS. The table shows changes between 1994 and 2008 in wage decomposition for the US and UK. Hourly wages are reported in 2008 dollars and pounds. Residual wage variance is based on standard Mincer wage equation, fit separately by year, gender, and immigration status.

Figure 1a: Log Hourly Wage Distribution, Natives and Immigrants Men,1994



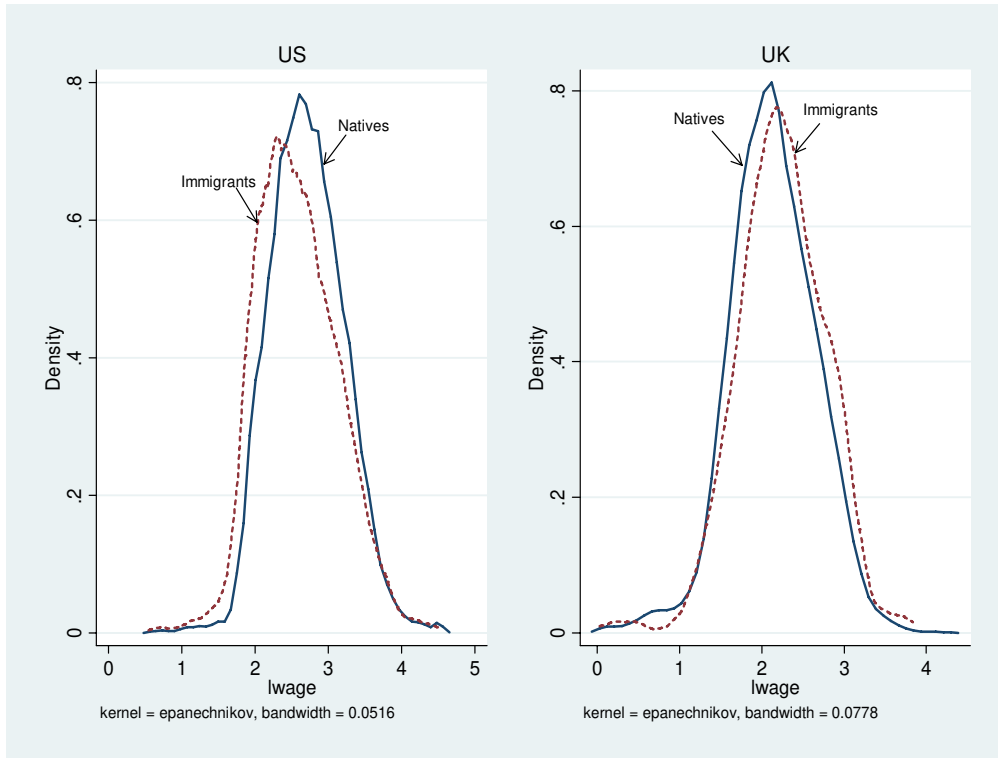
Notes: The figure plots the kernel density of the log hourly wage at 1994 for male natives and immigrants in the US and UK.

Figure 1b: Log Hourly Wage Distribution, Natives and Immigrants, Men 2008



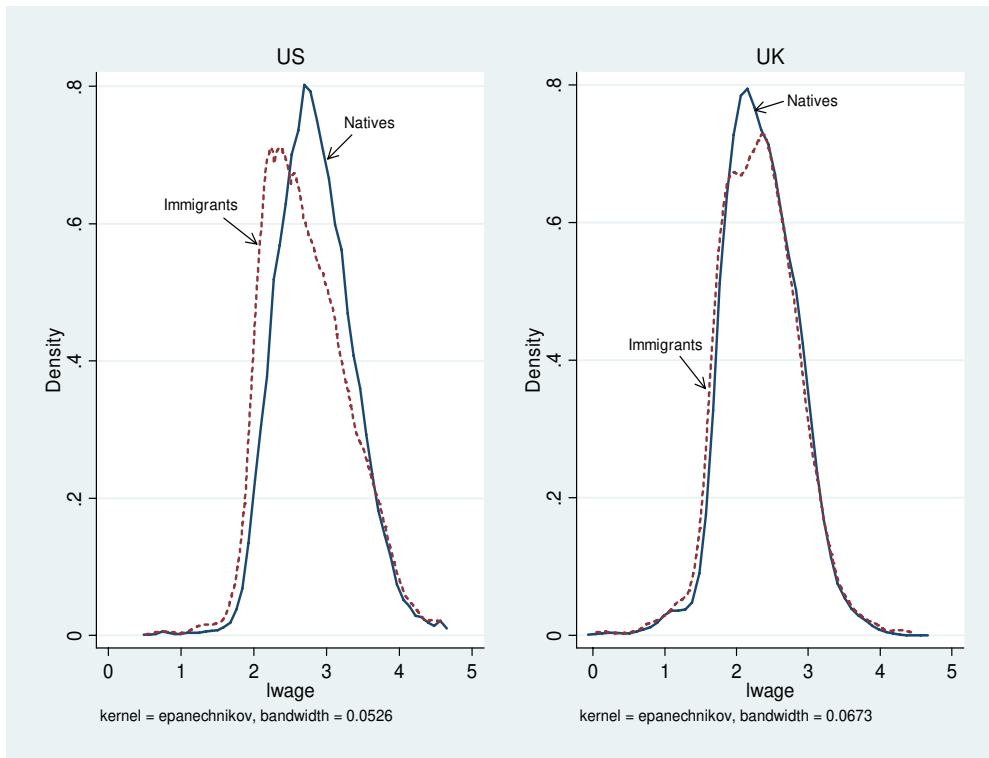
Notes: The figure plots the kernel density of the log hourly wage at 2008 for male natives and immigrants in the US and UK

Figure 1c: Log Hourly Wage Distribution, Natives and Immigrants, Women1994



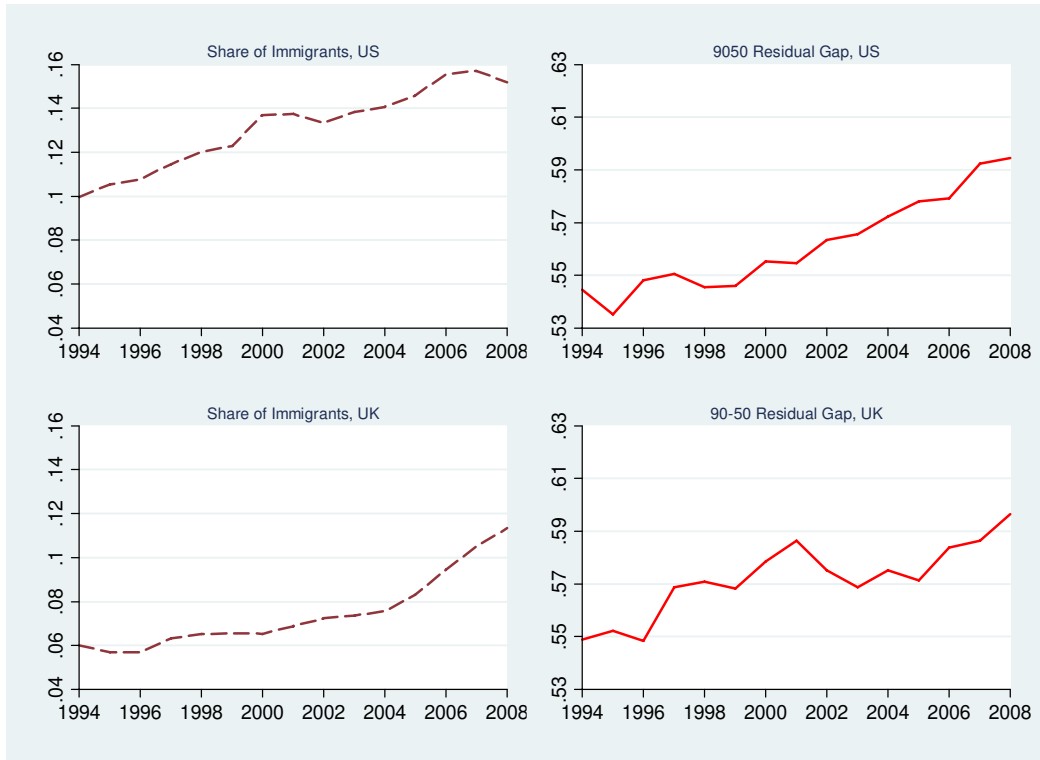
Note: The figure plots the kernel density of the log hourly wage in 1994 for female natives and immigrants in the US and UK.

Figure 1d: Log Hourly Wage Distribution, Natives and Immigrants, Women 2008



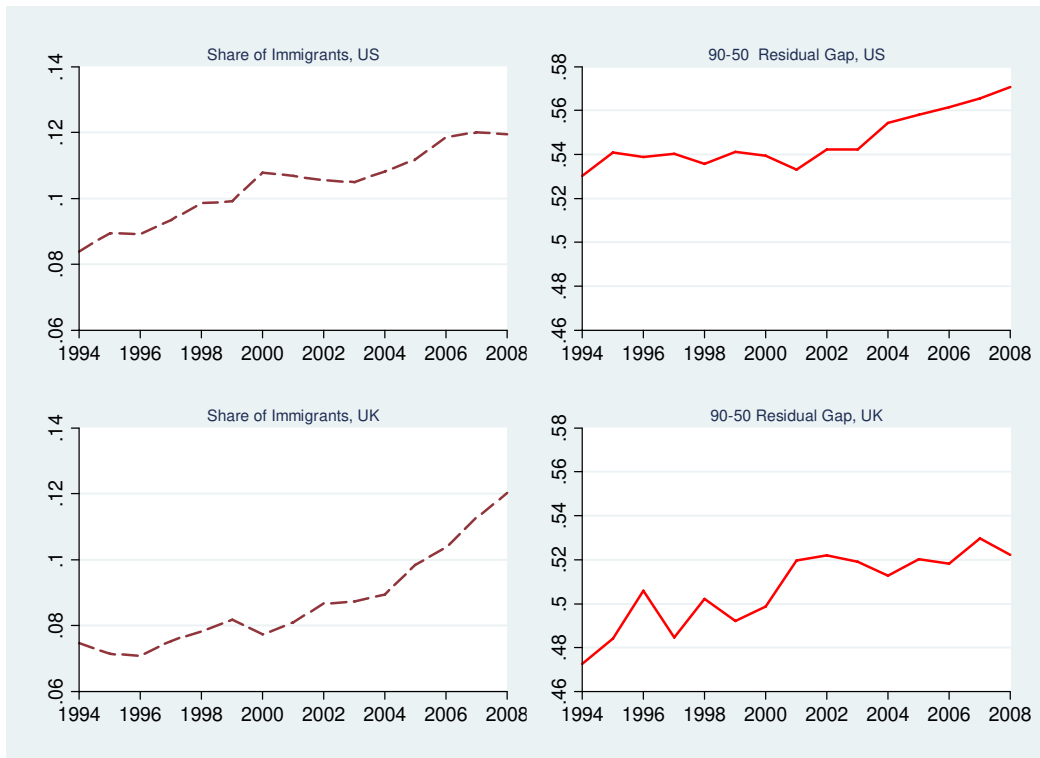
Notes: The figure plots the kernel density of the log hourly wage in 2008 for female natives and immigrants in the US and UK.

Figure 2a: Share of Immigrants and 90-50 Residual Gap, Men 1994-2008



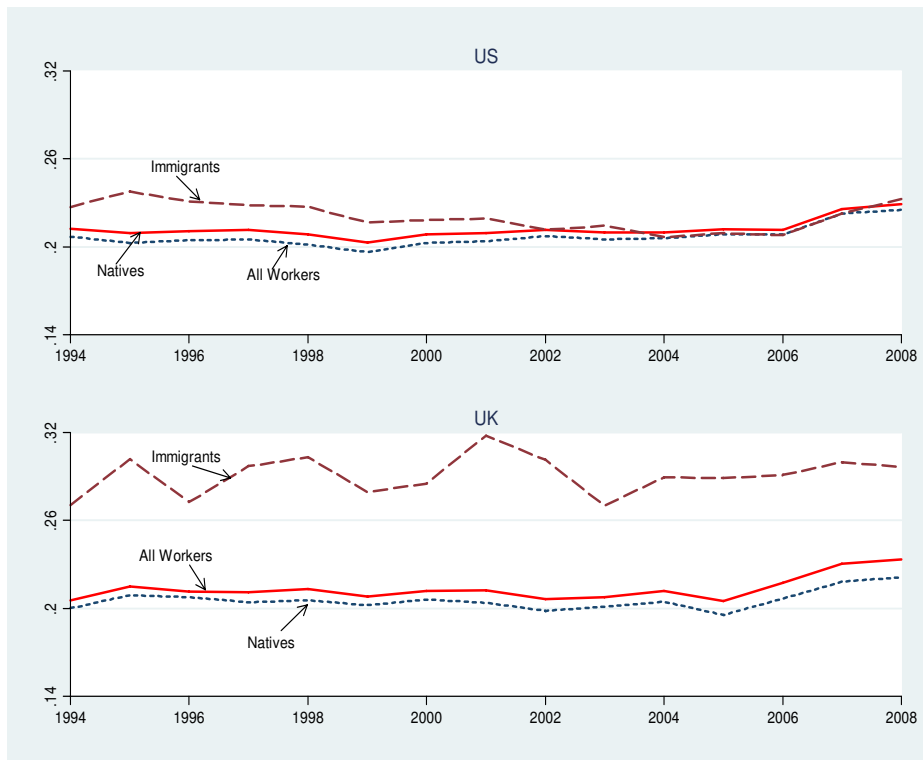
Notes: Based on ORG/CPS and LFS. Samples include men aged 16 to 64 with positive potential experience, working full time for the full year in their main job only. The figure plots the share of female immigrants in the labour force and the 90-50 residual gap for male all workers.

Figure 2b: Share of Immigrants and 90-50 Residual Gap, Women 1994-2008



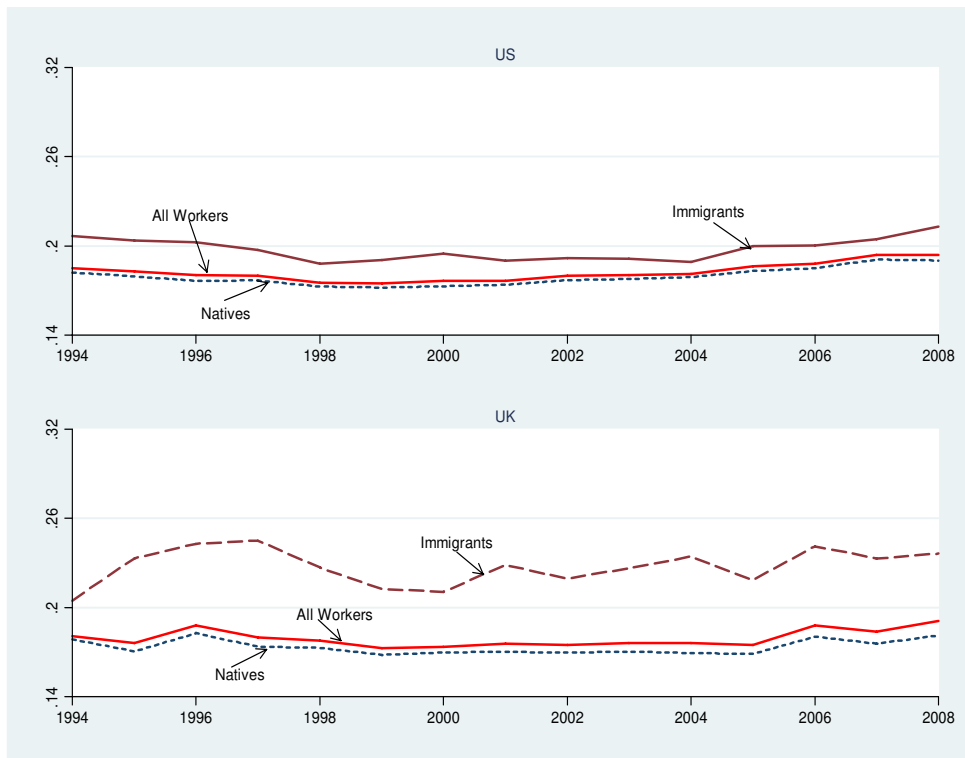
Notes: Based on ORG/CPS and LFS. Samples include men aged 16 to 64 for with positive potential experience, working full time for the full year in their main job only. The figure plots the share of female immigrants in the labour force and the 90-50 residual gap for female all workers.

Figure 3a: Actual Residual Variance for all Workers, Natives and Immigrants, men 1994-2008.



Notes: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. Residual wage variance is based on standard Mincer wage equation, fit separately by year, gender, immigration status.

Figure 3b: Actual Residual variance for all Workers, Natives and Immigrants Women



Notes: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. Residual wage variance is based on standard Mincer wage equation, fit separately by year, gender, immigration status.

Figure 4a: Actual Residual Variance, Distribution of Skills and Share of Immigrants at 1994 level, Men

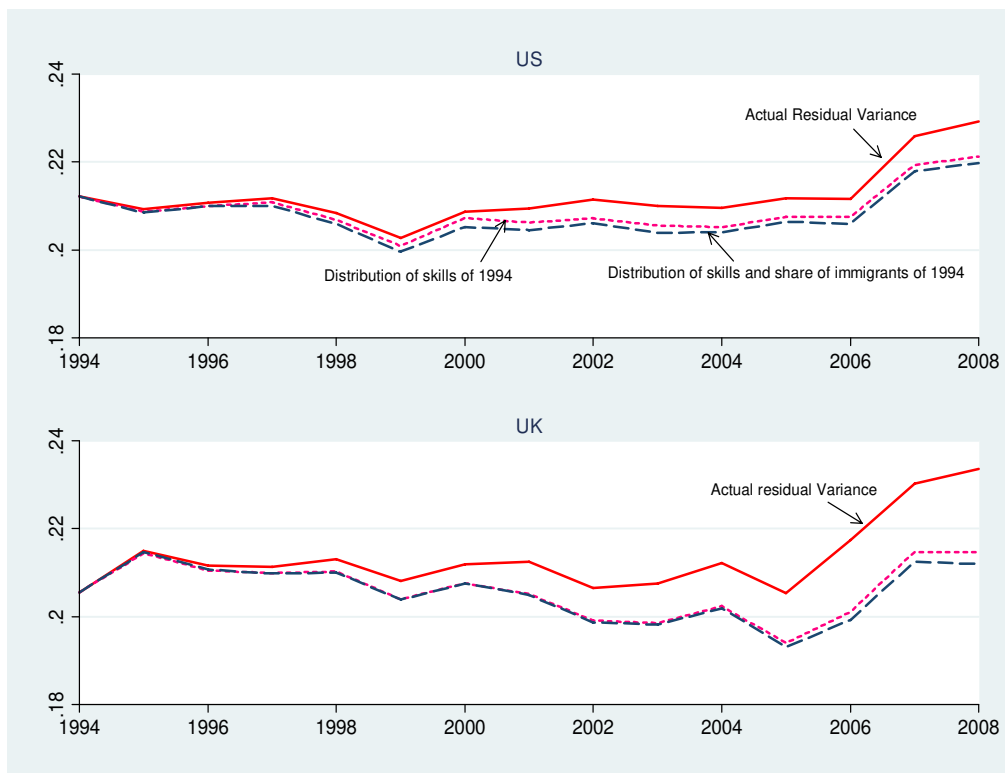


Figure 4b: Actual Residual Variance, Distribution of Skills and Share of Immigrants at 1994 level, Women



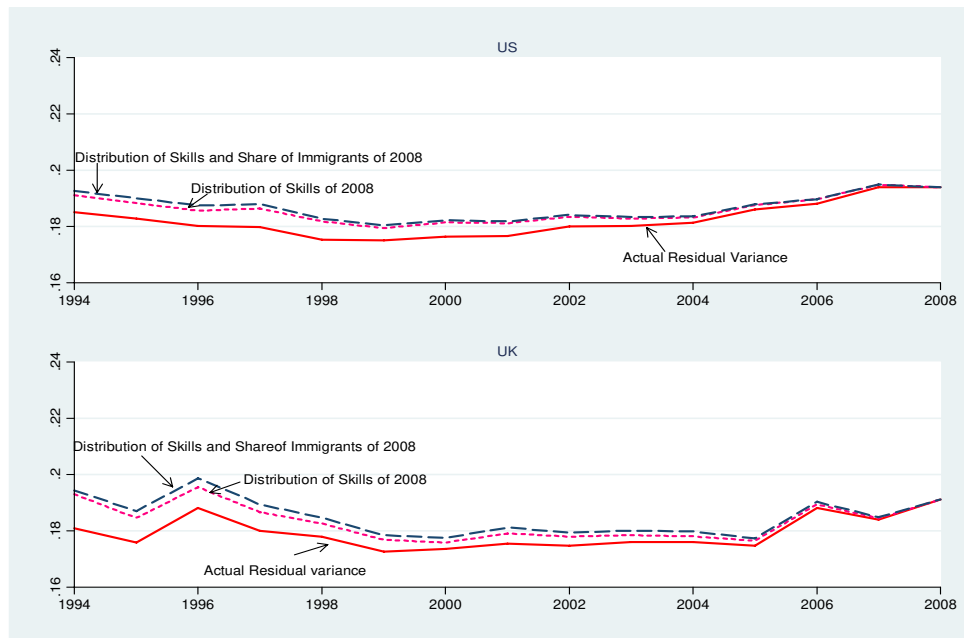
Notes: Based on ORG/CPS and LFS. Samples include all men in the labour force age with positive potential experience; working full time, full year and main job only. Hourly wages are reported in 2008 dollars and pounds. The figure plots the actual residual variance based on standard Mincer wage equation, fit separately by year, the residual holding the skills distribution in 1994 and that holding skills and the share of immigrants in 1994.

Figure 5a: Actual Residual Variance, Distribution of Skills and Share of Immigrants at 2008 Level, Men



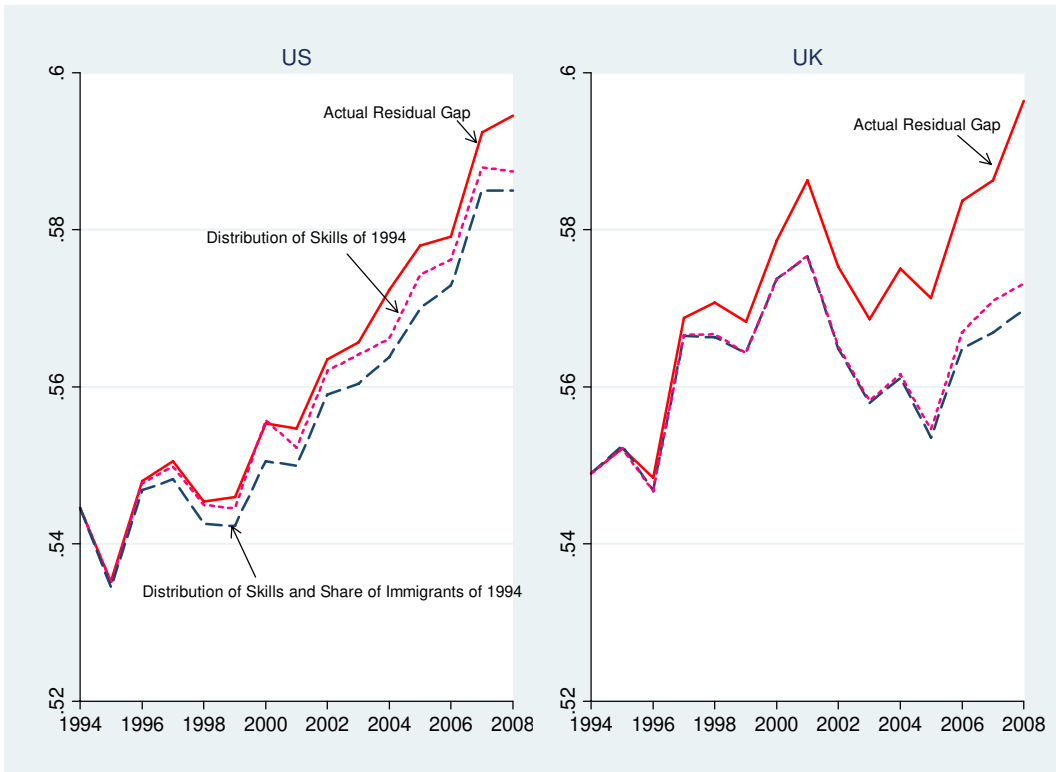
Notes: Based on ORG/CPS and LFS. Samples include men of labour force age with positive potential experience working full time for thll year in their main job only.

Figure 5b: Actual Residual Variance, Distribution of Skills and Share of Immigrants at 2008 Level, Women



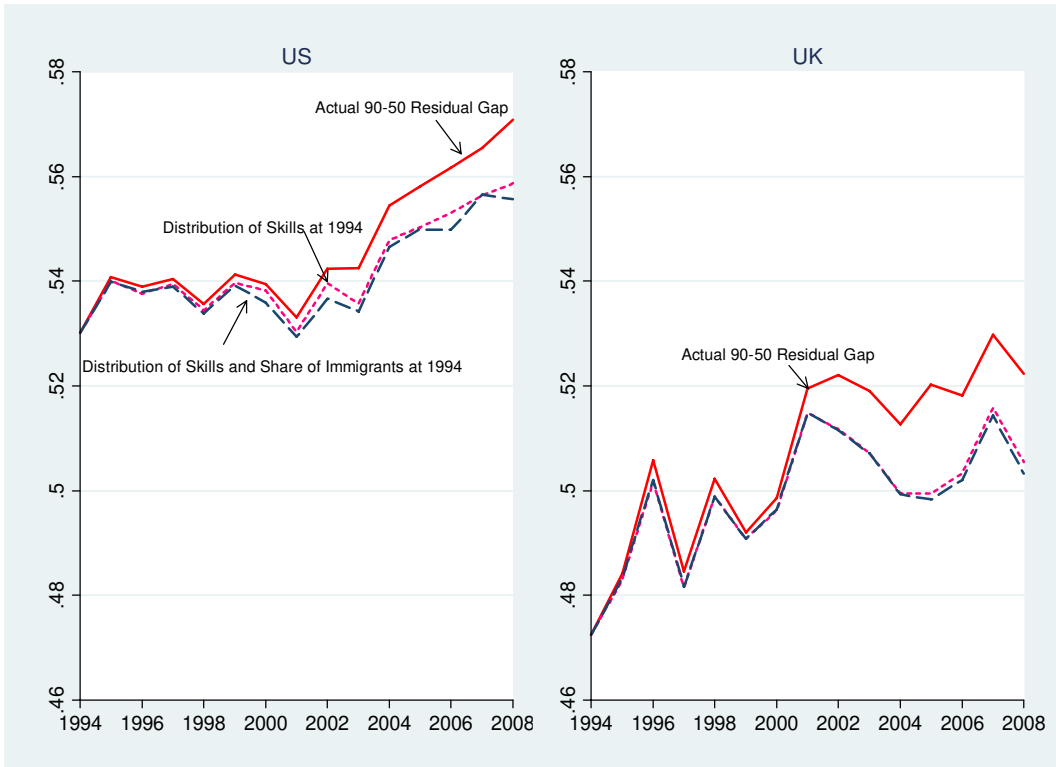
Notes: Based on ORG/CPS and LFS. Samples include men of labour force age with positive potential experience working full time for the full year in their main job only.

Figure 6a: 90-50 Residual Gap, Men US and UK
 (Holding Distribution of Skills and Share of Immigrants at 1994 Level)



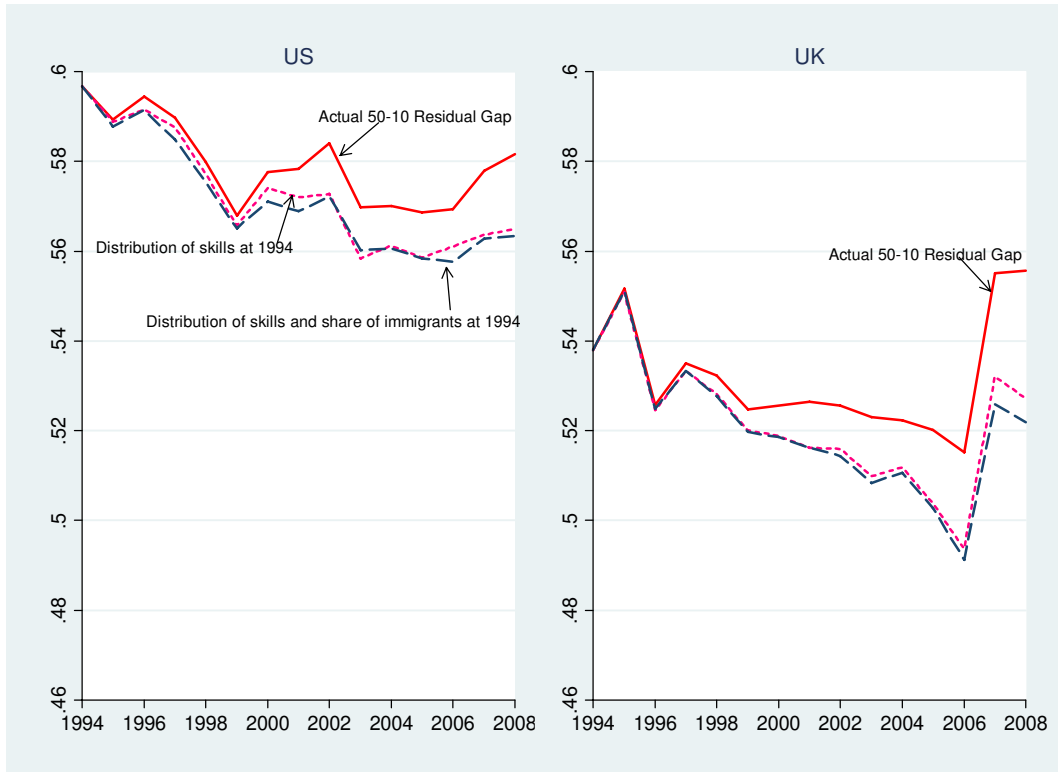
Note: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. The 90-50 residual gap is based on a standard Mincer wage equation fit separately by year, gender, and immigration status.

Figure 6b: 90-50 Residual gap, Women US and UK
 (Holding Distribution of Skills and Share of Immigrants at 1994 Level)



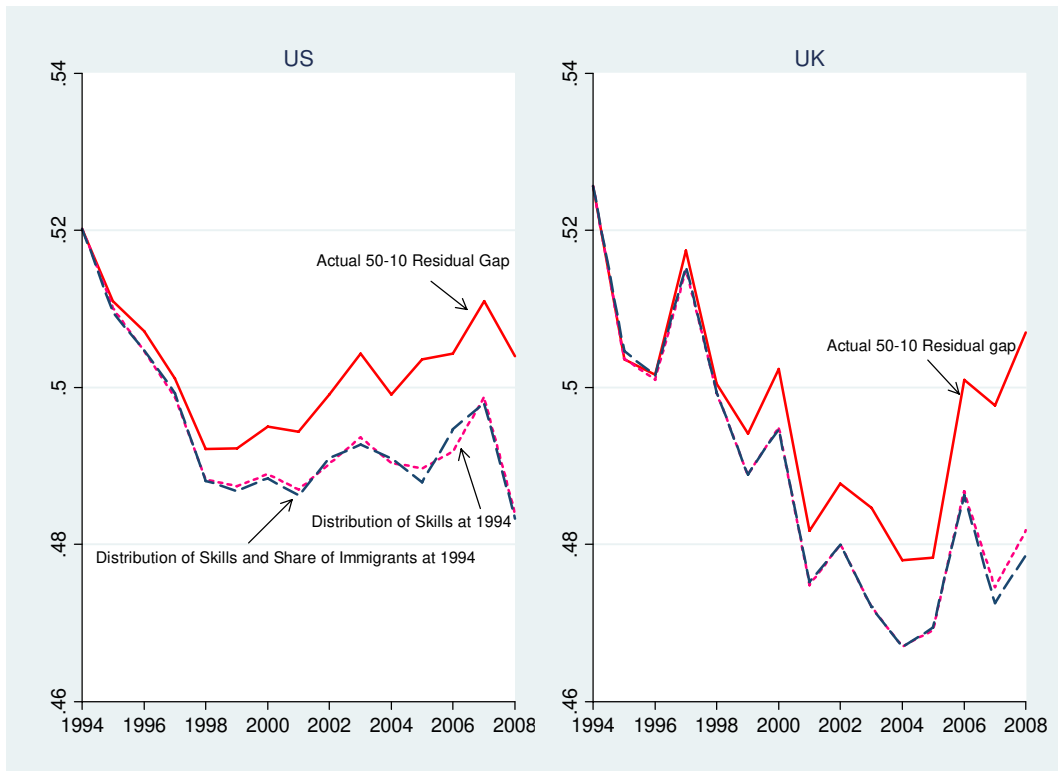
Note: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. The 90-50 residual gap is based on a standard Mincer wage equation fit separately by year, gender, and immigration status.

Figure 7a: 50-10 Residual gap, Men US and UK
 (Holding Distribution of Skills and Share of Immigrants at 1994 Level)



Note: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. The 50-10 residual gap is based on a standard Mincer wage equation fit separately by year, gender, and immigration status.

Figure 7b: 50-10 Residual gap, Women US and UK
 (Holding Distribution of Skills and Share of Immigrants at 1994 Level)



Note: Based on ORG/CPS and LFS. Hourly wages are reported in 2008 dollars and pounds. The 50-10 residual gap is based on a standard Mincer wage equation fit separately by year, gender, immigration status.