

Ethnic minorities in the UK: burden or benefit?

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REPLACED 13/07/2001

Key Words: immigrants, ethnic minorities, labour market
JEL CATEGORY: J15, J21, J31, J61

Abstract

This paper investigates the degree of the labour market competition between White and ethnic minority labour using four waves of the *British Quarterly Labour Force Survey (1997)*. The extent of the labour market competition is examined in terms of wage elasticities and elasticities of complementarity using translog production technology. The estimations suggest that ethnic minority labour is complementary to most of White workers. The substitution relationship is especially evident between ethnic minority labour on the one hand and low skilled, medium skilled non-manual and low skilled manual White labour on the other hand. Ethnic minorities do not seem to be substitute for each other.

Helpful comments from Richard Berthoud, Stephen Drinkwater, Joop Hartog, Stephen Wheatley Price and participants in the Monday afternoon seminar at Institute for Social and Economic Research, the University of Essex, is gratefully acknowledged.

This paper is based on work carried out during a visit to the European Centre for Analysis in the Social Sciences (ECASS) at the University of Essex, supported by the European Commission Training and Mobility of Researchers-Access to Large Scale Facilities Programme.

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1 Introduction

While Western Europe has been one of the magnet fields for international migration flows in the post-war period, many European countries have switched from being an emigration to an immigration country. Until 1973, immigration flows were dominated by guest workers who were recruited to meet with unskilled labour shortages generated by the post-war glory of many Western European economies. Since the Oil Crisis in 1973, immigration flows from developing countries towards West European countries have continued in the form of family reunification¹. In the eighties and nineties, immigration of asylum seekers from political unstable areas has increasingly gained importance.

Unlike other West European countries, the United Kingdom has directly recruited only a small minority of immigrants. Immigration policies have been designed to restrict immigration flows from former British colonies and dominions. However, these restrictive policies have not been always successful in reaching their objectives. Immigration from Caribbean countries and South Asia has increased considerably. Later immigration of non-White people has gone on in the form of family reunification. Additionally, a large number of professional workers, who typically did not settle permanently, have been allowed entry, and the immigration of low skilled workers from Southern Europe increased after free mobility of persons within the European Community was allowed (Wheatley Price 2000).

Integration of immigrants in host country labour markets does not proceed smoothly. As a reaction, the immigration policy of the EU-member countries becomes more and more restrictive. In particular, an attempt is made to limit immigrant flows from developing countries by new legislation or indirectly by tighter application of existing policy instruments. These restrictive immigration policies are based on an assumption that newly entering immigrants would have an adverse effect on wages and employment of natives and would also cause a further deterioration of the labour market position of settled immigrants in these countries. The disadvantaged labour market position of ethnic minorities from developing countries is a main cause of rising restrictive immigration policies in many European countries, which suffer high structural unemployment. However, it is unclear what the reaction of host country labour markets is to the entering immigrant labour force in terms of the capability of the labour markets to absorb new immigrants and the adjustment of these immigrants to host country labour markets.

In the last two decades, a large body of studies has been conducted since the seminal paper of Chiswick (1978). Most of these studies concern traditional immigration countries like the US, Canada, Australia (see for a survey Friedberg and Hunt 1994 and Borjas 1994; Schultz 1998). In Europe, the number of studies is still limited but increasing in the last few years (De New and Zimmermann 1994; Gang and Rivera-Batiz 1994; Venturini 1999; Zorlu and Hartog 2000). This may be due to the lack of appropriate data sets to make in-depth analysis. More and more questions about the ethnic origin are included in data sets. The emergence of data sets including a reasonable number of observations about ethnic minority workers stimulates research on this question.

In the UK, the labour market position of ethnic minorities is investigated in several studies. The research on ethnic minorities has focussed on the documentation of the disadvantaged position of ethnic minorities in the labour market. The main concern has been on discrimination, differences in earnings and unemployment rates of native and ethnic minority labour forces. It has been shown that members of ethnic minority groups are more frequently unemployed and they earn less than natives with similar observed socio-economic and individual characteristics (Blackaby et al. 1998, 1999a, 1999b; Bell 1997; Berthoud 1998; Shields and Wheatley Price 1998). The gap between unemployment and the wages of natives

¹ Increasing migration among developed countries as a result of economic globalisation is not seen as a problem. Therefore, it has not been a research topic for labour economists

and ethnic minorities is explained by the lack of relevant schooling and experience for the British labour market and unexplainable factors, which are partly referred to discrimination practices (Moodod et al 1997).

The disadvantaged position of ethnic minorities can be attributed to factors on both the demand and supply sides. Discriminating behaviour of employers and a decrease in demand for a certain type of labour may disturb labour market participation of ethnic minorities on the demand side while skill distribution, a lack of relevant education/training for the host country may play a crucial role on the supply side. The lack of education and experience can be overcome by relevant policies. For instance, providing education to those who need it could be a useful tool. However, the unexplained part of the disadvantage is often hard to identify and remove. This last aspect may be correlated with the absorption capacity of the labour market and with discrimination. The size and intensity of discrimination may, in turn, be, at least partly, related to business cycles. It might be expected that in periods of high unemployment, native workers would have bigger chance to be employed than workers from ethnic minority groups. When a economy stagnates, members of ethnic minority groups will be the first to lose their job.

In the UK, the labour market position of ethnic minorities is studied only from the supply side. No research has been conducted to study the impact of immigration on the labour market and reaction of the British labour market to ethnic minorities. The poor labour market position of ethnic minorities and the increasing fear of the native population of being flooded by immigrants generate a strong basis to investigate the interaction between the native and the ethnic minority labour force in the UK. This study investigates the interaction between White and ethnic minority labour in a broader context. The objective of this paper is to study the extent of labour market competition between ethnic minorities and Whites using data from the four waves of the *Quarterly Labour Force Survey 1997*, which are aggregated into a single data set. The White labour force is disaggregated into six categories: low, medium and high skilled manual workers, and low, medium and high skilled non-manual workers. Ethnic minorities are disaggregated first into three skill levels and then into four main groups for estimation of earnings: Black, Indian, Pakistani and Mixed. For the estimation of production technology, Black and Pakistani are aggregated into a single group, as well as Indian and Mixed in order to keep the number of observations reasonable.

In section 2, a short history of migration in the UK is discussed. In section 3, an overview of the data is given and descriptive statistics of selective variables are discussed. Section 4 presents a theoretical concept, which deals with the direct effect of ethnic minority labour on wages of White workers on a county basis. The hypotheses of this model are tested by the estimation of earnings functions in which percentages of ethnic minority labour in counties are included in section 5. Then, interactions between White and ethnic minority labour are examined in a general equilibrium framework in section 6. The absorption capacity of the British labour market is approximated by studying complementarity and substitution elasticities among various types of labour. Conclusions are presented in section 7.

2 UK's immigration experience

The United Kingdom has traditionally been an important source of migration flows. The vast majority of British emigrants have gone to English-speaking countries in the New World. In recent years has the United Kingdom turned out to be a country of net immigration². Immigration flows, originating in non-English speaking countries, have played a crucial role in that process. In particular, immigration from Commonwealth countries and Pakistan, and most recently refugees from Eastern Europe and other politically unstable countries has increased in the nineties. Table 1 shows net immigration and emigration flows by origin and

² Hatton and Wheatley Price (1998) discuss migration from and to the United Kingdom extensively.

host country. The New World seems to always be a destination for British emigrants while South East Asian, African and Caribbean Commonwealth countries have traditionally been a source of immigration flows. The EU countries, New Zealand and South Africa have switched from being destination to being source countries. Non-EU European countries have retained their earlier position as immigration countries between 1985 and 1994. This may be due to enlarging EU borders since 1981.

Table 1. UK Net Migration by country

	1965-74	1975-84	1985-94
Commonwealth and Pakistan			
Australia	-507.6	-146.9	-115.0
Canada	-259.3	-121.1	-32.6
New Zealand	-80.5	-17.2	+28.3
South Africa	-114.7	-19.9	+52.0
Other African Commonwealth	+73.4	+46.6	+58.4
Bangladesh, India, Sri Lanka	+117.4	+117.1	+90.5
Pakistan	-	+99.6	+64.5
Caribbean Commonwealth	+12.8*	+7.7	+1.2
Other Commonwealth	+66.1	+32.2	+27.9
Foreign			
European Union	-2.8	+23.6**	+63.6
Rest of Europe	+20.9	-29.0**	+22.2
United States	-29.6	-102.5	-63.1
Rest of America	+6.5	-2.0	-6.1
Middle East	0.0	-89.2 [#]	-10.0
Other Foreign		+31.2	+51.0
	-32.4	-89.2	-79.2

Source: Hatton and Wheatley Price (1998)

Notes: Average annual net migration in thousands, i.e. sign + represents net immigration and sign - denotes net emigration

* West Indies only

** EU countries before enlargement in 1981

[#] 1976-84 only

In 1991 the total stock of non-British people numbered nearly 4 million which made up 7.4% of the UK population. Nearly 3 million people from this population belonged to the ethnic minorities (5.5 % of the total population) of whom the majority was born outside the UK (Shields and Wheatley Price 1999).

Although Irish immigrants have formed the largest non-British group in the UK (Wheatley Price 2000 and Halpin 1997), both immigration policy and research on immigration and immigrants in the UK have been concerned in particular with non-White immigrants and their descendants. This is partly related to the fact that White immigrants have a relatively better labour market position than the non-White immigrants. However, the disadvantaged labour market position does not explain the focus on non-White immigrants. Chinese and Indian people, for example, do very well in the labour market but they nonetheless get attention from policy makers and researchers. This may be explained by UK immigration policies. Hatton and Wheatley Price (1998) state that UK immigration policies have been driven by political concerns. Behind the development of immigration policies, British governments have been concerned about domestic racial relations and the British perceptions concerning the ability and willingness of immigrants from different ethnic origin to assimilate in British society. Economic considerations have played little role in determining restrictive immigration policies.

Previous research on immigrants in the UK has focussed mainly on the explanation of the disadvantaged position of ethnic minorities with respect to earnings and (un-)employment prospect³. Blackaby et al. (1997) study male and female unemployment differences across ethnic minorities. They argue that the differences are not simply a result of differences in characteristics or discrimination. They emphasises characteristic differences among foreign born and UK born ethnic minorities and conclude that UK born non-White ethnic minorities are not doing worst. Blackaby et al. (1999) suggest that the differences in unemployment across ethnic minorities are not simply a result of discrimination. They take Indian and Pakistani/Bangladeshi groups as reference group assuming that a common level of discrimination exists against these groups because Indians are predominantly non-Muslim and the Pakistani/Bangladeshi groups are predominantly Muslim. They conclude that the relatively high unemployment among the second group is due to less favourable characteristics of this group. Wheatley Price (2000) finds a large initial employment disadvantage for recent male immigrants. However, the employment rate for White immigrants rapidly increases over the first five years in the UK. On the other hand, the employment rate of non-White immigrants increases over 20 years but it never does attain the employment level of native born men. The findings of Hatton and Wheatley Price (1998) confirm this result.

Bell (1997) finds a relative disadvantaged earnings profile for blacks. However, this disadvantage is reduced as duration of stay in UK increases. In other words, location specific human capital increases with the duration of residence in the UK. Lower earnings refer to the lack of relevant human capital (education, experience, etc). Human capital obtained abroad is appreciated less than the human capital in the UK although that strongly varies per country. Shields and Wheatley Price (1998) report a lower return to schooling obtained in the UK for most immigrant groups. Only the benefit of UK born non-Whites and White immigrants from this education is comparable with native born Whites if, at least, English is their first language. Additionally, experience obtained in the UK is more beneficial than experience abroad. However, Irish and non-White immigrants do not receive any reward from experience obtained in their country of origin while foreign experience of White immigrants is appreciated more than their potential UK experience. Language is a typical location specific human capital that has a large impact on labour market performance of immigrants. Indeed, Shields and Wheatley Price (1999) find, not surprisingly, that English language fluency considerably improves the labour market performance of immigrants and increases mean hourly wages by about 20 per cent.

As reported in the next section, ethnic minorities are concentrated in certain urban areas. Living in ethnic enclaves adversely affects human capital accumulation like obtaining English proficiency (Shields and Wheatley Price 1999) and consequently reduces labour market performance. Clark and Drinkwater (1999) find that in areas with a high degree of ethnic concentration, self-employment among ethnic minorities is low and unemployment is high. They argue that the poor economic performance of ethnic minorities is related to concentration of ethnic minorities in certain parts of urban areas.

It becomes clear from previous studies that some part of labour market disadvantage of ethnic minorities is not explainable from observable individual characteristics. Additionally, perceptions about the transferability of foreign human capital are more likely subjective in practice. Entering relevant institutional bodies, like schools, employment agencies, which allow and stimulate the accumulation of location specific human capital, is a dynamic process. It may be discouraged or resisted. This implies a certain level of resistance in the labour market against ethnic minorities. That resistance is substantiated from the viewpoint of lack of information and possible competition between native and ethnic minority labour. However, there is no information about the degree of the labour market competition. This

³ Hatton and Wheatley Price (1998) give a detailed survey of immigration policy and previous studies.

study examines the extent of labour market competition among White and ethnic minority workers for the first time. In the next section, a direct effect of ethnic minorities on the wages of native labour force is examined. In section 6, the effect is researched in a general equilibrium model.

3 The Data

The four waves of the *Quarterly Labour Force Survey (LFS)*, Spring 1997, Summer 1997, Autumn 1997, and Winter 1998, are pooled for this study because separate waves do not provide sufficient observations for the analysis conducted in this paper. Taking into account the longitudinal aspect of the LFS, each respondent is allowed to enter once in the data. Among all respondents, the population aged 16-64 is used for the descriptive analysis. Only employees are selected for further estimations. People, who are self-employed, working on government training programme and doing unpaid family work, are excluded from the survey. Employees are divided into five main categories on the basis of their ethnic background: firstly, Black, Indian, Pakistani/Bangladeshi and Mixed/Other origins are selected using the definition used in the Census of Population and then the rest of population is defined as White.

Table 2 presents the descriptive statistics of some selected variables concerning four ethnic minority groups and the White population. It can easily be seen that ethnic minority population, especially Pakistani and Bangladeshi, is younger than the White population. More than 50 percent of the Black and 43 percent of the Mixed/Other are single while less than 30 percent of Indian and Pakistani/Bangladeshi is single and more than 60 percent of these groups are married. The participation rate among ethnic minority groups both for women and men is higher than that among Whites. Especially Pakistani/Bangladeshi, Indian and Mixed/Other participate in the labour market less frequently. The unemployment rate among Black and Pakistani/Bangladeshi is, on average, the highest. However, the unemployment gap between White and the last three ethnic groups is considerably larger for men than for women, except Black women. A relatively large share of Indian people is self-employed. The average weekly earnings of the employed labour force vary widely among the five samples. Indian employees earn the highest net wages in a week, about £231. A large standard deviation for the mean net weekly earnings indicates a large variation in the earnings of Indian workers. In high level of earnings, Indian workers are followed by Mixed/Other (£212), White (£206) and Black (£193) respectively. Pakistani/Bangladeshi have the lowest average weekly earnings (£154). The same order of succession can be observed in the number of mean working-hours. However, the picture is different when experience and tenure are concerned. On average, Whites are much more experienced and they work much longer for a same employer than ethnic minorities. Black and Indian workers have similar dispersion in experience and tenure, as well as Pakistani/ Bangladeshi and Mixed/Other. Skill distribution across the groups differs strongly as well. Almost three-quarters of Pakistani/Bangladeshi workers are low skilled. Indian workers possess, on average, the highest skill levels, followed by Mixed/Other, Black, White and Pakistani/Bangladeshi. Temporary jobs seem to be more popular for ethnic minorities than for Whites. Indian and Pakistani/Bangladeshi workers are more often employed in the public sector than either other ethnic minorities or Whites. A relatively large proportion of Indian and Mixed/Other is non-manual workers and professionals. The distribution of ethnic minorities over regions differs fundamentally from Whites. Black people live in the West Midlands, Inner and Outer London. Indian people are concentrated mainly in the East Midlands, West Midland and Outer London. Pakistani people are concentrated in Greater Manchester, West York, the West Midlands, Inner and Outer London. People from category Mixed/Other are concentrated around London and the South East. In addition, the differences in employment by industries among the samples are notable: ethnic minorities are more concentrated in manufacturing, the wholesale industries, hotels, transport, real estate and health. Although

these summary statistics are only suggestive, they provide a useful background for the empirical results presented in the following part of this paper.

Table 2. Descriptive Statistics

column percentages

Age	White	Black	Indian	Pakist/Bangla	Mixed/other
15-25	21.72	24.5	24.03	38.07	32.32
26-35	24.08	34.74	27.06	27.26	28.43
36-45	18.86	18.78	22.24	16.12	20.01
46-65	35.34	21.98	26.67	18.55	19.24
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	179031	2939	2801	2146	2339
Marital status					
Single,	33.97	51.71	27.49	29.58	43.3
Married living togeth.	54.08	32.7	65.24	61.23	47.24
Married separated	2.83	6.17	2.19	4.39	3.48
Divorced	7.12	7.42	2.37	2.01	4.44
Widowed	1.99	2	2.71	2.79	1.53
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	183314	3046	2874	2187	2411
Economic Statute					
<i>Female</i>					
In employment	63.01	54.44	51.98	22.03	50.51
ILO unemployed	4.14	11.16	5.21	6.73	6.06
Inactive	32.85	34.4	42.81	71.24	43.43
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	90456	1657	1439	1085	1287
<i>Male</i>					
In employment	75.66	60.91	72.13	56.62	62.9
ILO unemployed	6.69	16.41	7.04	13.7	10.23
Inactive	17.64	22.68	20.84	29.67	26.87
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	86179	1389	1435	1102	1124
Economic activity					
Employee	87.12	91.17	84.69	82.71	87.69
Self-employed	11.79	7.16	14.07	15.42	11.19
Govern. emp/train prog	0.7	1.27	0.17	0.82	0.52
Unpaid family worker	0.39	0.4	1.07	1.05	0.599
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	121870	1733	1777	856	13499
Net weekly earnings ⁴					
Mean net weekly pay	206.60	193.89	231.80	154.28	212.88
Standard deviations	169.33	124.95	371.17	128.44	153.15
Number of observations	35620	477	465	218	368
Skill distribution					
Low skilled	52	53	59	74	58
Medium skilled	32	29	20	16	22
High skilled	16	18	21	10	20
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	152492	2929	2746	2071	2341
Type of job					
Permanent	91.99	87.98	88.84	85.14	86.92
Not permanent	8.01	12.02	11.16	14.86	13.08
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	105382	1573	1487	693	1177
Sector					
Private	76.98	66.92	80.87	84.74	77.27
Public	23.02	33.08	19.13	15.26	22.73
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	121483	1726	1772	852	1346
Occupation					
Manual	40.13	43.44	34.05	51.23	32.39
Non-manual	59.43	56.45	65.95	48.77	67.53
Armed force	0.45	0.12	0	0	0.07
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	121755	1729	1777	855	1349

continued

⁴ Net weekly earnings are calculated only for employees.

Table 2. Descriptive statistics (continued)

	White	Black	Indian	Pakis/Bangla	Mixed/other
	<i>Means</i>				
Experience (<i>Std. Dev.</i>)	21.27 (13.66)	16.90 (12.35)	17.65 (12.64)	15.21 (13.14)	14.66 (11.64)
Number of observations	157775	2916	2741	2096	2334
Tenure (<i>Std. Dev.</i>)	8.08 (8.05)	6.43 (6.94)	6.94 (6.66)	4.18 (4.87)	5.88 (6.43)
Number of observations	100873	1589	1490	708	1186
Work. Hours (<i>Std. Dev.</i>)	36.53 (15.87)	35.57 (15.03)	38.99 (16.58)	35.91 (16.04)	36.71 (15.87)
Number of observations	101687	1487	1568	760	1198
	<i>column percentages</i>				
Social class					
Professional occs	5.72	4.82	12.12	5.56	9.02
Intermediate occs	29.9	27.83	28.67	17.38	27.96
Skilled occs (non-manu)	23.47	23.77	24.29	24.59	30.05
Skilled occs (manual)	19.77	18.54	12.68	23.29	13.65
Partly skilled occs	15.77	17.55	19.34	24.82	14.77
Unskilled occs	4.92	7.38	2.9	4.37	4.47
Armed forces	0.45	0.12	0	0	0.07
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	121265	1721	1758	846	1341
Government office regions					
Tyne & Wear	1.84	0.1	0.1	1.55	0.79
Rest of Northern region	2.57	0.26	0.45	0.91	0.62
Greater Manchester	4.21	3.12	4.45	10.56	4.06
Merseyside	2.3	0.3	0.31	0.59	1.99
Rest of Northwest	4.9	0.56	2.71	4.94	1.78
South Yorkshire	2.25	1.02	0.52	2.56	1.16
West Yorkshire	3.53	2.2	4.63	14.54	2.28
Rest of Yorks/Humbers.	2.71	0.16	0.49	0.18	1.78
East Midlands	7.01	3.45	10.33	3.7	3.19
West Midlands	4.62	10.67	16.04	16.37	4.77
Rest of West Midlands	4.71	1.28	2.09	2.47	1.95
Eastern	8.87	3.97	4.84	4.48	6.59
Inner London	4.27	40.64	8.52	14.04	20.99
Outer London	7.24	24.92	33.79	12.39	27.83
South East	13.15	4.5	7.93	5.17	11.74
South West	7.96	1.77	1.04	0.73	3.19
Wales	4.86	0.33	0.52	1.6	2.03
Strathclyde	4	0.3	0.49	2.47	1.2
Rest of Scotland	5.17	0.33	0.31	0.64	1.66
Northern Ireland	3.82	0.13	0.42	0.09	0.37
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	183314	3046	2874	2187	2411
Industry sections					
Agriculture	1.68	0	0.39	0.12	0.22
Fishing	0.07	0	0	0	0
Mining	0.38	0.17	0.06	0	0.07
Manufacture	18.57	12.82	21.25	20.47	10.61
Electric	0.65	0.35	0.34	0	0.3
Construction	6.9	3.87	3.21	0.7	2
Wholesale	15.92	11.67	22.83	18.6	17.51
Hotels	5.04	6.93	3.89	19.88	19.21
Transport	6.41	7.16	8.23	11.35	5.64
Finance	4.19	2.72	4.74	1.4	4.01
Real estate	9.63	12.88	11.33	8.54	10.31
Public	5.88	7.63	4.11	4.21	4.53
Education	7.42	5.89	5.24	3.98	6.53
Health	11.34	20.39	10.77	7.37	12.02
Other	5.27	6.64	3.21	3.27	5.12
Private	0.54	0.29	0.11	0	0.89
Extra-	0.06	0.52	0.17	0.12	0.3
Workplace outside UK	0.05	0.06	0.11	0	0.74
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
Number of observations	121770	1731	1774	855	1348

4 THEORY: PARTIAL EFFECT

The summary statistics show that workers from ethnic minority groups differ from their counterpart Whites with respect to their human capital accumulation and socio-economic position. On the other hand, ethnic minority groups differ strongly from each other. This is also widely documented in previous studies (Berthoud 1998; Berthoud 1999; Blackaby 1997 and 1999; Moodod et al. 1997; Jones 1996). This raises the question of how different types of labour in the British labour market interact.

In the literature on immigration, the effect of immigration on labour market outcomes is examined on the basis of substitutability between natives and immigrants in production. Empirical analyses are mainly based on neo-classical multifactor models. In these models, changes in the employment of a certain production factor affect the demand curves of other factors through elasticities of substitution and complementarity. The predictions of these theories are straightforward: if immigrants are close substitutes for natives, in general terms, the theory predicts that immigration will have an adverse effect on wages and employment of natives (Borjas et. al. 1997). First, we analyse isolated partial interactions between different types of labour by direct modelling in this section and then simultaneous interactions will be taken into account in section 5.

We assume that aggregate production in a given labour market is a function of N types of native labour force and immigrant labour, L_M . The production function is linearly homogenous and is characterised by constant returns to scale.

$$1. Y = f(L_1, \dots, L_N, L_M)$$

The total labour force consist of native and immigrant workers, $L=L_1 + \dots + L_N + L_M$, which implies

$$2. 1 = \frac{L_i}{L_M}$$

The first order conditions requires that wage of each labour input is equal to its marginal product in terms of output.

$$3. w_i = \frac{\partial f(L_1, \dots, L_N, L_M)}{\partial L_i}$$

This demand system represents the wage determination process in a given labour market, given perfectly inelastic relative labour supplies. If we stress only an increase in the immigrant labour force, the effect of a proportional increase in immigrant labour on wages of different types of labour may be given as follows.

$$4. \frac{dw_i}{w_i} = (S_i C_{mi}) \frac{dL_m}{L_m}$$

where the price of output is normalised to 1. $S_m = w_m L_m / Y$ is the factor share of immigrants in production and C_{mi} is the Hicks partial elasticity of complementarity between factors m and i , defined as $C_{mi} = Y f_{mi} / f_m f_i$ (Sato and Koizumi 1973). f_m is the first derivative of production function with respect to factor m . Identically f_i is the first derivative of the production function with respect to factor i . $f_i = \partial f / \partial L_i$ and f_{mi} is the second

derivative, $f_{m_i} = \partial^2 f / \partial L_m \partial L_i$. The elasticity of complementarity registers the effect of a relative change in the quantity of one factor on the price of another factor. If an increase in the quantity of one factor has a positive (negative) effect on the price of another factor, these two factors are complements (substitutes). In terms of equation 4, immigrants are complementary to labour type 2 if $C_{m_2} > 0$. In opposite, immigrants and factor 2 are substitutable if $C_{m_2} < 0$.

Equation 4 reveals that a proportional increase in the immigrant labour force will affect the wages of different types of labour through elasticities of substitution or complementarity among types of labour⁵. This effect is related not only to relative share of immigrants, but also the relative shares of other inputs in production, even in the absence of labour market discrimination.

This analysis implies that if a number of new immigrant workers with low skill enters a certain county, the wages of workers who are closer substitute for immigrants, in this case low skilled workers, will decrease, and consequently the wages of workers who are compliments with immigrants will increase. Straightforwardly, if skill level of immigration flow is high, wages of high skilled workers will decrease in a certain county. These theoretical predictions may be tested by estimation of earnings functions.

We prefer to choose local labour market, i.e. county, rather than industries, as the production unit where different types of labour are employed in the production process. This choice relies on an assumption that labour force is less mobile across counties than across industries. Ethnic minorities are highly concentrated in certain regions, as shown in the preceding section. That implies a lower mobility. Low skilled labour is generally supposed to be less mobile across regions. Differently, it is a well-known phenomenon that high skilled labour is much more mobile across regions. However, the concentration of industries in certain regions weakens for mobility. This, together with some experimentation, brings us to the conclusion that labour market competition between ethnic minorities and White labour if at all present, may occur within counties rather than within industries.

In the next section, we assume that no simultaneous interactions occur among the different categories of labour in production process. Only direct partial interactions are allowed. Therefore, earnings functions of different categories of labour are estimated separately.

Estimations

For the analysis of earnings, employees are selected according to their economic statute based on the definition used by the International Labour Organisation. We assume that there is no difference between the physical quantities of native and immigrant labour but these two kinds of labour differ in their human capital accumulation expressed, for instance, as education and experience. In other words, individual wages are determined by observable individual characteristics and other socio-economic variables for both natives and immigrants. After many experiments, the entire labour force is disaggregated into 10 categories of workers, which are approximated by their education level and ethnic background. White employees are divided into two major categories: manual and non-manual since these two kinds of jobs are different in the production process. After this both groups are disaggregated into three skill levels using the highest education level: low, medium and high skilled workers. Subsequently, the disaggregation of the White labour force into six categories will create more insight with regard to competition in the labour market since the theoretical effect of immigration is typically based on the skill distribution of immigration flows.

⁵ Since $1 = \frac{L_i}{L_i}$ is assumed, the increase in the relative supply of immigrants must be compensated by a decrease in share of native labour force.

Ethnic minority groups are sub-sampled on basis of their country of origin according to the Census of Population definition. A more detailed disaggregation of ethnic minorities is desirable because immigrants are highly heterogeneous in the UK. However, the limited number of workers from ethnic minority groups in the data makes further disaggregation difficult.

The sub-samples are then as follows:

- | | |
|---|--------------------------------------|
| 1- low skilled manual workers | 4- low skilled non-manual workers |
| 2- medium skilled manual workers | 5- medium skilled non-manual workers |
| 3- high skilled manual workers | 6- high skilled non-manual workers |
| 7- Black workers (a pool of Caribbean, African and Mixed Black workers) | |
| 8- Indian workers | |
| 9- Pakistani (a pool of Pakistani and Bangladeshi workers) | |
| 10- Mixed (a pool of Chinese, Asian (non-mixed), other (non-mixed) and other (mixed) workers) | |

In the rest of the paper, the sample of Pakistani/Bangladeshi is shortly called Pakistani and the sample of Mixed/other is called Mixed. The effect of the share of ethnic minority workers on wages of Whites is estimated in the form of conventional earnings functions

$$1. \quad w_{xj} = \alpha + \beta X_{xj} + \gamma P_{jc} + \varepsilon_{xj} \quad \text{where} \quad \varepsilon_i \sim N(0, \sigma_\varepsilon^2)$$

w_{xj} is the logarithmic weekly net earnings from first and second job of individual x from the group j . X is a vector of explanatory variables. P is a vector of the percentage of the ethnic minority groups in 68 counties. Weekly net income is the sum of weekly net income from the first and second job. Because the data consist of four waves of the Quarterly Labour Force Survey, seasonal dummies are included in earnings functions to capture possible seasonal effects. Earnings functions are estimated for the three skill levels of manual and non-manual White workers as well as for four non-White ethnic minority groups⁶ separately.

In all equations, explanatory variables of a Mincer type earnings function are included. Experience is defined as age minus the age when the full-time education was finished. Tenure is the years that the individual started working for the current employer. Working hours refers to total actual hours worked in the main and second job. As the theoretical concept in Section 4 suggests, shares of different ethnic groups in employment in 66 counties are included in the earnings functions⁷. That allows us to measure the effect of ethnic concentration on the wages of other ethnic groups. To control for differences between both industries and regions, we include dummies for industries and regions where ethnic minority workers are concentrated. Earlier studies on ethnic minorities/immigrants in the UK show that the labour market disadvantage of ethnic minorities occurs in the form of relative high unemployment among ethnic minorities (Blackaby et al. 1997 and 1999; Wheatley Price 2000). This finding suggests that ethnic minorities are more vulnerable to unemployment than natives. Therefore unemployment rates for 66 counties are calculated and included in the earnings functions. In order to capture the scale effect in working places, a dummy variable for firms with less than 20 employees is used. Because the data is an aggregation of four quarters of LFS 1997, dummies are constructed to eliminate seasonal effects. Further, a number of dummy variables

⁶ The four ethnic minority groups are disaggregated according to their ethnic origin by Census of Population. The name of variable is ETHNICA in the Labour Force Survey. ETHNICA is a summary of ETHCEN.

⁷ These eight ethnic minority groups are identified according to their ethnic origin, which is a definition of Census of Population. The name of this variable is ETHCEN in the Labour Force Survey. The variable ETHNICA in which ethnic minorities are divided into four main groups is a summary of ETHCEN. Since this more detailed disaggregation of ethnic minorities has no consequences for the number of observations in the estimations, we prefer this variable rather than ETHNICA.

are used to control differences in gender, marital status, type of job, health problems, union membership, commuting and public/private sector. Additionally, for the earnings equations of ethnic minorities, we construct dummy variables to capture cohort effects. So, dummies are included for the five periods when immigrants arrived in the UK: between 1940-1960, 1961-1970, 1971-1980, 1981-1990 and after 1990.

The six categories of the White labour force and the four categories of ethnic minorities are estimated separately. The coefficients of P indicate the degree of labour market competition between Whites from different skill levels and ethnic minorities as well as ethnic minority groups themselves, given that the ethnic minority groups possess different skill levels. The results of the estimated earning functions with robust standard errors are presented in Table A1 and A2. Using the coefficients (γ) and mean values of the percentages of eight ethnic minority groups (P), partial wage elasticities are calculated for White workers between various types of labour⁸. A negative sign for elasticity indicates the substitution relationship between types of labour concerned. Straightforwardly, a positive sign indicates the complementarity relationship. Table 3 shows the wage elasticities for White workers by skill categories with respect to ethnic minority groups. The elasticities for Caribbean Black labour share are negative for low skilled non-manual, and low and medium skilled manual White workers but the elasticity is almost statistically significant for only the low skilled non-manual workers. Black African workers have a small positive significant effect on the earnings of high skilled non-manual White workers. The other elasticities are not significant and have varying signs. The elasticities for mixed Black workers are negative for all categories but significant only for medium skilled non-manual and high skilled manual White workers. The elasticity of Indian workers is negative only for low and medium skilled workers and is positive for the rest of the categories but it is significant only for the high skilled manual. The elasticities for Pakistani workers have, in many cases, the inverse signs of Indian workers.

Table 3. Estimated wage elasticities for Whites

With respect to quantity of	Changes in the wage of											
	NON-MANUAL						MANUAL					
	LOW		MED		HIGH		LOW		MED		HIGH	
	Elast.	t	Elast.	t	Elast.	t	Elast.	t	Elast.	t	Elast.	t
Per. black (Caribb)	-0.042	-1.69	0.021	0.81	0.001	0.02	-0.020	-0.90	-0.009	-0.40	0.030	0.46
Per. black (Afric.)	0.005	0.32	-0.001	-0.10	0.045	1.99	-0.003	-0.27	-0.003	-0.30	0.037	0.93
Per. black (Mixed)	0.000	-0.03	-0.044	-2.39	-0.031	-1.29	-0.001	-0.05	-0.012	-0.77	-0.125	-2.35
Percentage Indian	-0.015	-0.86	-0.012	-0.69	0.003	0.25	0.012	0.93	0.003	0.19	0.097	2.04
Percent. Pakistani	-0.025	-1.06	0.007	0.28	0.014	0.59	-0.004	-0.17	-0.016	-0.57	-0.114	-1.71
Perc. Bangladeshi	0.000	-0.01	-0.001	-0.05	-0.030	-1.56	0.012	1.13	0.014	1.00	0.000	-0.01
Percent. Chinese	0.013	1.14	0.001	0.10	0.008	0.64	-0.002	-0.19	-0.009	-0.73	-0.037	-1.04
Percentage Mixed	0.040	2.67	0.007	0.42	-0.014	-0.80	0.007	0.53	0.015	1.19	-0.007	-0.16

Elasticities are calculated on the basis of the estimated coefficients of earnings functions presented in Appendix. Elasticity can be simply calculated as (the estimated coefficient)*(the mean of the explanatory variable). t-statistics are the estimated coefficients of earnings functions presented in Table A1 in Appendix.

The percentage of Bangladeshi workers has a negative effect on all the other categories, except for low and medium skilled manual workers. The spatial concentration of Chinese workers affects the manual workers' wage negatively and the non-manual workers' wage

⁸ The wage elasticity is the product of the estimated coefficient and its mean.

positively. The coefficients of Mixed workers are negative only for high skilled and positive for the rest of the workers.

In other words, in terms of significant coefficients, Caribbean Black labour may be a substitute for low skilled non-manual White labour and African Black is complementary to high skilled non-manual workers. Mixed Black seems to be a substitute for medium skilled non-manual and high skilled manual workers. Indian workers may be complementary to non-manual high skilled manual workers. Finally, Mixed workers are complementary to low skilled non-manual White workers.

In Table 4, the estimations of earnings functions of ethnic minorities shows the labour market competition among ethnic minorities. Indian workers are complementary to Pakistani workers. The rest of the underlying coefficients are not statistically significant. Regardless of the significance of the coefficients, Black workers may compete with Indian workers and may be complementary to Pakistani and Mixed workers. Indian and Pakistani workers may be complementary to other ethnic minority workers. Mixed workers may be substitutes for Black, and complementary to Mixed workers. Mixed workers may be substitute for Black and complimentary to Indian workers. Own-wages elasticities are negative for Black and Indian, as expected but those are positive for Pakistani and Mixed. It is notable that the coefficients of the shares are larger among ethnic minority groups than among White and ethnic minorities. This outcome is in line with earlier studies.

Table 4. Estimated wage elasticities for ethnic minority groups

With respect to quantity of	Changes in the wage of							
	BLACK		INDIAN		PAKISTANI		MIXED	
	Elast.	t	Elast.	t	Elast.	t	Elast.	T
Percentage Black	-0.213	-0.74	-0.203	-0.64	0.077	0.30	0.164	0.40
Percentage Indian	0.089	0.45	-0.174	-0.38	0.885	2.66	0.361	0.88
Percentage Pakistani	0.029	0.29	-0.142	-0.67	0.488	1.16	0.355	0.87
Percentage Mixed	-0.028	-0.11	0.042	0.09			0.622	0.63

t statistics are the estimated coefficients of earnings functions presented in Table A2 in Appendix

Concerning the coefficients of the variables in the earnings functions presented in Table A1 in appendix, the unemployment rate has a small negative effect on the wages of all White workers. The significance level of this effect is higher for lower skill levels, e.g. lower t-statistics for high skilled manual and non-manual workers. In the earnings functions of ethnic minorities in Table A2, the coefficients for the unemployment rate are insignificant. It is even notable that the coefficient for Indian workers is positive which implies that the wages of Indian and Mixed workers are not affected by unemployment.

As expected, experience, tenure and the number of working hours have a highly significant effect on earnings, as presented in Table A1 and A2. However, the coefficients are not significant for Pakistani/Bangladeshi workers. A possible reason could be the relatively young age structure of the Pakistani/Bangladeshi workers. Female workers earn around 20 percent less than male and married workers do. The disadvantage is relatively less for women with a high education who are employed in non-manual jobs as well as for women from Black and Mixed groups. Temporary and, especially, part-time jobs pay notably lower wages than permanent and full-time. Wages for workers who are employed in firms with less than 20 workers, are 8 to 31 percent lower than large scale companies with more than 20 employees. The private sector offers 4 to 9 percent greater wages than the public sector for manual workers and Black workers. Union membership has a positive impact on earnings but

this effect is relatively small for non-manual workers and negative for high skilled manual workers. Workers who commute between home and work earn 4 to 13 percent more than non-commuters do. Workers with health problems have lower earnings than healthy workers do, except workers from the Indian, Pakistani and Mixed categories. Earnings dispersion among industries and geographical areas is substantial. In general, manufacturing offers slightly higher wages for all types of labour while hotels, education and wholesale industries pay lower wages although not all coefficients are significant. Only Pakistani workers in wholesale industries and education are better off. Employment in public administration and defence pays relatively higher wages for low skilled workers and relatively lower wages for higher skilled workers. All workers who are employed in London earn significantly higher wages. However, Whites in London have a bigger advantage than non-Whites. Only workers from the category Mixed workers who are employed in London earn wages which are comparable with earnings of White workers. Other minority workers in the same area have relatively low wage rates. The coefficient of having a health problem has a surprisingly positive sign for Indian, Pakistani/Bangladeshi and Mixed workers but it is not significant. Generally, the coefficients of many explanatory variables for ethnic minorities have more or less the same signs as those in the earnings functions for Whites. However, there are some differences among earnings functions for Whites: the signs of coefficients for dummy variables for the private sector are, in general, positive and the coefficients for the manufacturing-dummy is not always positive. In addition, the t-statistics for these variables are relatively low.

5 THEORY: WHEN PRODUCTION FACTORS ARE INTERRELATED

The empirical analysis of the competition between different categories of labour, which can be determined on the basis of skill, occupation, ethnic origin and so on is typically based on neo-classical input demand theory (Johnson 1980; Grant and Hamermesh 1981; Grossman 1982; Borjas 1985; Borjas 1987; Altonji and Card 1991; Lalonde and Topel 1991). The main methodological instrument of this theory is to determine the extent of the competition is the estimation of substitution parameters among type of labour and between labour types and capital. A preliminary procedure is the choice of a functional form of production function and its estimation to determine technology coefficients. Then, elasticities of substitution and complementarity among production factors can be calculated. On the basis of these elasticities, we can examine the degree of competition between labour inputs.

In the literature on estimation methodologies of demand for types of production factors, the discussion has been focussed on the choice between estimating a cost function or a production function, the choice of functional form and sample, and disaggregation of labour force. Hamermesh and Grant (1979) argue that empirical methodology makes sense for outcomes of substitution elasticities because estimations are based on different assumptions. They suggest that a choice of production function approach is a more appropriate methodology when quantity of labour, rather than wages, is assumed to be exogenous. Most of the choices mentioned here are restricted by availability of suitable data. So, capital is excluded in this study because data about capital is not available in the UK. Since this study examines substitution relationships only among types of labour, a risk exists that estimations may be biased. Hamermesh and Grant (1979) argue that estimates of own-price elasticity will be biased towards zero when a separability assumption is not satisfied. By the exclusion of input capital, the effect of capital on the substitution elasticities is ignored and a strong separability between labour and capital is implicitly assumed. Since we do not have data about capital, we are unable to test the separability and must assume that the separability assumption holds.

In previous studies, which have been overwhelmingly conducted in the United States, there is some evidence of substitution between native and immigrant labour in line with theoretical

predictions. Grant and Hamermesh (1981) analyse the competition among youth, adult White male, White female and Black workers in manufacturing using translog production functions. They find a weak substitutability between Black and White men, and a strong substitutability between youth and White women workers. Using a comparable method, Grossman (1982) studies complementarity among native, foreign-born and second generation workers, and reports that both foreign-born and second generation workers are substitutes for native workers but second generation workers are stronger substitutable. Foreign-born workers are stronger substitutes for second generation than for native workers. Capital is complementary to all kinds of labour but the complementarity is the strongest for immigrants. Using the generalised Leontief production function, Borjas (1983) finds no indication for substitutability between Black and Hispanic workers. In his work, Hispanic and White labour are complements while Black and White labour are neither substitutes nor complements. In his later work, Borjas (1986) finds competition between immigrant and White men as well as between women and White men but also finds complementarity between immigrant and Black males. Borjas (1987) disaggregates labour inputs further. White, Black, Hispanic, and Asian workers are all divided into two categories: native-born and foreign-born. Immigrants as a group are substitutes for White native-born workers. Black native-born workers are weakly substitutes for Black and Hispanic immigrants while they are strongly complementary to White immigrants. He finds no evidence of substitutability between Hispanic native-born and other native-born population groups. Griffin (1996) uses firm level data to detect substitutability relationships among various types of labour input and finds that White male and female workers are strong substitutes as well as minority male and White female workers. On the other hand, minority men and women seem to be closely complementary in production. New and Zimmermann (1994) use wage functions to measure competition between blue/white collar and immigrant workers. They show a small positive effect of the shares of immigrants in industry sectors on the wages of white-collar German workers but a large inverse effect on the wages of blue-collar German workers. They conclude that immigrants on the whole are substitutes for native German workers.

This study goes a step further. Ethnic minorities are firstly divided into the three skill categories and then into four ethnic groups. The disaggregation of Whites into 6 different categories allows investigation of labour market competition among six types of White labour and 3 skill- /4 ethnic categories of immigrant labour. The disaggregation of labour force in many categories may provide more insight into the labour market competition between various types of labour inputs.

Suppose that an economy produces Y units of goods employing eight types of labour. The production function in a given labour market is given by:

$$1. \quad Y = f(L_1, \dots, L_N), \quad f' > 0, f'' < 0, N = 1, 2, \dots, N$$

We prefer the production function approach because the quantity of labour is more likely exogenous than wages as long as the main focus here is on immigrant labour, and international migration is highly restricted. It is assumed that production function exhibits standard neo-classical properties and is linearly homogenous. In a perfectly competitive market, the first order condition for profit-maximisation is given.

$$2. \quad \frac{\partial Y}{\partial L_i} = w_i, \quad i = 1, 2, 3, \dots, N$$

where w_i refers to wage rate of labour input i . Equation 9 demonstrates that labour input i is paid the value of its marginal productivity.

The analysis of multifactor production function requires more specification of production technology. A transcendental logarithmic (translog) production function is a functional form,

which is a second-order approximation to a generalised production function in a given labour market (Christensen et al. 1973; Bernt and Cristensen 1973; Grant and Hamermesh (1981), Grossman (1982), Gang and Rivera-Batiz (1994). The standard translog production function is given as

$$3. \ln Y = \ln \alpha_0 + \sum_i \alpha_i \ln L_i + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln L_i \ln L_j, \quad i = 1, 2, 3, \dots, N$$

Where Y is output, the L_i are inputs and α_0 , α_i and β_{ij} are technology parameters. The production function is characterised by constant returns to scale. Y is assumed to be linear homogeneous in L . Constant return to scale implies the following restrictions on the parameters of the production function:

$$\sum_i \alpha_i = 1 \quad \text{and} \quad \sum_i \beta_{ij} = 0$$

N factor share equations are derived from the N output elasticity equations.

$$4. \frac{\partial \ln Y}{\partial \ln L_i} = \frac{\partial Y}{\partial L_i} \frac{L_i}{Y} = \frac{w_i L_i}{Y} = S_i \quad \text{for all } i.$$

where w_i is the wage rate and S_i is the share of input i in the value of output, with $\sum S_i = 1$. The factor share equations can be derived from equation (8), imposing linear homogeneity.

$$5. S_i = \frac{\partial \ln Y}{\partial \ln L_i} = \alpha_i + \sum_j \beta_{ij} \ln L_j + u_i$$

where u is the error term. Demand theory requires symmetry which implies cross-equation restrictions on the technology coefficients, i.e. $\beta_{ij} = \beta_{ji}$. Since homogeneity is assumed, one of the factor share equations becomes unnecessary. Because wages of the 8 types of labour are estimated by the earning functions, we can estimate the factor share equations. Since perfect competition is assumed, output may be equal to the sum of income generated by the production factors employed, in this case $Y = \sum_i w_i L_i$. Then we may construct the factor shares as follows:

$$6. S_i = \frac{w_i L_i}{\sum_i w_i L_i}$$

By choice of production function instead of the cost function, we assumed that factor quantities are exogenous, rather than factor prices. Therefore, the Hicks partial elasticities of complementarity are appropriate measure of factor substitutability (Grant and Hamermesh 1981). The Hicks partial elasticities of complementarity between factors L_i and L_j , C_{ij} , is defined as the proportional change in factor price i as a result of exogenous changes in factor j 's supply, holding the output price and other input quantities constant.

$$7. C_{ij} = \frac{F F_{ij}}{F_i F_j}$$

where F_i is the first derivative of the production function F with respect to factor i , i.e.

$$F_i = \frac{\partial F}{\partial L_i} \quad \text{and} \quad F_{ij} \text{ is the second derivative of the production function } F, \text{ i.e.}$$

$$F_{ij} = \frac{\partial^2 F}{\partial L_i \partial L_j}$$

In terms of the translog share equations, the Hicks partial elasticity of complementarity is given by (Hamermesh 1986)⁹:

$$8. \quad C_{ij} = \frac{(\beta_{ij} + S_i S_j)}{S_i S_j}$$

$$9. \quad C_{ii} = \frac{(\beta_{ii} + S_i^2 - S_i)}{S_i^2}$$

If an increase in input j rises price of i , i.e. $C_{ij} > 0$, factors i and j are complements. If an increase in input j decreases price of i , i.e. $C_{ij} < 0$, factors i and j are substitutes.

Using the elasticities of complementarity, C_{ij} , and average factor shares, S_i , the elasticities of factor prices can be computed as follows (Sato and Koizumi 1973):

$$10. \quad \frac{d(\log w_i)}{d(\log L_j)} = S_j C_{ij}, \quad i, j = 1, 2, \dots, N$$

It shows the proportional change in wage of factor i as a result of a change in quantity of factor j .

5.1 Substitutability of Whites and ethnic minorities

We estimate the system of the factor share equations in equation 10 using the predicted wages rather than the observed wages because there are too few observations about ethnic minorities across the regions. Additionally, ethnic minorities are pooled as two groups: Black workers and Pakistani/Bangladeshi are treated as one category, and Indian and Mixed/Other make up the other category. Unfortunately a further disaggregation of ethnic minorities is not possible since the number of observations from ethnic minorities are too few to obtain reasonable estimations. The categorisation of these groups is not arbitrary. Most similar groups are identified by the descriptive statistics presented in Table 2; also earlier studies on ethnic minorities in Britain (Jones 1996; Moodod et al. 1997; Berthoud 1998) support this identification. Preferring the aggregation of these groups does not mean that we ignore the differences between the aggregated ethnic minority groups. Also the White labour force is highly heterogeneous. In the end, the disaggregation of ethnic minorities into two groups is better than taking the ethnic minorities as a single group¹⁰.

The predicted wages are obtained by the estimation of earnings functions in section (4). The procedure of creating data for this estimation is as follows. Firstly, we predicted the wages of the nine and ten types of labour using the log earnings functions estimated and presented in Table 3 and 4. Then, mean wages and factor shares are calculated for 66 counties. Data is constructed for 8 types of labour. Zellner's seemingly unrelated regression technique, a maximum-likelihood method, is applied to these data sets to take into account the possible correlation among the error terms, u_i , u_j . The estimated technology coefficients and

⁹ The relationship between the complementary and substitution elasticities is demonstrated by Sato and Koizumi (1973)

¹⁰ The elasticities of complementarity and corresponding wage elasticities become smaller when ethnic minority groups are aggregated into a single group. This implies that ethnic minority groups reduce the degree of the substitutability or complementarity of each other through which elasticities of complementarity become smaller for the pooled sample. This also suggests that ethnic minority groups are highly heterogeneous. This experiment is not presented here.

corresponding t-statistics are presented in Table 5. Most of the technology coefficients are statistically significant.

Table 5. The estimated technology coefficients. ($S_i = \alpha_i + \sum_j \beta_{ij} \ln L_j + u_i$)

	Coefficient	t		Coefficient	t
α_1	0.0379	8.93	β_{18}	0.0007	0.68
α_2	0.0764	9.16	β_{23}	-0.0086	-3.72
α_3	0.1246	10.22	β_{24}	-0.0063	-2.34
α_4	0.1470	11.29	β_{25}	-0.0023	-1.07
α_5	0.2075	13.88	β_{26}	-0.0065	-2.50
α_6	0.2049	12.50	β_{27}	-0.0014	-0.57
α_7	0.1497	10.10	β_{28}	0.0000	0.02
α_8	0.0587	6.73	β_{34}	-0.0233	-3.29
β_{11}	0.0115	13.48	β_{35}	-0.0441	-9.58
β_{22}	0.0247	13.39	β_{36}	-0.0345	-7.79
β_{33}	0.1373	20.68	β_{37}	-0.0191	-4.50
β_{44}	0.1211	13.37	β_{38}	-0.0024	-0.81
β_{55}	0.1341	18.27	β_{45}	-0.0403	-9.35
β_{66}	0.1548	20.11	β_{46}	-0.0326	-7.58
β_{77}	0.1136	16.53	β_{47}	-0.0115	-2.59
β_{88}	0.0184	6.79	β_{48}	-0.0046	-1.42
β_{12}	0.0000	-0.03	β_{56}	-0.0298	-5.77
β_{13}	-0.0016	-0.92	β_{57}	-0.0169	-3.53
β_{14}	-0.0046	-2.31	β_{58}	-0.0005	-0.18
β_{15}	-0.0013	-1.13	β_{67}	-0.0523	-8.13
β_{16}	-0.0004	-0.28	β_{68}	-0.0066	-2.23
β_{17}	-0.0029	-2.00	β_{78}	-0.0040	-1.33

The figures in subscripts: 1: Black, Pakistani/Bangladeshi, 2: Indian and Mixed, 3: low skilled non-manual White workers. 4: medium skilled non-manual White workers. 5: high skilled non-manual White workers. 6: low skilled manual White workers. 7: medium skilled manual White workers. 8: high skilled manual workers.

Finally, complementarity and substitution elasticities are calculated by using equations 12 and 13 as well as the technology coefficients in Table 5.

Table 6. Partial elasticities of factor complementarity

The change in the wage of	With respect to the quantities							
	nmlow	nmmed	nmhigh	mlow	mmed	mhigh	Black- Pakist.	Indian- Mixed
nmlow	-0.021	0.125	-0.470	0.222	0.332	0.406	0.487	-1.134
nmmed		-0.071	-0.453	0.205	0.563	-0.162	-0.614	-0.673

Nmhigh	-0.065	0.356	0.432	0.895	0.588	0.464
Mlow		-0.147	-0.188	-0.024	0.918	-0.035
Mmed			-0.161	0.044	0.062	0.653
Mhigh				-0.235	2.553	1.062
black-Pakis					-0.347	0.930
Indian-mix						0.061
Factor shares	0.170	0.157	0.177	0.261	0.168	0.025
	0.018	0.024				

*nm*low is low skilled non-manual White workers. *nm*med is medium skilled non-manual White workers. *nm*high is high skilled non-manual White workers. *m*low is low skilled manual White workers. *m*med is medium skilled manual White workers. *m*high is high skilled manual workers. *bp* is Black and Pakistani/Bangladeshi workers. *im* is Indian and Mixed/Other workers.

The elasticities are calculated by Equations 13 and 14 using the technology coefficients in Table 5 and factor shares in the lowest row in Table 6.

Table 7. Own- and Cross-Price Elasticities (from table 6)

The change in the wage of	With respect to the quantities							
	<i>nm</i> low	<i>nm</i> med	<i>nm</i> high	<i>m</i> low	<i>m</i> med	<i>m</i> high	Blac-Pak	Ind-Mix
<i>Nm</i> low	-0.004	0.020	-0.083	0.058	0.056	0.010	0.009	-0.027
<i>Nm</i> med	0.021	-0.011	-0.080	0.053	0.095	-0.004	-0.011	-0.016
<i>Nm</i> high	-0.080	-0.071	-0.012	0.093	0.073	0.022	0.011	0.011
<i>M</i> low	0.038	0.032	0.063	-0.038	-0.032	-0.001	0.017	-0.001
<i>M</i> med	0.056	0.088	0.076	-0.049	-0.027	0.001	0.001	0.016
<i>M</i> high	0.069	-0.025	0.158	-0.006	0.007	-0.006	0.046	0.025
black-Pakis	0.083	-0.096	0.104	0.240	0.010	0.063	-0.006	0.022
Indian-mix	-0.192	-0.106	0.082	-0.009	0.110	0.026	0.017	0.001

*nm*low is low skilled non-manual White workers. *nm*med is medium skilled non-manual White workers. *nm*high is high skilled non-manual White workers. *m*low is low skilled manual White workers. *m*med is medium skilled manual White workers. *m*high is high skilled manual workers. *bp* is Black and Pakistani/Bangladeshi workers. *im* is Indian and Mixed/Other workers. The own- and cross-price elasticities are calculated using the elasticities of

complementarity and the formula $\frac{d \ln w_i}{d \ln L_j} = S_j C_{ij}$, $i, j = 1, 2, \dots, N$.

Black/Pakistani are substitutes for non-manual medium skilled Whites and complementary to other workers. Indian and Mixed workers are strong substitutes for low skilled non-manual Whites and weak substitutes for medium skilled non-manual and low skilled manual Whites. High elasticities of complementarity between ethnic minorities and high skilled manual Whites are notable. Further, the own-elasticities of complementarity have a negative sign for almost all sub-samples except the own-elasticity of Indian/Mixed.

Finally, own- and cross-wage elasticities of inputs are calculated using Equation 15. The results are presented in Table 7. The price effect of ethnic minorities on the wages of Whites is small due to their low share in the entire labour force in the UK. It is notable that ethnic concentration has no unambiguous negative effect on the wages of Whites. Ethnic minority labour competes with some types of labour while it is complementary to many other types of labour as reported in Table 6. These results imply that ethnic concentration does not affect White workers in a unanimously negative manner. However, this does not mean that the ethnic concentration in certain geographical areas has no further consequences. Clark and

Drinkwater (1999) find a high unemployment rate and a low degree of self-employment among ethnic minorities in geographical concentrations. However, this conclusion may suggest that successful workers and entrepreneurs from the ethnic minority groups are the only one's to leave the concentration areas.

6 Conclusions

This paper examines the degree of substitutability and complementarity between White British and ethnic minority workers using *the Quarterly British Labour Force Survey 1997*. First, the direct interaction among various types of labour is analysed by the estimation of earnings functions. The shares of ethnic minority labour force in 66 counties are included in earnings functions in addition to all relevant demographic and socio-economic variables. The estimations show that the share of African Black workers has a significant positive effect on the wages of high skilled non-manual Whites while mixed Black workers have an adverse effect on the wages of medium and high skilled non-manual Whites as well as on the wages of high skilled manual workers. A negative effect represents a substitution relationship between maintained samples and a positive effect the complementarity. Mixed workers have a significant positive effect on the wages of low skilled non-manual White workers. The other coefficients of ethnic minority shares are not significant. If we are concerned only with the signs of the coefficients, irrespective of their significance level, a clear pattern is visible: African and Caribbean Black workers have an adverse effect on the wages of lower skilled White workers and a positive effect on the wages of high skilled White workers. Mixed Black workers affect all White workers negatively. The geographical concentration of Pakistani workers has a positive effect on higher skilled non-manual White workers while Bangladeshi workers adversely affect the wages of lower skilled manual White workers. Chinese workers may compete with all manual White workers. Relatively higher skilled Mixed workers may be substitutes for high skilled White and complementary to low skilled White workers. However, all these effects are very small. The cross-elasticities among different ethnic minority groups show that Indian workers are complementary to Pakistani workers.

In the second part of the paper, a neo-classical factor demand theory is applied to measure the extent of substitutability or complementarity among various type of labour in a general equilibrium framework. The structure of production technology is specified in the form of a translog production function. In this concept, the productivity or wages of a certain type of labour is determined not only by own supply and demand of this labour input, but by relative numbers of workers from other types of labour as well. For estimations of technology coefficients, the data are constructed on the basis of counties. The entire labour force is disaggregated into 8 samples: 6 samples of White labour and 2 samples for ethnic minority labour. Consequently, the demand systems are estimated. The estimated technology coefficients generate the necessary information to calculate the elasticities of complementarity.

The predicted Hicksian elasticities of complementarity prevail and result in the following striking findings: (a) Black and Pakistani/Bangladeshi compete with medium skilled non-manual whites. (b) Indian and Mixed/Other workers compete with low and medium skilled non-manual Whites as well as low skilled manual workers. (c) These two group of ethnic minorities do not compete with each other in the labour market. (d) Despite even high elasticities of complementarity/substitutability in the case of the spatial distribution of labour, the price effect of ethnic minority labour is small, this is caused primarily by the low share of ethnic minority labour in employment.

Finally, ethnic minorities have no clear unambiguous adverse effect on the wages of White labour. Two pooled immigrant groups are both complements and substitutes to the White labour force simultaneously. In other words, they affect wages of some types of White workers positively and wages of some other types of White labour negatively. In balance,

ethnic minority labour may have a small positive effect on the wages of White labour since the complementarity effect dominates.

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Table A1. Estimated log weekly earnings of Whites

	NON-MANUAL						MANUAL					
	LOW		MED		HIGH		LOW		MED		HIGH	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Experience	0.035	15.64	0.034	14.44	0.031	16.42	0.028	13.60	0.026	9.12	0.016	2.11
Experience sq.	-0.001	-16.43	-0.001	-13.94	-0.001	-16.73	-0.001	-14.22	-0.001	-9.86	0.000	-2.68
Tenure	0.010	11.40	0.010	10.44	0.009	10.62	0.008	9.73	0.007	7.57	0.019	6.36
Working hours	0.017	21.66	0.012	17.69	0.009	16.79	0.020	26.61	0.015	18.32	0.014	6.37
Per. black (Caribb)	-0.051	-1.69	0.027	0.81	0.001	0.02	-0.027	-0.90	-0.015	-0.40	0.041	0.46
Per. black (Afric.)	0.010	0.32	-0.003	-0.10	0.059	1.99	-0.008	-0.27	-0.011	-0.30	0.081	0.93
Per. black (Mixed)	-0.001	-0.03	-0.138	-2.39	-0.072	-1.29	-0.002	-0.05	-0.046	-0.77	-0.416	-2.35
Percentage Indian	-0.009	-0.86	-0.008	-0.69	0.002	0.25	0.008	0.93	0.002	0.19	0.071	2.04
Percent. Pakistani	-0.027	-1.06	0.008	0.28	0.015	0.59	-0.004	-0.17	-0.018	-0.57	-0.138	-1.71
Perc. Bangladeshi	-0.000	-0.01	-0.003	-0.05	-0.089	-1.56	0.053	1.13	0.068	1.00	-0.002	-0.01
Percent. Chinese	0.037	1.14	0.004	0.10	0.020	0.64	-0.006	-0.19	-0.031	-0.73	-0.115	-1.04
Percentage Mixed	0.050	2.67	0.009	0.42	-0.015	-0.80	0.010	0.53	0.025	1.19	-0.010	-0.16
Unemp. rate	-0.001	-2.87	-0.001	-3.84	-0.001	-1.74	-0.002	-5.18	-0.001	-2.12	-0.002	-1.57
D-female	-0.194	-13.82	-0.208	-14.55	-0.148	-11.98	-0.154	-10.89	-0.240	-12.36	-0.190	-3.59
D-single	-0.193	-9.16	-0.135	-7.27	-0.114	-7.53	-0.159	-8.31	-0.124	-5.38	-0.056	-0.94
D-married+livtog	0.238	10.08	0.136	5.10	0.060	3.13	0.232	10.39	0.182	6.82	0.036	0.49
D-temporary	-0.107	-3.34	-0.080	-2.63	-0.065	-2.82	-0.016	-0.64	-0.038	-1.21	0.017	0.23
D-part time	-0.511	-27.61	-0.570	-27.16	-0.598	-28.50	-0.478	-23.89	-0.550	-19.56	-0.600	-9.59
D-small scale	-0.152	-11.88	-0.130	-9.04	-0.174	-9.96	-0.140	-10.62	-0.104	-6.78	-0.227	-4.31
D-private sector	-0.009	-0.43	-0.020	-1.06	-0.004	-0.22	0.074	3.92	0.076	2.80	0.029	0.40
D-union member	0.044	1.78	0.047	1.86	0.046	1.97	0.120	5.65	0.108	4.04	0.026	0.31
D-health problem	-0.022	-1.44	-0.044	-2.37	-0.041	-2.35	-0.052	-3.37	-0.042	-2.18	-0.060	-0.88
D-commute	0.115	10.05	0.109	8.75	0.105	9.33	0.082	6.85	0.108	7.45	0.083	1.96
D-manufacture	0.007	0.35	-0.014	-0.67	0.026	1.38	0.106	6.65	0.095	5.14	0.088	1.57
D-wholesale	-0.165	-9.89	-0.170	-8.86	-0.131	-4.67	-0.046	-2.10	-0.082	-3.28	0.019	0.22
D-hotels	-0.231	-5.96	-0.289	-7.66	-0.217	-2.99	-0.076	-3.14	-0.143	-4.36	-0.134	-1.88
D-transport	-0.055	-1.95	0.020	0.74	-0.015	-0.42	0.049	2.48	-0.020	-0.67	0.023	0.28
D-real estate	0.052	2.29	0.038	1.68	0.092	4.50	-0.079	-3.01	-0.088	-2.62	-0.020	-0.17
D-pub adm.& def.	0.031	1.37	-0.019	-0.83	-0.043	-2.01	-0.007	-0.18	-0.203	-2.75	-0.087	-0.65
D-education	-0.080	-2.00	-0.036	-1.12	-0.005	-0.38	-0.169	-6.59	-0.172	-4.36	-0.078	-0.97
D-West Yorksh	0.086	3.01	-0.018	-0.54	0.062	2.11	0.092	3.20	0.084	2.56	0.001	0.01
D-Central London	0.396	11.55	0.407	11.73	0.329	12.69	0.337	7.00	0.185	3.65	0.260	1.97
D-Inner London	0.257	6.91	0.319	9.28	0.232	8.59	0.260	5.40	0.213	4.10	0.365	3.62
D-Outer London	0.161	6.40	0.167	5.67	0.166	6.88	0.210	7.32	0.164	3.78	0.337	2.36
D-Rest of S-East	0.074	4.87	0.055	2.89	0.091	5.31	0.047	2.87	0.068	3.25	0.029	0.47
D-West Midland	0.033	1.34	-0.019	-0.65	0.020	0.80	0.071	2.91	0.078	2.82	0.041	0.59
D-autumn	-0.003	-0.21	-0.021	-1.18	-0.011	-0.62	-0.029	-1.99	-0.021	-1.09	-0.016	-0.27
D-summer	-0.030	-2.41	0.002	0.15	-0.007	-0.62	-0.010	-0.83	0.009	0.58	-0.013	-0.33
D-spring	0.021	1.70	0.012	0.89	0.014	1.19	0.020	1.59	0.013	0.80	0.012	0.27
Intercept	4.370	93.25	4.684	100.43	5.032	131.42	4.033	86.60	4.397	79.76	4.686	34.07
N	7043		5502		6597		7063		4434		540	
R-squared	0.68		0.62		0.43		0.45		0.45		0.45	

Table A2. Estimated log weekly earnings of ethnic minorities

	BLACK		INDIAN		PAKISTANI		MIXED	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Education	0.030	3.64	0.052	6.56	0.014	1.26	0.027	2.24
Experience	0.025	2.94	0.025	2.89	0.009	0.57	0.027	2.33
Experience squared	0.000	-2.28	0.000	-2.37	0.000	-0.86	-0.001	-2.26
Tenure	0.010	2.88	0.012	2.47	0.015	1.6	0.015	2.44
Working hours	0.017	6.15	0.013	5.62	0.018	3.49	0.015	5.3
D-im90+	-0.015	-0.83	0.016	0.56	0.021	0.67	-0.107	-2.37
D-im8090	-0.016	-0.75	0.010	0.56	-0.040	-2	0.080	2.19
D-im7080	-0.059	-1.87	-0.036	-1.24	-0.015	-0.73	-0.045	-1.26
D-im6070	0.043	1.49	0.045	1.58	0.035	1.15	0.021	1
D-im4060	0.097	0.9	0.054	0.26	0.222	1.29	0.230	0.93
Percentage Black	-0.105	-0.74	-0.134	-0.64	0.048	0.30	0.098	0.40
Percentage Indian	0.058	0.45	-0.077	-0.38	0.433	2.66	0.219	0.88
Percentage Pakistani	0.037	0.29	-0.144	-0.67	0.191	1.16	0.228	0.87
Percentage Mixed	-0.022	-0.11	0.033	0.09			0.247	0.63
D-manual	-0.114	-2.25	-0.204	-3.73	-0.140	-1.99	0.043	0.65
D-female	-0.133	-2.42	-0.192	-2.94	-0.264	-2.42	-0.120	-1.22
D-single	0.114	1.36	0.055	0.33	0.657	4.09	0.169	1.14
D-married & liv.tog	-0.077	-0.8	0.152	1.88	0.025	0.31	-0.042	-0.49
D-temporary	-0.201	-3.5	-0.201	-3.04	-0.400	-4.11	-0.150	-1.92
D-part time	-0.439	-5.51	-0.420	-4.77	-0.637	-5.4	-0.644	-5.97
D-small scale	-0.088	-1.65	-0.162	-2.16	-0.315	-3.55	-0.137	-1.92
D-private sector	0.067	0.85	-0.008	-0.09	-0.226	-1.25	-0.056	-0.52
D-union member	0.135	1.84	0.111	1.19	-0.012	-0.08	0.178	1.35
D-health problem	-0.074	-1.01	0.065	0.83	0.032	0.27	0.044	0.59
D-commute	0.131	2.68	0.111	2.06	0.180	2.39	0.044	0.64
D-manufacture	0.065	0.81	0.046	0.44	0.134	0.89	-0.079	-0.7
D-wholesale	-0.045	-0.46	-0.216	-2.05	0.004	0.03	-0.402	-3.48
D-hotels	-0.026	-0.24	-0.263	-1.97	-0.353	-1.63	-0.206	-0.93
D-transport	0.190	2.3	0.069	0.69	0.216	1.17	-0.165	-1.34
D-real estate	-0.038	-0.49	0.155	1.77	-0.059	-0.4	0.023	0.2
D-public adm.& def.	0.113	1.59	0.022	0.2	0.294	1.64	0.018	0.15
D-education	-0.179	-1.56	-0.031	-0.27	0.338	1.96	0.033	0.21
D-West Yorksh	-0.067	-0.48	0.149	1.44	-0.017	-0.16	-0.072	-0.61
D-Central London	0.072	0.93	0.295	2.23	0.045	0.31	0.256	2.42
D-Inner London	0.093	1.42	0.129	1.38	0.096	0.87	0.341	3.38
D-Outer London	0.124	1.93	0.059	0.83	-0.147	-1.37	0.180	1.73
D-Rest of S-East	0.047	0.49	0.110	1.37	-0.108	-1.45	0.204	2.24
D-West Midlands	-0.071	-1.19	-0.047	-0.6	-0.112	-1.02	0.176	1.04
D-autumn	-0.011	-0.22	0.002	0.03	-0.099	-1.19	-0.038	-0.48
D-summer	0.037	0.7	-0.118	-2.25	-0.121	-1.73	0.037	0.58
D-spring	0.049	0.95	0.086	1.41	0.076	1.26	-0.092	-1.43
Intercept	3.924	20.16	3.933	13.97	4.376	13.74	4.006	11.6
N	383		395		175		300	
R-squared	0.686		0.657		0.839		0.690	