IZA/CEPR 11[TH] EUROPEAN SUMMER SYMPOSIUM IN LABOUR ECONOMICS

Supported and Hosted by the Institute for the Study of Labor (IZA)

Buch, Ammersee

17-19 September 2009

Product Demand Shifts and Wage Inequality

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August 27, 2009

Abstract

The US and the UK have experienced both rising skill premia and rising employment of skilled workers since the 1980s. These trends are typically attributed to skill-biased technical change or trade. If more skilled workers demand more skill-intensive goods, then an exogenous increase in relative skill supply will also induce a shift in relative skill demand. This channel reduces the need to rely on technology and trade to explain the patterns in the data. I illustrate this mechanism with a simple two-sector general equilibrium model with non-homothetic preferences. This paper demonstrates that in the US and in the UK more educated and richer workers demand both more very low skill-intensive services (such as cleaning and personal services) and very high skill-intensive services (such as education and professional services). A parametrization of the model suggests that this induced demand shift can explain 5% of the total relative demand shift in the US between 1980 and 2000. Similar results are provided for the UK.

Keywords: Wage inequality, product demand, income elasticity.

JEL classification: J21, J31.

1 Introduction

Although the pattern of the increase in wage inequality and the college premium in the US (Lemieux, 2006; Autor, Katz, and Kearney, 2008) and the UK (Gosling,

*I would like to thank Daron Acemoglu, Tito Boeri, David Lee, Steve Machin, Enrico Moretti, Steve Nickell and Steve Pischke. This is an extensively revised version of IZA DP. 908 which was presented at seminars at MIT (Labor Lunch), LSE, IZA, Carlos III Madrid and AIAS Amsterdam. This paper was partially written while I was visiting the UC Berkeley Economics Department whose hospitality is kindly acknowledged. All remaining errors are mine. Address for correspondence: Dept. of Economics, University of Milan, via Conservatorio 7, 20122 Milan, Italy. Email: marco.leonardi@unimi.it

Machin and Meghir, 2000) during the 1980s and the 1990s has been well documented, there is still some disagreement about the causes of the changes. Several reasons have been proposed to explain the shift in demand against low skilled workers, in particular skill-biased technical change, trade liberalization and changes in wage setting institutions. None of these three explanations seem to be exhaustive.[1]

In this paper, I investigate an additional mechanism that may contribute to explaining the evolution of wage inequality and of the skill premium. I explore the correlation between consumption habits of educated and rich workers and the demand for skills. The mechanism is an "education elasticity of demand" in which individuals with relatively higher education have consumption preferences that favor goods and services whose production is relatively skill-intensive. Thus an increase in the relative supply of skilled workers can shift demand for final products in favor of skill-intensive goods and contribute to the rise in the relative demand for skills.[2] As an auxiliary mechanism, income elasticities of demand may also favor skill-intensive products so that rising income of workers will reinforce the education demand effect. Income effects and differences in utility functions across educational groups are potentially distinct mechanisms but education and permanent income are obviously very correlated and may contribute jointly to the demand shifts.

In the empirical section I investigate (i) if there is an association between the "skill-content" of different goods and their relative demand by people with different incomes or education and (ii) to what extent exogenous changes in the

[1] Acemoglu (2002) reviews some of the reasons why none of the three main explanations is entirely convincing from the empirical point of view. Card and DiNardo (2003) point out the many shortcomings of the skill-biased technical change hypothesis. Machin and VanReenen (1998) and Berman, Bound and Machin (1998) among others claim that the trade hypothesis has little explanatory power.

[2] Throughout the paper I focus only on college education and consider the accumulation of college education to be exogenous to changes in wage inequality. This hypothesis seems to be plausible at least at the outset of the rise in wage inequality (Acemoglu 2002).

composition of skills (e.g. skill-biased technological change) feed back into additional demand for skills through an increase in demand for high-skill goods. A simple general equilibrium model with non-homothetic preferences is developed to clarify the mechanism and to establish whether differences in the elasticities of demand for goods with different "skill-content" can play a quantitatively relevant role in determining the aggregate demand for skills in an economy.

To translate the consumption patterns into changes in the skill composition of employment and into skilled-unskilled relative wages, I combine microdata on consumption of 40 non-durable consumption goods and services from the US Consumer Expenditure Survey (CEX) to data on industry skill composition from the Current Population Survey (CPS). Figure 1 shows the change in the employment share (top panel) and wage bill share (bottom panel) of 40 two-digit industries in the US between 1980 and 2000 ranked by their skill intensity in 1980 (the proportion of college graduates in industry employment). The picture shows a clear positive correlation between employment and wage changes towards skill-intensive industries which is suggestive of a role for demand shifts in the labor market and possibly in the product market.[3] To provide empirical evidence of the "education and income elasticity effect", I estimate education and income elasticities and regress them on the skill intensity of the industries which manufacture the final consumption good or provide the final consumption service.

In the course of the empirical exercise, I address the issue of intermediate inputs and import penetration. Intermediate inputs are important because the manufacturing industry of the final good or service may not be indicative of the

[3]This evidence may hide many confounding factors such as supply shifts (immigration or female labor force participation) and/or demand shifts (the effect of trade or technology or the effect on product demand due to changes in prices). Other papers focus on price effects on wage inequality: Cortes (2008) finds that low-skilled immigration benefits the high-skilled native population by decreasing prices of nontraded-goods, Frattini (2008) finds the same on UK data. Moretti (2008) looks at changes in housing prices on purchasing power of households.

actual skill content of the final product.[4] The import penetration in each industry is relevant because, even if higher income and education elasticities increase the demand for skill-intensive goods, imported goods do not contribute to the domestic relative demand of skills. Input-Output tables are used to account for the skill intensity of intermediate goods and to correct the skill intensity of those goods that are mostly imported.

The results indicate that income elasticities are positively and significantly related to industry skill intensity. In particular I find evidence of income elasticities higher than one for very high-skill-intensive services (education, health and professional services) but also for very low-skill-intensive services (food preparation, cleaning, repair services, see Mazzolari and Ragusa, 2007). This U-shaped relationship is very evident for income elasticities calculated at the 90th percentile of log total expenditure and remains significant even after controlling for intermediate inputs and import penetration. The positive relationship between income elasticities and the skill content of goods and services is robust to various sample cuts and appears to be common also to the UK as shown by similar evidence based on the UK Family Expenditure Survey (FES) consumption data matched to UK Labor Force Survey (LFS) data.

Finally to establish the quantitative importance of the mechanism, I parametrize the model using the estimates for the relevant elasticities and labor aggregates of the US and UK economy. To benchmark the magnitude of the contribution that income effects make to wage inequality, I consider a simple counterfactual case where preferences are homothetic. The results indicate that education and income elasticities in favor of high-skill-intensive goods can explain about 5% of the total shift in relative labor demand in the US and 6% in the UK.

[4] I consider consumption of 40 final goods and services (46 in the UK). While the 40 consumption items represent 98% of non-durable household consumption, the corresponding manufacturing industries represent only 25% of the total wage bill and 28% of employment in the US economy.

The plan of the paper is as follows. In Section 2 I review the most important literature. In Section 3 I present the basic model. The analysis of the empirical evidence is in Section 4 while in Section 5 I quantify the contribution of education and income elasticities in explaining the shift in relative labor demand. The interpretation of the results and the conclusion is found in Section 6.

2 Previous Literature

This paper focuses on a particular mechanism which relates the increased demand for educated workers to the changing composition of the workforce itself. There is an old debate on the possibility that the supply of skilled labor can trigger an increase in the equilibrium demand for skilled labor.[5] Among the studies which document how changes in skill supply may induce changes in skill demand Kiley (1997) and Acemoglu (1998) give an explanation of the increase in wage inequality in terms of directed technical change. In these models an increase in the supply of college graduates increases the size of the market for skill-complementary technologies and thus the demand for skills. In another paper, Acemoglu (1999) shows how the increase in the supply of skilled workers can induce an organizational change which in turn leads to higher demand for skills. While in these papers the mechanism which translates an increase in skill supply to an increase in skill demand is based on the production side of the economy, in this paper I investigate an income effect of commodity demand.

Focussing on the product demand side and on income elasticities, this paper is related to the literature on structural change. The idea that income growth may explain the evolution from agriculture to services dates back to Colin Clark (1957)

[5] Goldin and Katz (2007) recently review much of the evidence which shows how the dynamics of education wage premia over time are a reflection of the race between demand for and supply of educated workers.

who found that income elasticity of demand for services is greater than unitary, implying that preferences are non-homothetic. If so, rising prosperity increases the share of income devoted to services, even with balanced productivity growth.

Recently the two papers which explicitly link skill supply and skill demand through consumption habits are Manning (2004) and Mazzolari and Ragusa (2007). Both papers rely on a substitution effect in labor supply i.e. the hypothesis that rising returns to skill spur high-skilled workers to substitute market for home-based production of household services. Manning (2004) claims that employment of the unskilled is higher within cities where the fraction of college-educated workers is higher because the latter are more likely to buy low-skill time-intensive services that free them from home production tasks. Using city-level variation Mazzolari and Ragusa (2007) show that the growth in the proportion of skilled workers and of wages at the top of the distribution is related to an increase in demand for low-skill-intensive services such as personal services which in turn increases the demand for low skilled labor (which appeared stable and modestly recovering in the US only after 1995). These papers look only at low-skill-intensive untradable services because the substitution effect is a plausible explanation for personal services such as cleaning and baby-sitting. In this paper I do not rely on the substitution effect in labor supply and show that the consumption channel may also work at the top of the distribution reinforcing the demand shift in favor of skilled workers. Looking at different services with different degrees of skill intensity (e.g. the education sector vs. the personal service sector) I establish whether the growth of service employment favors the demand of skilled or unskilled workers and whether education and income elasticities may contribute to the explanation not only of the recent increase in employment and wages at the bottom of the distribution but also of the trend increase in employment and wages at the top of the distribution.

The empirical literature has put forward two competing explanations (which can coexist) for structural change: a utility-based explanation, which requires different income elasticities for different goods and a "technological" explanation which attributes structural change to different rates of sectorial TFP growth (e.g. Kongsamut, Rebelo and Xie, 2001; Ngai ad Pissarides, 2007; Bertola, Foellmi and Zweimuller, 2006). Recently, Autor and Dorn (2008) combine the idea of Baumol (1967) recently modelled in Weiss (2008) of slow productivity growth in the service sector with the "polarization hypothesis": contrary to the decline of middle-skill occupations, employment and wages in the low-skilled personal service sector grow over time because personal services imply non-routine tasks which cannot be easily substituted by new technologies (Autor, Levy and Murnane, 2003).[6] Autor and Dorn (2008) document how the growth of personal services is related to the growth of wages at the top of the distribution within local labor markets. Their mechanism is based on the observation that if demand for the outputs of service occupations does not admit close substitutes in consumption, the substitution of information technology for routine tasks used in goods production may, in the long run, lead to rising wages and employment in service occupations.

There are many competing (and probably coexisting) explanations for the evolution of industry employment and wages pictured in Figure 1, in this paper I focus on the relatively unresearched and complementary role of income and education elasticities to explain the increasing demand for high-skilled products and services (and of some low-skilled services) and the evolution of the relative demand for skills. The empirical strategy will not try to distinguish the various explanations, but rather to document an empirical relationship and quantify its relevance comparing the results of a model with non-homothetic preferences which incorporates income effects with a counterfactual downward sloping relative demand for skills

[6] Acemoglu (1999) and Autor, Katz and Kearney (2006 and 2008) for the US and Goos and Manning (2007) for the UK present evidence of employment polarization during the last two decades. The polarization literature has looked also at other countries such as West Germany, see Spitz-Oener (2006) and Dustmann, Ludsteck and Schönberg (2007).

obtained in absence of income effects.

3 The Model

This model is meant as a guidance for the empirical part and provides a framework to quantify the importance of the elasticities of product demand with respect to income and education in explaining the evolution of education wage premia. It is a $2x2$ model with two sectors and workers-consumers of two education types; consumers' preferences are non-homothetic and may vary across education group.[7]

The economy consists of H skilled workers and L unskilled workers, skilled workers are workers with a college degree, unskilled workers are workers without a college degree. Labor supply is assumed to be exogenous and inelastic, factor supplies in the two production sectors are given by: $L = L_1 + L_2$ and $H = H_1 + H_2$. Sector 1 is the high-skill-intensive sector, sector 2 is the low-skill-intensive sector. Production functions are assumed to be CES with elasticity of substitution $\sigma_1 = \sigma_2 = \sigma$. $Y_h = F_1(H_1, L_1)$ denotes the high-skill-intensive commodity (i.e. the aggregate of all high-skill-intensive items) and $Y_l = F_2(H_2, L_2)$ the low-skill-intensive commodity (i.e. the aggregate of all low-skill-intensive items). Since the focus is on the role of product demand, in this model there is no technical progress.[8]

Demands for the two commodities have a generic form that allows for non-homotheticity, and are different for skilled and unskilled workers:

[7] In a traditional model with homothetic preferences, a rise in the relative supply of skills moves the economy down the relative demand for skills and reduces the skill premium. However, when consumption preferences are allowed to vary by education group (i.e. educated workers favor consumption of high-skill-intensive goods) and are non-homothetic (i.e. richer consumers within education group favor consumption of high-skill-intensive goods), education and income elasticities of consumption work against the neoclassical mechanism of downward sloping relative demand for skills and may contribute to explaining the increase of the skill premium.

[8] For the effect of technical progress on the wage structure in multi-sector economies, see among others Haskel and Slaughter (2002) or Weiss (2008).

$$Y_h = Hy_h^h(\frac{p_h}{p_l}, w_h) + Ly_h^l(\frac{p_h}{p_l}, w_l) \quad (1)$$

$$Y_l = Hy_l^h(\frac{p_h}{p_l}, w_h) + Ly_l^l(\frac{p_h}{p_l}, w_l) \quad (2)$$

where, $\frac{p_h}{p_l}$ is the relative price of skill-intensive commodity and w_h (w_l) is the wage of skilled (unskilled) workers. Equation 1 denotes the total demand for the high-skill-intensive commodity Y_h. The first term of the right hand side (RHS) of equation 1 represents demand by the H skilled workers, the second term represents demand by the L unskilled workers. In this model there is a role for education elasticities because the demand functions for both high-skill-intensive commodity $y_h^i(.)$ and the low-skill-intensive commodity $y_l^i(.)$ are assumed to depend from education $i = h, l$. Skilled and unskilled workers are allowed to have different price and income elasticities. Equation 2 has the same interpretation for the low-skill-intensive commodity Y_l.

The system is solved for $d\log w_h$ as a function of $d\log H$, assuming that $dH = -dL$ i.e. the initial exogenous increase in skilled workers leaves total labor supply unchanged.[9] Because of the normalization of w_l and the assumption of constant labor supply, $\frac{d\log w_h}{d\log H}$ denotes the percentage change in the skill premium over the percentage change in the skill ratio. The derivations are given in the Appendix. The result is:

$$\frac{d\log w_h}{d\log H} = \frac{(1-a_2)\{(\lambda_H - \lambda_L)[R_1 - (1-R_1)\frac{H}{L}] - [1 + \lambda_H + \frac{H}{L}(1+\lambda_L)]\}}{(\lambda_L + 1)\sigma + (\lambda_H - \lambda_L)(1-a_1)\sigma - (\lambda_H - \lambda_L)T} \quad (3)$$

where $T = \{R_1[(a_1 - a_2)\varepsilon_{hp}^h + (1-a_2)\varepsilon_{hm}^h] + (1-R_1)[(a_1-a_2)\varepsilon_{hp}^l - a_2\varepsilon_{hm}^l]\}$.

[9]The assumption that $dH = -dL$ implies both a constant labor supply and that one hour of work by an educated worker is weighted with the same efficiency units as one hour of work for a non educated worker. The model can be adjusted to imply an increase in labor supply and a higher efficiency of educated workers without substantial changhes in the results.

Equation 3 establishes the condition that links wage inequality (the skill premium) $\frac{w_h}{w_l}$ to a rise in the skill ratio $\frac{H}{L}$ and depends from the following parameters:

- The parameter $a_1 = \frac{w_h H_1}{p_h F_1(.)}$ denotes the wage bill share of skilled labor in the high-skill-intensive sector h. $a_2 = \frac{w_l H_2}{F_2(.)}$ is the wage bill share of skilled labor in the low-skill-intensive sector l.

- $\lambda_H = \frac{H_1}{H_2}$ and $\lambda_L = \frac{L_1}{L_2}$ are respectively the ratio of skilled labor employed in sector h and l and the ratio of unskilled labor employed in sector h and l. We know that $a_1 - a_2 > 0$ and $\lambda_H - \lambda_L > 0$, given that sector Y_h is high-skill-intensive.

- $R_1 = \frac{Hy_h^h(.)}{Hy_h^h(.)+Ly_h^l(.)}$ is the share of total expenditure on the high-skill-intensive commodity h by skilled workers.

- ε_{hp}^i and ε_{hm}^i are respectively the price and the income elasticities of demand for the high-skill-intensive commodity. The index $i = h, l$ indicates that both elasticities may be different for skilled and unskilled workers.[10]

- σ is the elasticity of substitution between skilled and unskilled workers in production.

This paper focuses on estimating education and income elasticities of different consumption goods and neglects the role of price elasticities. The reason for this choice is that I am interested in assessing the importance of education and income which are considered exogenous to consumption preferences. In this view product prices are endogenous variables and price elasticities are not estimated in the following system of demand equations. Notice however that price elasticities

[10] Due to normalization with respect to the low-skill sector $p_l = w_l = 1$, ε_{hm}^i (ε_{hp}^i) indicates the income (price) elasticity for the skill-intensive commodity relative to the income (price) elasticity for the low-skill-intensive commodity for education group i.

(which are typically negative) tend to decrease wage inequality because they increase the denominator of equation 3. At the end of the paper I will parametrize equation 3 on the basis of the relevant elasticities and labor market aggregates estimated in the empirical part. At that stage I will also provide an estimate for price elasticities.

3.1 The Effect of Education and Income Elasticities

The hypothesis of the model is that college educated workers have different utility functions and may prefer particular types of goods and services such as the education of their own children, health services, professional goods and services, books and newspapers. The effect of education elasticities may contribute to increase the relative wage of the skilled in equation 3 through the term $R_1 = \frac{Hy_h^h(.)}{Hy_h^h(.)+Ly_h^l(.)}$. In this model an exogenous increase in $\frac{H}{L}$ implies a shift from the demand of the high-skill-intensive commodity by unskilled workers, $y_h^l(.)$, to the demand of the high-skill-intensive commodity by skilled workers $y_h^h(.)$. This mechanism tends to increase wage inequality if skilled (i.e. educated) workers demand more of the high-skill-intensive commodity than unskilled workers, i.e. $y_h^h(.) > y_h^l(.)$. To see this more clearly notice that, if educated and non-educated workers had the same demand for the high-skill-intensive commodity (i.e. $y_h^h(.) = y_h^l(.)$), then $R_1 = \frac{H}{H+L}$ and the term $(\lambda_H - \lambda_L)[R_1 - (1 - R_1)\frac{H}{L}]$ would disappear and the numerator of equation 3 would then be unambiguously negative. The term R_1 increases the numerator of 3 if $R_1 > (1 - R_1)\frac{H}{L}$ i.e. if $y_h^h(.) > y_h^l(.)$.

The traditional income effect is potentially distinct from the "education effect" and works within education groups. Income and education effects will be estimated separately but in equation 3 they contribute jointly to the shift in product demand. Income elasticities (which are typically positive) contribute to explain the rise of the relative wage of the skilled reducing the denominator of equation 3. If richer workers (after controlling for education) tend to consume more of the high-skill-intensive commodity (i.e. $\varepsilon^l_{hm} = \varepsilon^h_{hm} > 0$ for both skilled and unskilled workers), then an increase in the general level of income (both w_l and w_h) will also shift out the relative demand of the skill-intensive commodity and increase the skill premium.[11]

4 The Empirical Evidence

To assess whether more educated and richer consumers consume relatively more skill-intensive goods and services, I match the information on individual consumption items from the Consumer Expenditure Survey (CEX) to the skill intensity of the manufacturing industry calculated from the Current Population Survey (CPS). I do the same exercise matching UK consumption data from the Family Expenditure Survey (FES) to industry data from the Labour Force Survey (LFS). The analysis proceeds in two steps. First, I estimate the education and income elasticities of each consumption item in a system of share equations. Secondly I calculate the industry skill intensity and regress the estimated education and income elasticities on the industry skill intensity.

[11] An increase in income dispersion raises the income of some workers but reduces that of others. Hence, the net effect on product demand is ambiguous. The effect of inequality on consumption of low-skill-intensive services is the focus of Mazzolari and Ragusa (2007). In this paper I neglect the role of home production and potential market substitutes to focus on differences in utility and income across educational groups. In this model skilled and unskilled workers may respond differently to an increase in their income. An exogenous increase in inequality, w_h relative to w_l, due for example to skill-biased technical change will raise demand for the skill-intensive commodity and increase wage inequality further if skilled and unskilled workers have different income elasticities and skilled workers tend to increase their demand of the skill-intensive commodity more than unskilled workers (i.e. $\varepsilon^h_{hm} > \varepsilon^l_{hm}$).

4.1 The Match between Consumption Data and Industry Data

The data on consumption are drawn from the Consumer Expenditure Survey 1984-2002 provided at NBER (see data appendix). I use data on all non-durable items whose consumption has been consistently recorded from 1994 to 2002. Durable goods such as housing expenditure and purchase of motor vehicles are excluded. The final sample includes 40 consumption items which are matched to their respective manufacturing industry in the CPS in Table 1 in the Appendix. They represent 98% of total non-durable household expenditure and 85% of total expenditure inclusive of durables. The 46 UK consumption items are drawn from FES data 1994-1997 and are matched to LFS industry data (as defined in the 1992 Standard Industrial Classification code) in Table 2 in the Appendix.[12]

4.2 Econometric Specification

Education and income elasticities are estimated using a partial linear model. The purpose of the econometric exercise is to estimate the coefficient on the head's education after controlling for a non-parametric function of income. Semiparametric models have been used extensively to study the effect of household demographic composition (i.e. the presence and number of children) on Engel curves (see for example Blundell et al., 1998 and 2007). I adopt the semiparametric specification to study how household expenditures vary with the education level of the head of household. The Engel curve specification has the form (time subscripts omitted):

$$\omega_{ij} = g_j(\log x_i) + b_j X_i + \gamma_j' ed_i + \varepsilon_{ij} \qquad \text{for } j = 1, .., J \qquad (4)$$

[12] I drop expenditure on housing and durables, I also exclude expenditure on TV licence and car tax because they do not have an obvious industry match.

with $J = 40$ for the US and $J = 46$ for the UK. $E(\varepsilon_{ij}|\log x_i, ed_i, X_i) = 0$ and $Var(\varepsilon_{ij}|\log x_i, ed_i, X_i) = \sigma_j^2(\log x_i, ed_i, X_i)$. $\omega_{ij} = \frac{p_j y_{ij}}{x_i}$ is the expenditure share of item j by household i, $\log x_i$ is the log of real total expenditure, X_i contains the age and sex of the head of household, the number of adults and the number of children under 18 in the household. ed_i is an education dummy which is equal to one if the head of household holds a college degree.[13]

The parameters of interest are the γ_j education dummies and the first derivative $\widehat{g}_j'(.)$ for each share equation j where $\widehat{g}(.)$ is a kernel smoother. When calculated at the mean of total expenditure, $\widehat{g}_j'(.)$ indicates the mean income elasticity of each share equation j. $\widehat{g}_j'(.)$ is also calculated at the 90th and at the 10th percentile of the log expenditure distribution to get the income elasticity at the top and bottom of the distribution. The income elasticity for each share equation j is calculated using the perturbation method i.e. the derivative of the Engel curve is calculated in the neighborhood $h = 0.1$ of the average of log total expenditure: $\widehat{g}_j'(x) = \frac{1}{2h}(\widehat{g}(x+h) - \widehat{g}(x-h))$ where $x = \overline{\log x}$.The standard error of this estimate is given by the formula $s_{\widehat{g}_j'}(x) = \sqrt{\frac{(1/2\pi^{0.5})1/n\sum(\omega_{ij} - \widehat{g}_j(\log x_i))^2}{\lambda\widehat{p}(x)n}}$ where $\widehat{p}(x) = \frac{1}{\lambda n}\sum_{i=1}^n K\frac{(x_i - x)}{\lambda}$ is the density estimated at the mean of log total expenditure $x = (\overline{\log x})$ (Yatchew, 2003). $\widehat{g}_j'(x)$ and its standard error are also calculated at the 10th and 90th percentile of the distribution of log total expenditure choosing the appropriate x.

If the non-parametric component $g(.)$ is assumed to be constant across j, then the system of share equations stacked into a column vector can be estimated by minimum distance:[14]

[13] The "education-elasticity" is estimated through a dummy variable for college education, rather than a continuous variable (e.g. years of schooling) because differences in taste are unlikely to vary by each year of education and the dummy is easier to relate to the 2-skill GE model.

[14] This specification includes the popular QUAIDS system of Engel curves if $g(\log x) = \alpha + \beta_1 \log x + \beta_2(\log x)^2$. Blundell et al. (1998) show that for theoretical consistency the demographic term should also enter the non-parametric function $g_j(\log x_i - \theta X_i)$. While the interpretation of θ as equivalence scale is straightforward in the case of a demographic term (i.e. the presence of children in the household), it is more problematic when it measures the equivalent income of a household with an educated head. Because ed is a dummy variable, $\theta' ed$ simply shifts the Engel

$$\min_{\{b_j,\gamma_j\}} \frac{1}{n}\sum_{i=1}^{n}(\omega_{ij}-\widehat{g}(\log x_i)-b_jX_i-\gamma_j ed_i)'(\omega_{ij}-\widehat{g}(\log x_i)-b_jX_i-\gamma_j ed_i) \quad (5)$$

Since the equations are semi-logaritmic the education elasticity is equal to:

$$\widehat{\eta}_j^{ed} = \frac{\widehat{\gamma}_j * \overline{ed}}{\overline{\omega}_j}$$

where $\overline{\omega}_j$ is the average budget share of item j and $\overline{ed}$ is the percentage of heads of household who hold a college degree. There is a large difference between the US and the UK in the percentage of heads of household with a college degree: $\overline{ed}=$ 0.50 in the US sample (CEX 1994-1997) while in the UK sample (FES 1994-1997) the percentage of those who left full-time education at 21 or later $\overline{ed}=$ 0.139. The budget elasticity (in the text and tables is often called income elasticity) is equal to:

$$\widehat{\eta}_j^{budget} = \frac{\widehat{g}_j'}{\overline{\omega}_j} + 1$$

I calculate income elasticities at the average of log total expenditure, at the 90th income percentile (the percentile which increased the most over the last twenty years both in the US and the UK) and at the 10th percentile.

The standard errors of education and income elasticities are calculated using the Delta method.

4.2.1 The Education and Income Elasticities

The results of the estimation for the US are shown in Table 1 in form of elasticities. Table 1 shows the education and the budget (income) elasticities for each one of the

curve horizontally for households with a college educated head. We present estimates with $\theta = 0$ which are equivalent to equation-by-equation estimates.

40 items in the US CEX 1994-1997. The elasticities calculated at the 90th and 10th percentile are not shown in the Table for space reasons but are plotted in Figure 5. An education elasticity higher than zero indicates that college educated workers tend to consume proportionally more of that product than less educated workers. Income elasticities larger than one indicate that an increase of one percentage point in income is translated in an expenditure higher than 1% point for that product. Although the vast majority of elasticities are estimated with precision, the standard errors indicate that the income and education elasticities of some of the items are not estimated with precision reflecting their infrequent purchase (for example fuel oil and coal, hospitals and nursing homes). The average share in total household expenditure of each item is shown in the last column of Table 1.

Poor families tend to spend relatively more (i.e. income elasticity lower than one) on food consumed at home and home electricity, gas, water and telephone; rich families allocate a relatively larger proportion of their total expenditure in food eaten out, clothing, recreation goods and services and education at all levels (i.e. income elasticity higher than one). Education elasticities of low-skill-intensive goods and services such as food outside the house, domestic services and clothing are higher than zero; much higher than zero are also the education elasticities of high skill intensive goods and services such as books and maps, airline fares and education services of all levels. Figure 2 shows the estimated non-parametric Engel curve of the expenditure share of two items at the extremes of the skill intensity distribution, personal care services (low-skill-intensive) and education (high-skill-intensive). The figure shows that richer individuals tend to consume in higher proportion not only low-skill-intensive services (Mazzolari and Ragusa, 2007) but also high-skill-intensive services as education.

I put the results on UK data in Table 3 in the Appendix. The 46 goods in Table 3 in the Appendix are ranked in ascending order according to the skill intensity of their manufacturing industries (as defined below). The results are similar to the US even if the disaggregation of the consumption variables is different and consumption data of food is more disaggregated. The education elasticities indicate that, keeping income constant, more educated workers tend to consume less tobacco and beer but spend more on education and on transport fares such as rail and airplane fares. The table also indicates that both low-skill-intensive items (hairdressing, footwear, domestic help) and high-skill-intensive goods and services have high income elasticities. In particular, expenditure on high-skill-intensive services such as education and professional services have a budget elasticity much higher than one. Among high-skill-intensive products only drugs have an income elasticity lower than one.

4.3 The Industry Skill Intensity

Table 2 shows the industry skill intensity calculated from CPS data 1979-1980 as the share of workers who obtained a college degree qualification. Low-skill-intensive industries (with less than 25% of college graduates) are food production and eating places, apparel production, repairs, personal services, house supplies and house services. High-skill-intensive industries with more than 50% of college graduates are business and professional services, education and social services and financial services and insurance.

I put the same Table 4 for the UK in the Appendix. The table shows that skill intensity is on average much lower in the UK because the proportion of workers with a college degree is much lower. The ranking of UK industries in terms of skill intensity is however similar to the US as shown in Table 4 in the Appendix which ranks the industries from the least skill intensive to the most skill intensive. The least skill-intensive industries are hairdressing, footwear manufacturing and soft furnishing manufacturing (less than 2% of workers in these industries hold a college degree qualification). The most skill-intensive industries are professional services, pharmaceuticals and education. Education is an outlier in the industry skill intensity distribution in the UK: more than 50% of workers in the education industry hold a college degree qualification even in the UK where the average percentage of college graduates in the economy in the period considered is 13.9%.

4.3.1 Input-Output Tables

The skill intensity of the manufacturing industry is arguably not the best measure of the skill content of the consumption goods. In fact, the 40 industries which have a direct match to a consumption item represent only about 25% of the total wage bill and 28% of total employment in the US economy. Intermediate goods may be important because the industries that produce inputs may have a different skill intensity than those that produce the final output.

To account for the skill intensity of the input-producing industries, I use the US industry-by-industry Input-Output tables in year 1995 (see data Appendix and Table 5 in the Appendix for the details) which provide information on the input contribution of 123 industries.[15] The industries are classified according to an Input-Output industry code and are matched to the original 3-digit industry code of the CPS. The coarser classification of industries in I-O tables than in the CPS implies that an equal value of skill intensity - when it is adjusted for intermediate goods and services - is attributed to different industries, for example in the case

[15] For UK data the 1997 Input-Output table is classified according to the same 1992 Standard Industry Classification code which I used to match the consumption items to their manufacturing industries in the LFS therefore there is no need to match different industry classifications to calculate the second and third column of Appendix Table 4. The only discrepancies between the coding used to calculate skill intensity in the first column of the Table, and the coding of the Input-Output table used to calculate skill intensity in the second and third column of the same Table, are the following: SIC 1992 codes 93.02 "hairdressing" and 93.05 "domestic help" are joint in 93 "other service activities". SIC codes 15.91+15.92 "alcoholic drinks distilling", 15.93 "wine production" and 15.96+15.97 "beer production" are joint in 15.91 to 15.97 "alcoholic beverages". SIC codes 22.1+22.2 "printing and publishing" and 22.3 "reproduction of recorded media" are joint in 22 "printing and publishing and reproduction of recorded media".

of the last four industries in the second column of Table 2 (education of different levels and social services belong to the same industry in the Input-Output tables).

In the second column of Table 2, I calculate the skill intensity of each of the 40 (46 for the UK) original industries as the weighted average of the skill intensity of their inputs. In formulas, the skill intensity of final product j, z_j^A, is calculated as $z_j^A = \sum_i \frac{I_{ij}}{\Sigma_i I_{ij}} z_i$. The weights $\frac{I_{ij}}{\Sigma_i I_{ij}}$ indicate industry's i input contribution to produce one unit of product in industry j and are provided by the Input-Output table. z_i is the skill intensity of intermediate industry i.

An eye-ball comparison of the first and second column of Table 2 shows that taking into account intermediate inputs increases the skill intensity of the low-skill-intensive items and reduces the skill intensity of the high skill intensive items. Low-skill-intensive intermediate inputs, like the retail sector, are expected to reduce the skill intensity of all final products. For the low-skill-intensive final items the effect of the retail sector is offset by the contribution of other intermediate inputs which are relatively more skill-intensive. Figure 3 shows this phenomenon: very low-skill-intensive items (e.g. apparel) become more skill intensive when skill intensity is adjusted for intermediate goods while very high-skill-intensive goods and services (e.g. education) go through the opposite process.

A further concern, specific to the hypothesis that high education and income elasticities of high-skill-intensive items may contribute to the explanation of a rising relative wages of skilled workers, regards import penetration in the different industries. Namely it may be the case that consumption goods with very high income elasticities are mainly produced abroad and therefore contribute nothing to the increase in the domestic demand for skilled labor.[16] To take into account import penetration, I multiply intermediate-inputs-adjusted skill intensity z_j^A by the import penetration of the final industry. The import penetration of industry

[16] Most of the industries have a very low share of imports in proportion to total output, the industries with the highest import penetration are clothing and drugs production.

j, NX_j, is calculated as $NX_j = (1 - I_j)/Y_j$. In this expression E_j, I_j and Y_j are respectively exports of goods and services, imports of goods and services and total final demand of industry j. E_j, I_j and Y_j are obtained from the Input-Output tables. The resulting measure of skill intensity, $z_j^B = z_j^A * NX_j$, reduces the skill intensity of the importing sectors.[17]

4.4 The Relationship between Elasticities and Skill Intensity

Having defined different measures of skill intensity, I separately regress the estimated education elasticities and the estimated income elasticities at the mean, at the 90th percentile and at the 10th percentile on the corresponding industry skill intensity. To allow for the possibility that more educated and richer consumers consume both more low-skill-intensive and high-skill-intensive items, I estimate the quadratic relationship:

$$\widehat{\eta}_j = \alpha + \beta_1 z_j + \beta_2 z_j^2 + \varepsilon_i \tag{6}$$

where $\widehat{\eta}_j$ is in turn the estimate of education and of income elasticity (at the mean, the 90th and the 10th percentile) for commodity j and z_j is skill intensity of industry j as defined above. The regressions are weighted by the inverse of the dependent variable variance.

For US data the estimated coefficients $\widehat{\beta}$ are shown in Table 3. Each panel of Table 3 shows the estimated coefficient obtained using a different measure of skill

[17] This measure of skill intensity makes the strong hypothesis that the skill content of imports is the same as the skill content of domestically manufactured goods. An interesting political economy application of heterogenous preferences by skill level - therefore related to this paper - is provided in Baker (2005). With an empirical analysis of survey data from 41 nations, Baker (2005) shows that heavy consumers of exportables (generally low-skilled workers) are found to be more protectionist than heavy consumers of imports and import-competing goods (generally skilled workers).

intensity. In panel A of Table 3, income and education elasticities are regressed on the skill intensity z_j of the manufacturing industry in 1980. The significant coefficients in the second column of Table 3 indicate that, keeping education constant, richer workers tend to consume both more high-skill-intensive goods and services and more low-skill-intensive goods and services. This result is also evident in the bottom panel of Figure 4 which plots income elasticities against industry skill intensity. The polarization of consumption towards both extremes of the skill intensity distribution is very evident in the case of income elasticities calculated at the 90th percentile (Figure 5). The results in the third column of Table 3 indicate a significant quadratic relationship between the income elasticities at the 90th percentile of the log expenditure distribution and all measures of skill intensity.

In panel B of Table 3 skill intensity z_j^A is corrected for the contribution of intermediate inputs; in panel C, skill intensity $z_j^B = z_j^A * NX_j$ takes into account both the contribution of intermediate inputs and import penetration. The results in panel B and C of Table 3 answer two different questions. The first question is whether skilled (or richer) workers consume more high-skill-intensive goods and services. In this case we do not need to consider the import penetration of each industry. The relevant results are those of panel B of Table 3, where skill intensity is corrected for the contribution of intermediate inputs.

The second question is how relevant are the education and income elasticities in increasing the domestic demand for skilled labor. In this case we should weigh the skill intensity of the manufacturing industry for imports since imported goods are not going to increase domestic labor demand. The relevant results are shown in panel C of Table 3. Panel B and C confirm that both the increase in education and in wage inequality (calculated at the 90th income percentile) have plausibly shifted product demand towards both very high-skill-intensive and low-skill-intensive goods and services.

The results on UK data are presented in Table 5. Also for the UK the polarization result is evident in the case of income elasticities calculated at the 90th percentile. However, when skill intensity is adjusted for intermediate inputs and imports in panel B and C, the coefficients become insignificant and the R square is very low.

4.5 Robustness Exercise

Table 4 for the US and Table 6 for the UK provide some robustness exercises with respect to (i) the year in which the elasticities are calculated; (ii) the age of the heads of household used to estimate the elasticities; (iii) using log household income instead of log total expenditure to estimate income elasticities. The results in both tables indicate that the quadratic relationship between income elasticities estimated at the 90th percentile and skill intensity is robust to (i) changes in the year of estimation (year 2000-2002 for the US and year 1988 for the UK); (ii) the relationship holds on the group of heads aged 18-60 (due to the large number of elderly heads this group is 75% of the US sample and 74% of the UK sample) and therefore does not depend on patterns of consumption varying by age; (iii) the endogeneity of total expenditure with respect to the expenditure shares of the single goods which is typically addressed instrumenting total expenditure with total household income.

5 Quantification of the Demand Shift

The US and UK have in common higher income and education elasticities both for very low-skill-intensive goods and services like personal care and domestic services, beauty services and repairs (Mazzolari and Ragusa, 2007) but also for very high-skill-intensive goods and services such as professional and legal services and educational services. However, these coefficients do not tell us the extent to which an increase in education or income raises or decreases the demand for skilled labor. To answer this question, in this section I parametrize the two-sector model of section 3 using the relevant elasticities and the labor market aggregates of the US and UK economy. I quantify the increase in the relative demand of skilled labor in response to an increase in the relative supply of skills making use of the relationship between the skill premium and the skill ratio implied by the model in equation 3.

I use data on all the 40 consumption items and the 40 corresponding industries as listed in Appendix Table 1. To match the two-sector nature of the model, the 40 items and the corresponding industries are divided into 20 low-skill-intensive items and 20 high-skill-intensive items. All consumption items matched to industries with a skill intensity lower than 0.36 (the median industry skill intensity) in the first column of Appendix Table 1 are considered low-skill-intensive.

The 46 UK consumption items in Appendix Table 2 are also divided in low-skill-intensive and high-skill-intensive: all goods and services matched to industries in Appendix Table 2 up to "Luggage, jewelry and musical instruments" included are considered low-skill-intensive, from there onwards they are considered high-skill-intensive. Appendix Table 2 already ranks the industries in order of skill intensity, notice that skill intensity is much lower on average in the UK and the threshold that separates low-skill-intensive from high-skill-intensive consumption items is 0.092 (9.2% of workers in industry "Luggage, jewelry and musical instruments" in the UK hold a college degree).

Once we have divided the low-skill-intensive and the high-skill-intensive industries (and the respective consumption items) to match the two-sector model, we can estimate the parameters of equation 3. The parameters λ_H, λ_L, a_1, a_2 and $\frac{H}{L}$ are estimated using CPS 1994-1997 data (LFS 1994-1997 for the UK). ε^h_{hp}, ε^l_{hp},

ε^h_{hm}, ε^l_{hm}, R_1 are estimated using CEX 1994-1997 data (FES 1994-1997 for the UK). The elasticity of substitution between educated and non-educated workers, $\sigma = 1.4$, is taken from Katz and Murphy (1992).

Table 7 summarizes the next two sections of the text listing the parameters values used in equation 3.

5.1 Parameters from the CPS and LFS

I keep in the CPS sample all workers in sample years 1994-1997 with a valid information on attained education. The ratio of the number of college-educated workers who work in the 20 high-skill-intensive industries over those who work in the 20 low-skill-intensive industries is calculated at $\lambda_H = \frac{H_1}{H_2} = 2.21$. The ratio of the number of workers without a college education who work in the 20 high-skill-intensive industries over those who work in the 20 low-skill-intensive industries is calculated at $\lambda_L = \frac{L_1}{L_2} = 0.6$. The value of the wage bill share of college-educated workers in the 20 high-skill-intensive industries is $\alpha_1 = \frac{w_h H_1}{p_h y_h} = 0.65$; in the 20 low-skill-intensive industries it is $\alpha_2 = \frac{w_h H_2}{p_l y_l} = 0.37$.[18] The skill ratio $\frac{H}{L} = 0.57$ in the CPS sample 1994-1997.

For the UK the numbers are taken from the LFS 1994-1997. The ratio of the number of college-educated workers who work in the 23 high-skill-intensive industries over those who work in the 23 low-skill-intensive industries is $\lambda_H = \frac{H_1}{H_2} = 6.73$. The ratio of the number of workers without a college education who work in the 23 high-skill-intensive industries over those who work in the 23 low-skill-intensive industries is calculated at $\lambda_L = \frac{L_1}{L_2} = 0.74$. The value of the wage bill share of college-educated workers in the 23 high-skill-intensive industries is $\alpha_1 = \frac{w_h H_1}{p_h y_h} = 0.42$; in the 23 low-skill-intensive industries it is $\alpha_2 = \frac{w_h H_2}{p_l y_l} = 0.07$.

[18] a_1 and a_2 are calculated assuming constant returns to scale i.e. $p_h y_h = w_l L_1 + w_h H_1$ and $p_l y_l = w_l L_2 + w_h H_2$.

The skill ratio is much lower in the UK than in the US: $\frac{H}{L} = 0.28$ in the LFS sample 1994-1997.

5.2 Parameters from the CEX and FES

Equation 3 requires the estimation of income and price elasticities only of high-skill-intensive items ε^i_{hm} and ε^i_{hp} (and separately for each education group i). However the elasticities are expressed in relative terms (due to normalization in the model) and they refer to consumption of high-skill-intensive items relative to low-skill-intensive items, therefore the estimation must take into account a system of equations and the constraints imposed by the theory. The two-equation system will have an equation for high-skill-intensive items and one "auxiliary" equation for low-skill-intensive items with the purpose of imposing constraints on the first equation.

The price and income elasticities of demand for skilled workers, ε^h_{hm} and ε^h_{hp}, are obtained estimating a system of two equations on the sample of skilled workers only. The first equation pools the expenditure shares of the 20 high-skill-intensive items, the second equation pools the 20 low-skill-intensive items and both equations allow for fixed effects for each items. The two-equation system - estimated on the sample of college educated heads of household - is of the form (time subscripts omitted):

$$\omega^h_{ij} = \gamma X_i + \beta_{h1}\log(\frac{x}{P})_i + \beta_{h2}\log(\frac{x}{P})^2_i + \theta_{h1}\log p_h + \theta_{h2}\log p_l + \zeta^h_j + \varepsilon_{ij} \tag{7a}$$

$$\omega^l_{ij} = \gamma X_i + \beta_{l1}\log(\frac{x}{P})_i + \beta_{l2}\log(\frac{x}{P})^2_i + \theta_{l1}\log p_h + \theta_{l2}\log p_l + \zeta^l_j + \varepsilon_{ij} \tag{7b}$$

where $\omega^{h,l}_{ij} = \frac{p_i y_{ij}}{x}$ is the expenditure share of item j by household i and the superscript h, l indicates that the equation pools the 20 high-skill-intensive items or the 20 low-skill-intensive items. $\zeta_j^{h,l}$ indicates fixed effects for each item j, the superscript indicates if the items are high- or low-skill-intensive. $\log(\frac{x}{P})$ is log total expenditure and $\log P = \sum_j w_j \log\, p_j$ is the Stone price index where w_j is the annual average share of commodity j in the data. X_i contains age and sex of the head and the number of children in the household. $\log p_{h,l} = \sum_{j=1}^{20} w_j \log\, p_j$ is an aggregate price index constructed using the individual commodity price series $\log p_j$ of the 20 high-skill-intensive items (or of the 20 low-skill-intensive items) and their annual shares in total expenditure w_j as weights. The standard errors are clustered at the household level.

The system is estimated imposing the homogeneity constraint (the effect of a 1% increase in income will produce between the two equations a total increase in expenditure of 1% therefore the sum of the income elasticities must be equal to one) i.e. $\varepsilon_{hm} = \frac{(\widehat{\beta}_{h1}+2\widehat{\beta}_{h2}\overline{\log(\frac{x}{P})})}{\overline{\omega}} + 1 = 1 - \varepsilon_{lm} = 1 - \left(\frac{(\widehat{\beta}_{l1}+2\widehat{\beta}_{l2}\overline{\log(\frac{x}{P})})}{\overline{\omega}} + 1\right)$ and and the symmetry constraints (the effect of an increase in $\log p_h$ or $\log p_l$ must be symmetric across the two equations) i.e. $\theta_{h1} = -\theta_{l1}$ and $\theta_{h2} = -\theta_{l2}$.

In the same way, the income and price elasticities of low-skilled workers, ε_{hm}^l and ε_{hp}^l, are obtained estimating system 7a on the sample of non-college-educated workers. The results of the system estimation are in Table 6 in the Appendix. The first two columns of Appendix Table 6 show the results obtained on the sample of college-educated workers, columns three and four refer to the sample of non-college educated workers.

Column 1 and 3 of Appendix Table 6 refer to the "auxiliary" equation of low-skill-intensive items and their coefficients are not used directly in calculating the elasticities. We use instead the coefficients in the second and fourth columns of the table which refer to the equations of high-skill-intensive items. The income elasticities calculated at the average household characteristics are equal to $\varepsilon_{hm} = \frac{(\widehat{\beta}_1+2\widehat{\beta}_2\overline{\log(\frac{x}{P})})}{\overline{\omega}} + 1$ where $\overline{\log(\frac{x}{P})}$ is the average log real expenditure and $\overline{\omega}$ is the average expenditure share. To calculate income elasticity of skilled workers, ε^h_{hm}, I use $\overline{\omega}, \widehat{\beta}_{h1}, \widehat{\beta}_{h2}$ and $\overline{\log(\frac{x}{P})}$ of the sample of college-educated workers (column 4 of Appendix Table 6). To calculate the income elasticity of unskilled workers, ε^l_{hm}, I use $\overline{\omega}, \widehat{\beta}_{h1}, \widehat{\beta}_{h2}$ and $\overline{\log(\frac{x}{P})}$ of the sample of non-college-educated workers (column 2 of Table Appendix 6). On the basis of the coefficient estimates shown in Appendix Table 6, the income elasticities are estimated at $\varepsilon^h_{hm} = 0.89(0.30)$ and $\varepsilon^l_{hm} = 0.83(0.38)$.

The uncompensated price elasticity is given by: $\varepsilon_{hp} = \frac{\widehat{\theta}_{h1}}{\overline{\omega}} - (\widehat{\beta}_{h1} + 2\widehat{\beta}_{h2}\overline{\log(\frac{x}{P})}) - 1$. To calculate the price elasticity of skilled workers, ε^h_{hp}, I use $\widehat{\theta}_{h1}, \overline{\omega}$ of the sample of college-educated workers (column 4 of Appendix Table 6). To calculate the price elasticity of unskilled workers, ε^l_{hp}, I use $\widehat{\theta}_{l1}, \overline{\omega}$ of the sample of non-college-educated workers (column 2 of Appendix Table 6). ε^h_{hp} and ε^l_{hp} are estimated at ε^h_{hp} =-0.22(0.09) and ε^l_{hp} =-1.39(0.46). Finally, the share of expenditure on the 20 most skill-intensive goods by college-educated workers, R_1, is calculated summing up total expenditure on the 20 high-skill-intensive items across college-educated workers and taking the ratio over total expenditure on the 20 high-skill-intensive items across all workers, $R_1 = \frac{Hy^h_h(.)}{Hy^h_h(.)+Ly^l_h(.)} = 0.66$.

The results for the UK are in Table Appendix 7. On the basis of the coefficient estimates the elasticities are calculated at ε^h_{hm} =0.91 ε^l_{hm} =1.08 ε^h_{hp} =-0.61 ε^l_{hp} =-1.39. While income and price elasticities are fairly similar across the US and UK, the value of R_1 is much lower in the UK, $R_1 = 0.15$. This is not surprising because the numerator of R_1 is the total expenditure on the 20 high-skill-intensive items by college-educated workers and the share of college educated workers is much lower in the UK than in the US.

5.3 Results of the Calibration and Counterfactual

The result of this exercise is summarized in Table 8. Plugging the parameter values of Table 7 in equation 3, the final result is $\frac{d \log w_h}{d \log H} = -0.67$ (for the UK -0.78). The interpretation of this number makes sense with respect to the counterfactual of what would have happened without the education and income effect in favor of high-skill-intensive consumption items. The same model solved with identical demand functions for skilled and unskilled workers (i.e. $y_h^h(.) = y_h^l(.) = y_h(.)$) gives the following counterfactual result:

$$\frac{d \log w_h}{d \log H} = \frac{-(1-a_2)[1+\lambda_H+\frac{H}{L}(1+\lambda_L)]}{(\lambda_L+1)\sigma+(\lambda_H-\lambda_L)(1-a_1)\sigma-(\lambda_H-\lambda_L)\varepsilon_{hp}(a_1-a_2)} \tag{8}$$

Notice that without education and income effects, $\frac{d \log w_h}{d \log H}$ is unambiguously negative. The only additional parameter which we need to calibrate equation 8 is ε_{hp} i.e. the price elasticity of high-skill-intensive consumption items estimated on the sample of all workers (educated and non-educated). ε_{hp} is estimated at ε_{hp} =-0.53(0.21) for the US and -0.59(0.11) for the UK. Calibration of equation 8, gives the result $\frac{d \log w_h}{d \log H} = -0.73$ (for the UK -0.85).

The comparison between equation 3 and equation 8 shows that differences in consumption preferences across educational groups contribute to reduce the extent of the fall of $\frac{w_h}{w_l}$ in response to an increase in $\frac{H}{L}$.[19] To understand the magnitude of this effect we need to compare the actual numbers of the skill premium in the US

[19] The total effect is of 0.06 points (0.67-0.73). The total effect can be also decomposed in different parts. The direct effect of education elasticities can be quantified in $(1-a_2)(\lambda_H - \lambda_L)[R_1 - (1-R_1)\frac{H}{L}] = 0.50$ in the numerator of 3. The effect through different price and income elasticities across educated and non-educated workers can be quantified in the difference between $T = \{R_1[\varepsilon_{hp}^h(a_1-a_2)+\varepsilon_{hm}^h(1-a_2)]+(1-R_1)[\varepsilon_{hp}^l(a_1-a_2)-a_2\varepsilon_{hm}^l]\}$ and $\varepsilon_{hp}(a_1-a_2)$. The difference in income elasticities is calculated at $R_1(1-a_2)\varepsilon_{hm}^h-(1-R_1)a_2\varepsilon_{hm}^l$ =0.27. The difference in price elasticities is calculated at $R_1(a_1-a_2)\varepsilon_{hp}^h+(1-R_1)(a_1-a_2)\varepsilon_{hp}^l-(a_1-a_2)\varepsilon_{hp} = -0.10$.

economy with the counterfactual prediction of the model with homothetic demand functions (equation 8) and calculate how much of the difference can be explained by the prediction of equation 3 which includes education and income effects.

The actual skill ratio in the US economy $\frac{H}{L}$ increased by 81% between 1984 and 2002 and the skill premium $\frac{w_h}{w_l}$ increased by 11% (CEX data). Taking $\frac{H}{L}$ as the exogenous variable, equation 3 which incorporates the education and income effect in favor of skill-intensive consumption items implies that $\frac{w_h}{w_l}$ should have fallen by 54% (-0.67*0.81=-0.54) as a result of an increase in $\frac{H}{L}$ of 81%. Equation 8 with identical preferences across educated and non-educated workers implies a fall of $\frac{w_h}{w_l}$ by 59% (-0.73*0.81=-0.59).

If we take equation 8 with identical demand functions across educated and non-educated workers as the counterfactual, the total shift in relative labor demand which is left unexplained is 70% (the actual 11% plus the counterfactual 59% implied by equation 8). These calculations imply that the education effect in favor of skill-intensive consumption items can account only for around 7% of the total shift in the relative demand of labor. Namely the effect of different preferences across educated and non-educated workers reduces by 5% the fall of the relative wage (54% instead of 59%) and 5% points constitute about 7% of the 70% total shift in the relative labor demand.

The data for the skill ratio and the skill premium in the UK are similar: $\frac{H}{L}$ increased by 88% between 1982 and 2000 and the skill premium $\frac{w_h}{w_l}$ increased by 13%. Equation 3 implies that $\frac{w_h}{w_l}$ should have fallen by 65% (-0.74*0.88=-0.65) as a result of an increase in $\frac{H}{L}$ of 88%. Equation 8 with identical preferences across educated and non-educated workers (which we take as counterfactual of what would have happened if there had not been an effect of income and education elasticities) implies a fall of $\frac{w_h}{w_l}$ by 70% (-0.80*0.88=-0.70). Therefore the total unexplained shift in relative labor demand in the UK is 83% (the actual 13% plus the counterfactual 70% implied by equation 8). These calculations imply that the education effect in favor of skill-intensive goods can account only for around 6% of the total shift in the relative demand of labor. A reduction of 5% in the fall of the relative wage (65% instead of 70%) corresponds to about 6% of the 83% total shift in the relative labor demand.

Although the evolution of the skill ratio and the skill premium has been similar across the UK and US, other factors such as the proportion of college-educated workers and the consumption goods and services considered in the consumption surveys are different across the two countries. Notwithstanding these differences, the overall results in terms of explanatory power are similar across the UK and US. The education and income elasticities mechanism can give an additional contribution (besides the traditional explanations) to the accounting of the increasing skill premium but it is certainly not able to fully explain this phenomenon. Inspection of equation 3 reveals that only implausibly high values of the education (R_1) and income elasticities (ε^h_{hm}) would be able to explain the whole increase in $\frac{w_h}{w_l}$.

6 Conclusions

In this paper I claim that the shift in relative skill demand does not need to be attributed exclusively to skill-biased technical change or trade. The shift in relative skill demand can be at least partially explained by an education/income effect that increases the demand for skill-intensive products which in turn will increase the relative demand of skilled labor.

In the empirical part of this paper, I regress estimates of education and income elasticities on the skill intensity of the manufacturing industry. The evidence shows that more educated and richer consumers consume more of very low-skill-intensive goods and services (for example cleaning services; see Mazzolari and Ragusa, 2007) and more of very high-skill-intensive services such as education and professional services. The U-shaped relationship between income elasticities and skill-intensity of consumption goods and services is particularly evident for income elasticities estimated at the 90th percentile which indicates that the increase in wage inequality at the top of the distribution may contribute to the shift in final product demand. This phenomenon is common across the UK and the US notwithstanding the differences in consumption items considered and the much lower proportion of college-educated workers in the UK economy. The US results are also robust to different measures of skill intensity calculated using Input-Output tables to take into account the contribution of intermediate inputs to the skill content of final goods. Both the US and UK results are robust to the period considered for the estimation, the age group of heads of household in the sample and the endogeneity of total expenditure in the Engel curves.

There are many concurrent explanations of the increase in wage inequality. The recent papers which explicitly link skill supply and skill demand through consumption habits relying on a substitution effect in labor supply (Manning, 2004 and Mazzolari and Ragusa, 2007) or on computerization of routine tasks (Autor and Dorn, 2008) focus exclusively on low-skill-intensive services. Although I am unable to distinguish the various explanations, in this paper I point to a robust and relatively unresearched empirical fact and quantify its relevance comparing the results of a model with non-homothetic preferences which incorporates income effects with a counterfactual downward sloping relative demand for skills obtained in absence of income effects.

A parametrization of a simple two-sector model suggests that overall the income effects are in favor of high-skill-intensive goods and services and can explain around 5% of the total increase in relative skill demand in the US from 1984 to 2002 and 6% in the UK 1982-1997. The effect is not large but of potential interest because of the stable structure of income and education elasticities over time which suggests a constant (but small) bias towards high-skill-intensive services.

Data Appendix

US: the data used in this paper are drawn from the Consumer Expenditure Survey 1980-2002 provided by Ed Harris and John Sabelhaus at NBER (http://www.nber.org/data/ces_cbo.html). The mapping of the single items into the 40 aggregate items considered here is detailed in (www.nber.org/ces_cbo/Cexfam.pdf). Price data are obtainable on the BLS web page. The Input-Output tables used to account for intermediate inputs and import penetration are the industry-by-industry domestic use matrices at basic prices for the US in 1995.

UK: the aggregation of FES data into the 46 consumption items considered in this paper follows a rather obvious procedure. For reasons of space, the exact procedure can be provided upon request. The only items not considered in the aggregation are cars and housing and other very minor expenditures such as TV licence and car tax which did not have any obvious industry match. Total expenditure is calculated as the sum of the 46 items considered, excluding cars and housing. The level of aggregation was kept at the most disaggregated level possible. When the consumption items were aggregated at a higher level, the corresponding price series were constructed as a weighted average of their basic components. The price series were provided by the Office of National Statistics. Input-Output tables are 1997 Office of National Statistics official tables.

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Model Appendix

Demands for goods have a generic form that allows for non-homotheticity, and are different for skilled and unskilled workers:

$$Y_h = H y_h^h(\frac{p_h}{p_l}, w_h) + L y_h^l(\frac{p_h}{p_l}, w_l) \tag{9}$$

$$Y_l = H y_l^h(\frac{p_h}{p_l}, w_h) + L y_l^l(\frac{p_h}{p_l}, w_l) \tag{10}$$

Labor markets are competitive and both labor inputs move across sectors to equate their marginal value. Factor returns are given by: $w_h = p_h F_{1H_1}(H_1, L_1) = p_l F_{2H_2}(H_2, L_2)$ and $w_l = p_h F_{1L_1}(H_1, L_1) = p_l F_{2L_2}(H_2, L_2)$.

The general equilibrium is completely described by the following five equations where the price of the low-skill-intensive commodity has been normalized to unity, $p_l = 1$:

$$
\begin{aligned}
p_h F_1(H_1, L_1) &= w_l L_1 + w_h H_1 && (11)\\
F_2(H - H_1, L - L_1) &= w_l(L - L_1) + w_h(H - H_1) && (12)\\
d\log\left(\frac{H_1}{L_1}\right) &= -\sigma d\log\left(\frac{w_h}{w_l}\right) && (13)\\
d\log\left(\frac{H - H_1}{L - L_1}\right) &= -\sigma d\log\left(\frac{w_h}{w_l}\right) && (14)\\
H y_h^h(p_h, w_h) + L y_h^l(p_h, w_l) &= F_1(H_1, L_1) && (15)
\end{aligned}
$$

The first two equations, 11 and 12, restate the constant returns assumption. Equations 13 and 14 are definitions of substitution elasticities in a CES technology. The last equation 15 is the market equilibrium condition for commodity Y_h. According to Walras' law, equilibrium in the factors' market and in the market of commodity Y_h implies that the market of commodity Y_l clears.

Taking the total differential and logs of equations 11-15:

$$d\log p_h = a_1 d\log w_h + (1 - a_1) d\log w_l \tag{16a}$$

$$(1 - a_2) d\log w_l = -a_2 d\log w_h \tag{16b}$$

$$d\log H_1 - d\log L_1 = -\sigma(d\log w_h - d\log w_l) \tag{16c}$$

$$(1 + \lambda_H) d\log H - \lambda_H d\log H_1 - (1 + \lambda_L) d\log L + \lambda_L d\log L_1 = -\sigma(d\log w_h - d\log w_l) \tag{16d}$$

$$
\begin{aligned}
&R_1[\varepsilon_{hp}^h d\log(p_h) + \varepsilon_{hm}^h d\log w_h + d\log H] + \\
&+(1 - R_1)[d\log L + \varepsilon_{hp}^l d\log(p_h) + \varepsilon_{hm}^l d\log w_l] = a_1 d\log H_1 + (1 - a_1) d\log L_1
\end{aligned} \tag{17}
$$

The parameter $a_1 = \frac{w_h H_1}{p_h F_1(.)}$ denotes the wage bill share of skilled labor in the high-skill-intensive sector h. $a_2 = \frac{w_l H_2}{F_2(.)}$ is the wage bill share of skilled labor in the low-skill-intensive sector l. $\lambda_H = \frac{H_1}{H_2}$ and $\lambda_L = \frac{L_1}{L_2}$ are respectively the ratio of skilled labor used in sector h and l and the ratio of unskilled labor used in sector h and l. $R_1 = \frac{Hy_h^h(.)}{Hy_h^h(.)+Ly_h^l(.)}$ is the share of total expenditure on the skill-intensive commodity h by skilled workers. ε_{hp}^i and ε_{hm}^i are respectively the price and the income elasticities of demand for the high-skill-intensive commodity. The index $i = h, l$ indicates that both elasticities may be different for skilled and unskilled workers.

Assuming total labor supply is fixed $dH = -dL$, substituting equations 16a to 16d in 17 we obtain:

$$\frac{d\log w_h}{d\log H} = \frac{(1-a_2)\{(\lambda_H - \lambda_L)[R_1 - (1-R_1)\frac{H}{L}] - [1 + \lambda_H + \frac{H}{L}(1+\lambda_L)]\}}{(\lambda_L \sigma_1 + \sigma_2) + (\lambda_H - \lambda_L)(1-a_1)\sigma_1 - (\lambda_H - \lambda_L)T} \tag{18}$$

where $T = \{R_1[\varepsilon_{hp}^h(a_1 - a_2) + \varepsilon_{hm}^h(1-a_2)] + (1-R_1)[\varepsilon_{hp}^l(a_1-a_2) - a_2\varepsilon_{hm}^l]\}$.

Since sector Y_h is skill-intensive, $a_1 - a_2 > 0$ and $\lambda_H - \lambda_L > 0$. The sign and the magnitude of this expression are the result of the direct effect of an increase in $\frac{H}{L}$ on $\frac{w_h}{w_l}$ through substitution elasticities in the production function and the indirect effect through relative prices p_h in the product market.

In this model the relationship between $\frac{w_h}{w_l}$ and $\frac{H}{L}$ depends on substitution elasticities in the production function and on price and income elasticities of demand for high-skill-intensive goods which in turn reflect elasticities of substitution of high-skill-intensive and low-skill-intensive goods in consumption. Obviously factors should not be perfect substitutes in production ($\sigma_i \neq \infty$) nor goods should be perfect substitutes in consumption ($\varepsilon_{hp}^i \neq \infty$).

Figure 1: Percentage change in employment and wage bill share 2000-1980 by industry skill intensity in 1980. Source: US CPS data

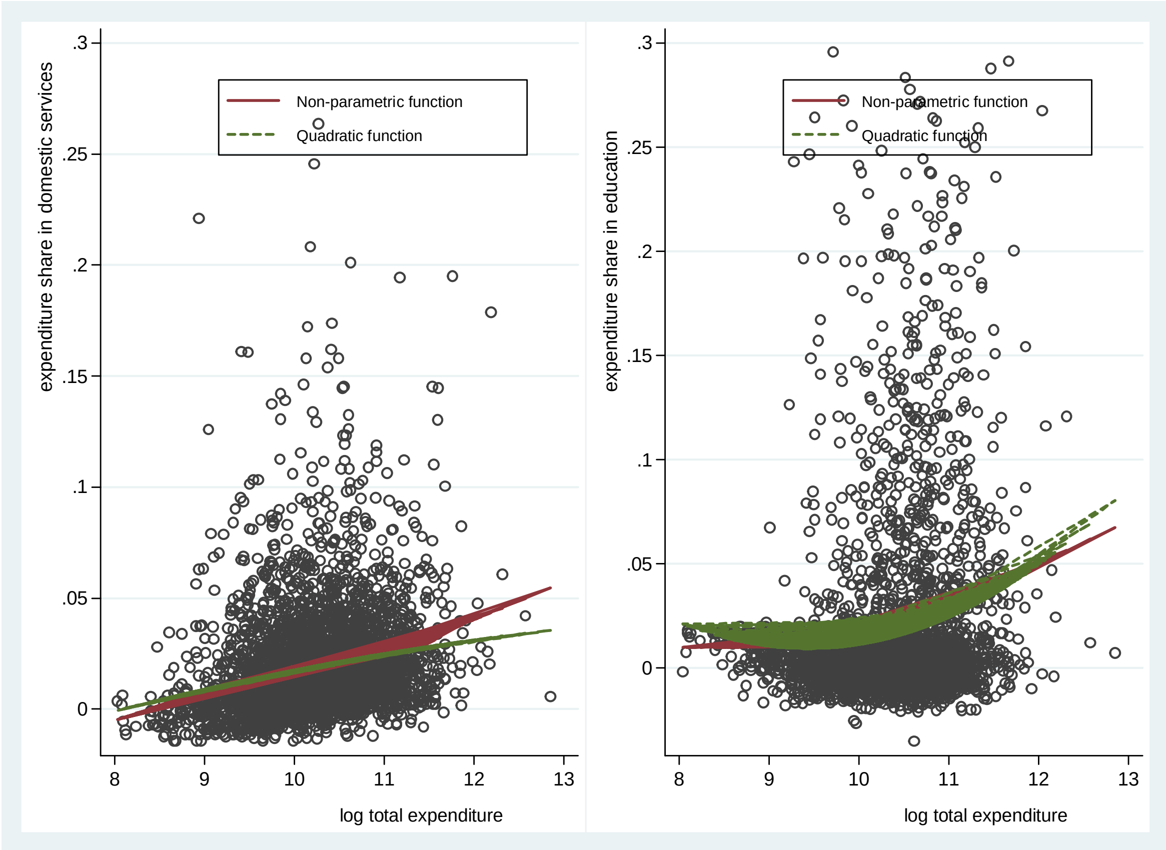

Figure 2: Non-parametric Engel curves of domestic services and expenditure on education (primary+secondary+tertiary). Source: US CEX year 2000, 19 observarvions with expenditure shares in education >30% dropped.

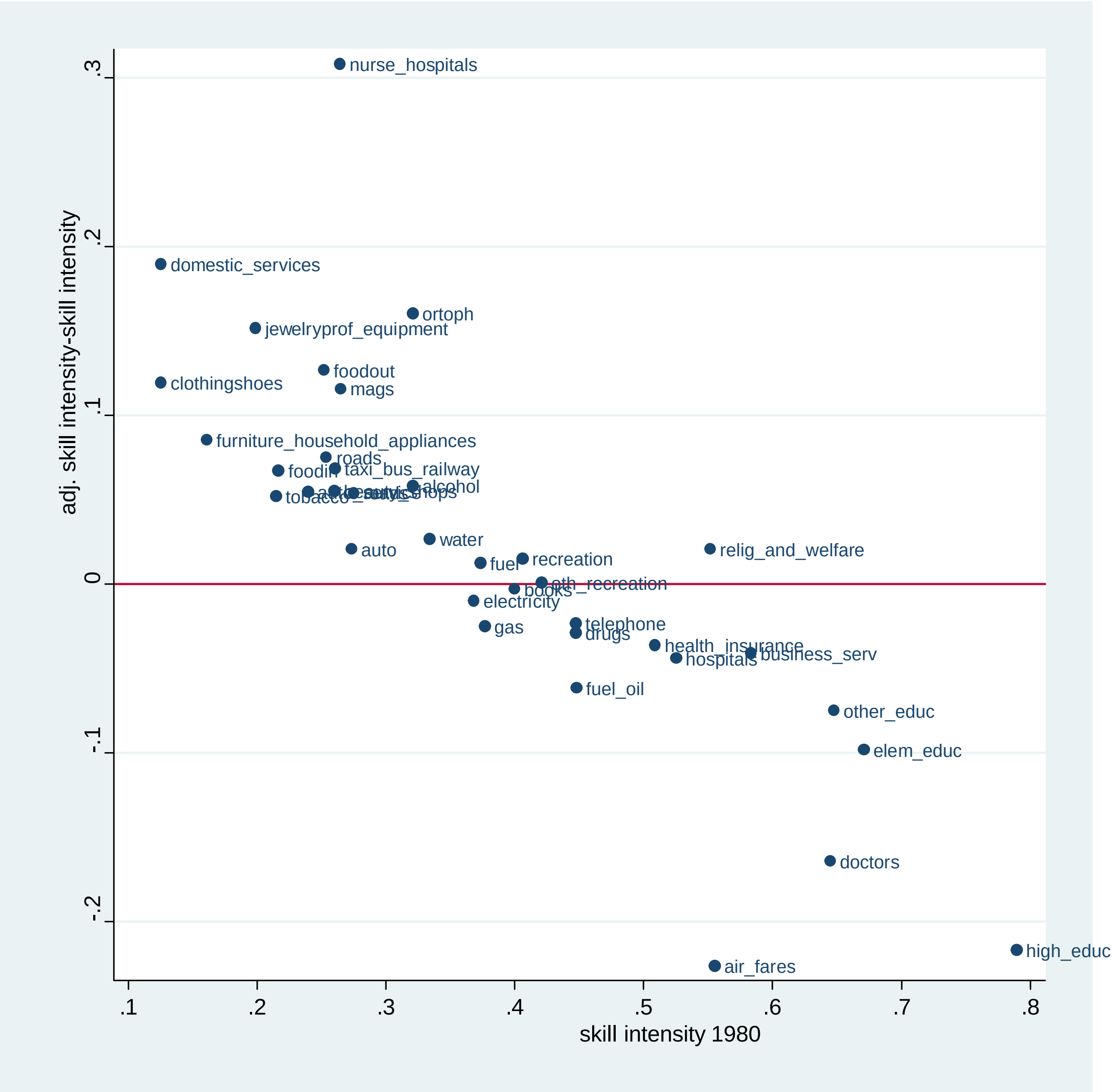

Figure 3: The difference between skill intensity adjusted for intermediate inputs and skill intensity. Source: US CPS data and 1995 Input-Output tables.

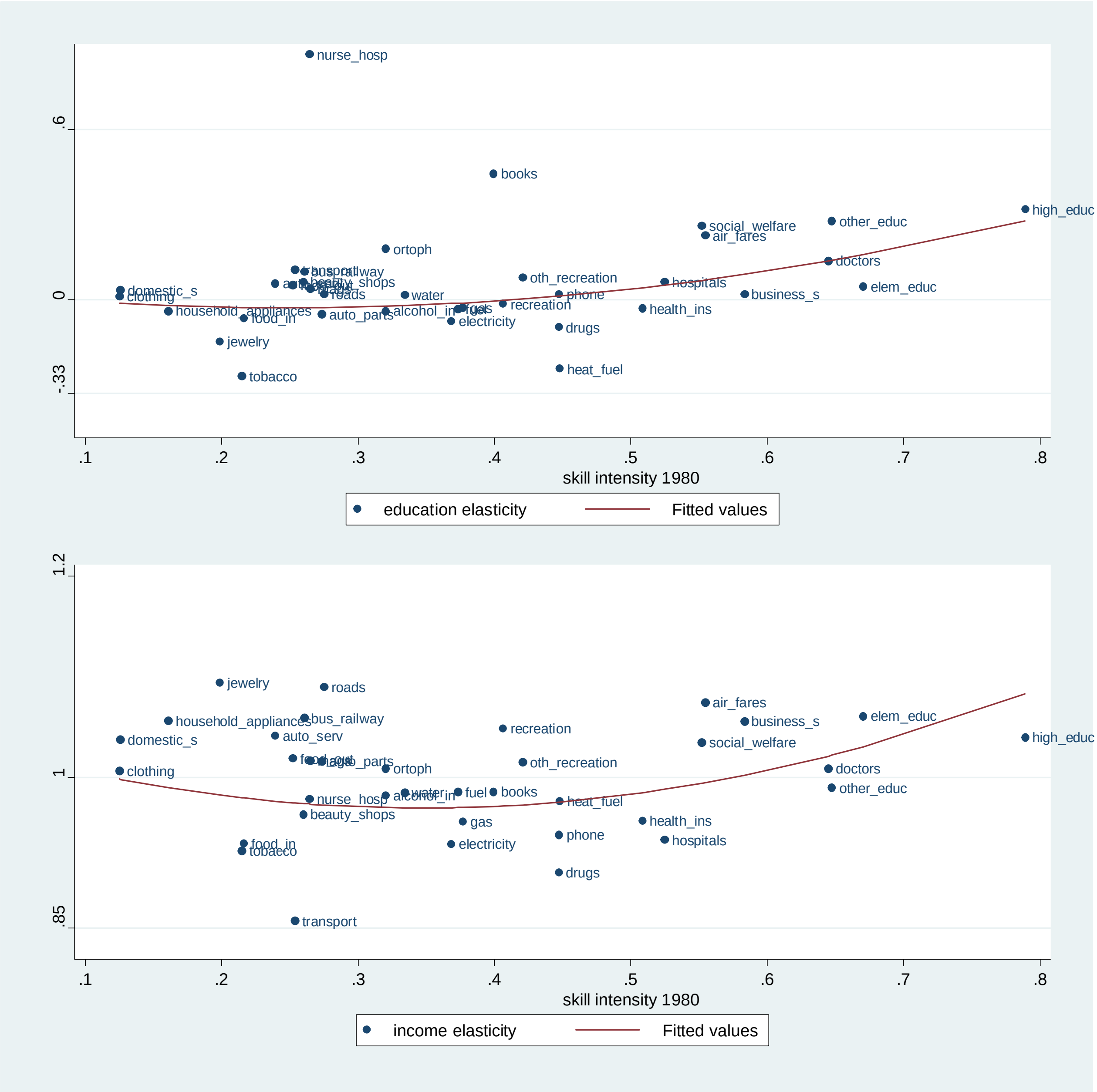

Figure 4: OLS regression of education and income elasticities on industry skill intensity. Fitted values assume a quadratic relationship. Source: US CPS and CEX data.

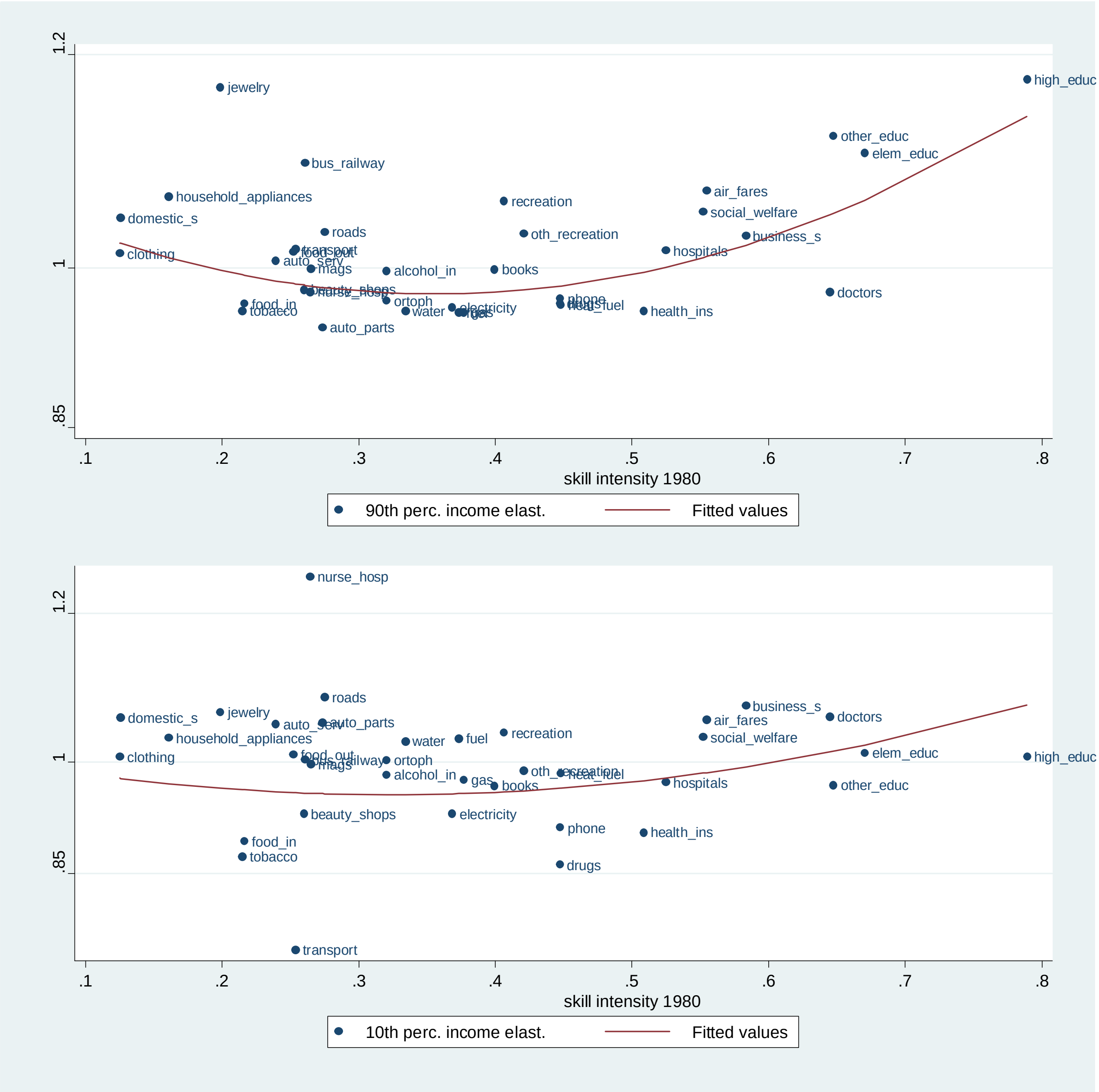

Figure 5: OLS regression of income elasticities at the 90th and at the 10th income percentile on industry skill intensity. Fitted values assume a quadratic relationship. Source: US CPS and CEX data.

Table 1: US CEX 1994-1997 Estimates of Education and Income Elasticities.

CEX consumption item	educ. elast.	std.err.	income elast.	std. err.	mean share
Food Off-Premise	-0.064	0.009	0.933	0.055	0.054
Food On-Premise	0.051	0.018	1.018	0.042	0.040
Tobacco Products	-0.268	0.042	0.926	0.339	0.006
Alcohol Off-Premise	-0.040	0.042	0.981	0.379	0.031
Alcohol On-Premise	0.076	0.059	0.998	0.581	0.038
Clothing and Shoes	0.011	0.016	1.006	0.057	0.013
Clothing Services	0.071	0.037	0.924	0.409	0.036
Jewelry and Watches	-0.146	0.065	1.094	0.874	0.012
Barbershops, Beauty Parlors, Health Clubs	0.062	0.022	0.963	0.159	0.009
Nondurable Househ. Supplies and Equipment	-0.039	0.028	1.056	0.067	0.019
Electricity	-0.075	0.015	0.934	0.097	0.039
Gas	-0.028	0.027	0.955	0.197	0.057
Water and Other Sanitary Services	0.016	0.020	0.984	0.136	0.008
Fuel Oil and Coal	-0.243	0.073	0.976	0.830	0.014
Telephone and Telegraph	0.018	0.013	0.942	0.087	0.030
Domestic Service, Other Household Operation	0.033	0.026	1.037	0.104	0.007
Drug Preparations	-0.096	0.062	0.902	0.550	0.054
Ophthalmic Products, Orthopedic Appliances	0.179	0.082	1.008	0.883	0.026
Physicians, Dentists, Medical Professionals	0.136	0.062	1.008	0.285	0.005
Hospitals	0.062	0.187	0.937	2.571	0.019
Nursing Homes	0.863	0.656	0.978	1.397	0.012
Health Insurance	-0.036	0.028	0.956	0.143	0.016
Business Services	0.019	0.052	1.055	0.259	0.008
Expense of Handling Life Insurance	-0.043	0.039	1.046	0.160	0.006
Tires, Tubes, Accessories, and Other Parts	-0.051	0.042	1.016	0.365	0.010
Repair, Greasing, Washing, Parking etc.	0.057	0.029	1.041	0.071	0.008

Table 1: continued

CEX consumption item	educ. elast.	std. err.	income elast.	std. err.	mean share
Gasoline and Oil	-0.033	0.013	0.985	0.053	0.046
Bridge, Tunnel, Ferry, and Road Tolls	0.019	0.074	1.089	0.750	0.036
Auto Insurance	-0.034	0.018	0.993	0.076	0.020
Mass Transit Systems	0.105	0.089	0.857	1.364	0.004
Taxicab, Railway, Bus, Other Travel Expenses	0.098	0.071	1.058	0.826	0.025
Airline Fares	0.226	0.047	1.074	0.303	0.068
Books and Maps	0.444	0.041	0.985	0.466	0.005
Magazines, Newspapers, Nondurable Toys	0.038	0.022	1.016	0.132	0.010
Recreation and Sports Equipment	-0.015	0.038	1.048	0.121	0.002
Other Recreation Services	0.078	0.015	1.014	0.042	0.003
Higher education	0.317	0.089	1.039	0.598	0.001
Nursery, Elementary, Secondary Education	0.046	0.077	1.060	0.486	0.001
Other Education Services	0.276	0.108	0.989	1.755	0.008
Religious and Welfare Activities	0.260	0.047	1.034	0.214	0.006

Notes: The standard errors are calculated with the Delta method. The mean share is the average expenditure share in the CEX 1994-1997.

Table 2: US CPS 1994-1997 Industry Skill Intensity

CPS Industry	(1) skill intensity	(2) adj. skill intensity interm. goods	(3) adj. skill intensity import penetration
Food production	0.216	0.283	0.260
Eating places	0.252	0.378	0.378
Tobacco	0.214	0.266	0.238
Beverage	0.320	0.378	0.378
Bars and drinking places	0.252	0.421	0.419
Apparel	0.122	0.244	0.133
Repair	0.239	0.293	0.293
Jewelry and toys	0.198	0.350	0.321
Personal services	0.259	0.315	0.315
House supplies	0.160	0.246	0.206
Electric	0.368	0.358	0.356
Gas	0.376	0.351	0.351
Water	0.334	0.360	0.360
Petroleum	0.447	0.386	0.352
Communications	0.447	0.424	0.420
House services	0.125	0.315	0.315
Drugs	0.447	0.418	0.284
Optical	0.320	0.481	0.481
Health services	0.645	0.481	0.481
Hospitals	0.524	0.481	0.481
Nurse homes	0.264	0.572	0.572
Health Insurance	0.508	0.472	0.468
Business serv.	0.583	0.542	0.540
Life Insurance	0.508	0.472	0.468
Motor parts	0.273	0.293	0.293
Auto Repair	0.239	0.293	0.293

Table 2: continued

CPS industry	(1) skill intensity	(2) adj. skill intensity interm. goods	(3) adj. skill intensity import penetration
Petroleum	0.373	0.386	0.352
Transport	0.274	0.329	0.327
Car Insurance	0.508	0.477	0.468
Railways	0.253	0.328	0.327
Railroads	0.260	0.329	0.327
Air transport	0.554	0.328	0.282
Printing	0.399	0.396	0.386
Newspaper	0.264	0.380	0.365
Profess equip	0.406	0.421	0.419
Entertainment	0.420	0.421	0.419
College	0.789	0.572	0.572
Elementary	0.670	0.572	0.572
Educational	0.647	0.572	0.572
Social services	0.551	0.572	0.572

Notes: Skill intensity in column (1) is calculated from CPS data 1994-1997 as the share of workers in the industry with a college-level qualification. Skill intensity in column (2) is calculated using the 1997 industry-by-industry Input-Output table. Skill intensity in column (3) is calculated using the Input-Output tables weighted for import penetration. See the text for more details.

Table 3: US data - OLS Regression of Estimated Education and Income Elasticities on Various Measures of Skill Intensity

	Dependent variable			
	education elasticity	income elasticity	90th perc. income elast.	10th perc. income elast.
	PANEL A			
skill intensity 1980	-0.522	-0.403	-0.636	-0.361
	[0.502]	[0.238]*	[0.198]***	[0.355]
skill intensity 1980 sq.	1.049	0.581	0.891	0.557
	[0.639]	[0.303]*	[0.252]***	[0.452]
Constant	0.037	1.039	1.089	1.014
	[0.089]	[0.042]***	[0.035]***	[0.063]***
R-squared	0.22	0.12	0.29	0.06
	PANEL B			
adjusted skill int. (interm. goods)	-1.592	-0.713	-1.409	-0.280
	[1.354]	[0.667]	[0.582]**	[0.988]
adjusted skill int. (interm. goods) sq.	2.708	1.096	1.946	0.661
	[1.724]	[0.848]	[0.741]**	[1.257]
Constant	0.198	1.089	1.235	0.978
	[0.256]	[0.126]***	[0.110]***	[0.187]***
R-squared	0.24	0.11	0.19	0.10
	PANEL C			
adjusted skill int. (imported goods)	-1.096	-0.542	-0.808	-0.488
	[0.761]	[0.375]	[0.334]**	[0.559]
adjusted skill int. (imported goods) sq.	2.159	0.932	1.254	0.963
	[1.050]**	[0.518]*	[0.460]***	[0.771]
Constant	0.096	1.049	1.111	1.013
	[0.132]	[0.065]***	[0.058]***	[0.097]***
R-squared	0.27	0.14	0.20	0.12

Notes: N=40. All regressions are weighted by the inverse of the dependent variable variance. Skill intensity in Panel A is the proportion of college graduates in total industry employment, in Panel B is adjusted using Input-Output tables and in Panel C is adjusted using Input-Output tables and industry import penetration.

Table 4: Robustness Test: US data - Income Elasticities calculated on various samples regression on Skill Intensity

	elasticities in year 2000		sample of head of h. age 18-60		elasticities calculated wrt. log househ. income	
	income elasticity	90th perc. income elast.	income elasticity	90th perc. income elast.	income elasticity	90th perc. income elast
skill intensity 1980	-0.519	-0.600	-0.448	-0.631	-0.117	-0.424
	[0.290]*	[0.268]**	[0.255]*	[0.237]**	[0.100]	[0.149]***
skill intensity 1980 sq.	0.828	0.942	0.741	1.018	0.186	0.640
	[0.432]*	[0.399]**	[0.370]*	[0.344]***	[0.149]	[0.221]***
Constant	1.046	1.070	1.034	1.072	1.007	1.049
	[0.041]***	[0.038]***	[0.037]***	[0.035]***	[0.015]***	[0.022]***
R-squared	0.11	0.16	0.14	0.25	0.05	0.21

Notes: N=40. All regressions are weighted by the inverse of the dependent variable variance.

Table 5: UK data - OLS Regression of Estimated Education and Income Elasticities on Various Measures of Skill Intensity

	Dependent Variable			
	education elasticity	income elasticity	90th perc. income elast.	10th perc. income elast.
	PANEL A			
skill intensity 1980	-0.164	-0.324	-0.690	-0.218
	[0.111]	[0.139]**	[0.345]*	[0.238]
skill intensity 1980 sq.	0.797	1.019	1.952	0.712
	[0.287]***	[0.509]**	[0.892]**	[0.616]
Constant	0.003	1.018	1.040	1.011
	[0.009]	[0.018]***	[0.026]***	[0.018]***
R-squared	0.23	0.06	0.10	0.03
	PANEL B			
adjusted skill int. (interm. goods)	-0.388	0.695	0.712	0.520
	[0.617]	[1.223]	[1.811]	[1.195]
adjusted skill int. (interm. goods) sq.	1.807	-1.994	-2.301	-1.153
	[2.167]	[4.294]	[6.357]	[4.194]
Constant	0.016	0.948	0.953	0.953
	[0.041]	[0.082]***	[0.122]***	[0.080]***
R-squared	0.04	0.01	0.00	0.02
	PANEL C			
adjusted skill int. (imported goods)	0.059	0.831	0.969	0.214
	[0.500]	[0.954]	[1.426]	[0.919]
adjusted skill int. (imported goods) sq.	-0.227	-2.022	-2.713	0.373
	[1.628]	[3.109]	[4.648]	[2.994]
Constant	-0.003	0.928	0.925	0.960
	[0.036]	[0.069]***	[0.103]***	[0.066]***
R-squared	0.00	0.04	0.02	0.08

Notes: N=46. All regressions are weighted by the inverse of the dependent variable variance. Skill intensity in Panel A is the proportion of college graduates in total industry employment, in Panel B is adjusted using Input-Output tables and in Panel C is adjusted using Input-Output tables and industry import penetration.

Table 6: Robustness Test: UK data - Income Elasticities calculated on various samples regression on Skill Intensity

	elasticities in year 1988		sample of head of h. age 18-60		elasticities calculated wrt. log househ. income	
	income elasticity	90th perc. income elast.	income elasticity	90th perc. income elast.	income elasticity	90th perc. income elast.
skill intensity 1980	-0.226	-0.631	-0.366	-0.631	-0.334	-0.534
	[0.222]	[0.187]***	[0.185]*	[0.184]***	[0.152]**	[0.147]***
skill intensity1980 sq.	1.193	2.092	1.162	2.112	0.929	1.879
	[0.725]	[0.611]***	[0.548]**	[0.546]***	[0.434]**	[0.421]***
Constant	1.006	1.011	1.027	1.017	1.027	1.030
	[0.015]***	[0.012]***	[0.012]***	[0.012]***	[0.009]***	[0.009]***
R-squared	0.11	0.23	0.10	0.28	0.11	0.33

Notes: N=46. All regressions are weighted by the inverse of the dependent variable variance.

Table 7: Parameters of the model

λ_H	λ_L	a_1	a_2	$\frac{H}{L}$	ε_{hm}^h	ε_{hm}^l	ε_{hp}^h	ε_{hp}^l	ε_{hp}	R_1	σ
US CPS					US CEX						
2.21	0.6	0.65	0.37	0.57	0.89	0.83	-0.22	-2.33	-0.53	0.66	1.4
UK LFS					UK FES						
6.73	0.74	0.42	0.07	0.28	0.91	1.08	-0.61	-1.39	-0.59	0.15	1.4

Notes: λ_H, λ_L, a_1, a_2 and $\frac{H}{L}$ are estimated using CPS and LFS 1994 to 1997. ε_{hp}^h, ε_{hp}^l, ε_{hm}^h, ε_{hm}^l, R_1 are estimated using CEX and FES 1994 to 1997. σ is from Katz and Murphy (1992)

Table 8: Quantification of the income effects

	(a) model with income effect	(b) model without income effect	(c) difference (a)-(b)	(d) demand shift $\frac{w_h}{w_l}$	(e) contribution income effect (c)/(d)
US CEX					
Implied $\frac{d\log w_h}{d\log H}$	-0.67	-0.53			
Percentage terms	-54%	-59%	5%	70%	7%
UK FES					
Implied $\frac{d\log w_h}{d\log H}$	-0.74	-0.80			
Percentage terms	-65%	-70%	5%	83%	6%

Notes: Implied $\frac{d\log w_h}{d\log H}$ are obtained parametrizing equation 3 in column (a) and equation 8 in column (b). Percentage terms in column (a) and (b) are obtained multiplying the implied $\frac{d\log w_h}{d\log H}$ by the actual increase between 1984-2002 in $\frac{H}{L}$ in the US=81% and in the UK=88%. Percentage terms in column (d) is obtained summing the implied decrease of $\frac{w_h}{w_l}$ along the relative demand curve of the counterfactual model, i.e. the number in column (b), to the actual increase between 1984-2002 in $\frac{w_h}{w_l}$ in the US=11% and in the UK=13%.

Table 1: APPENDIX. US data - The Consumption Item-Industry Match

CEX consumption item	CPS Industry name	Sic 70	Sic 80
Food Off-Premise	Food and kindred products	268-298	100-122
Food On-Premise	Eating and drinking places	669	641
Tobacco Products	Tobacco manufactures	299	130
Alcohol Off-Premise	Beverage industries	289	120
Alcohol On-Premise	Eating and drinking places	669	641
Clothing and Shoes	Apparel and finished textile prod.	319-327	151-152
Clothing Services	Repair Services	749-759	751-760
Jewelry and Watches	Watches, clocks, clockwork devices	249	381
Barbershops, Beauty Parlors etc.	Personal Serv., Except Private Housh.	777-798	762-791
Nondurable Household Supplies	Soaps and cosmetics	358	182
Electricity	Electric light and power	467	460
Gas	Gas and steam supply systems	469	461
Water and Other Sanitary Services	Water supply	477	470
Fuel Oil and Coal	Petroleum products	558	200-201
Telephone and Telegraph	Communications	447-449	440-442
Domestic Service, Other Househ. Op.	Private Household Services	769	761
Drug Preparations	Drugs and medicines	357	541
Ophthalmic Products	Optical and health services supplies	247	372
Physicians, Dentists, Medical Profess.	Health Services , Except Hospitals	828-837, 839-848	812-830, 832-840
Hospitals	Hospitals	838	831
Nursing Homes	Convalescent institutions	839	832
Health Insurance	Insurance and Real Estate	717-718	711-712
Business Services	Business Services	727-748	721-750
Expense of Handling Life Insurance	Insurance and Real Estate	717-718	711-712
Tires, Tubes, Accessories and Parts	Motor vehicles, motor vehicle equip.	219	351
Repair, Greasing, Parking etc.	Repair Services	749-759	751-760

Table 1: APPENDIX. continued

Gasoline and Oil	Petroleum products	558	200-201
Bridge, Tunnel, Ferry, and Road Tolls	Street railways and bus lines	408	401
Auto Insurance	Insurance and Real Estate	717-718	711-712
Mass Transit Systems	Street railways and bus lines	408	401
Taxicab, Railway, Bus, and Travel Exp.	Railroads and railway express serv.	407	400
Airline Fares	Air transportation	427	421
Books and Maps	Printing, publishing	339	171
Magazines, Newspapers, Toys, etc.	Newspaper publishing and printing	338	172
Recreation and Sports Equipment	Professional and photo equipment	239-257	371-382
Other Recreation Services	Entertainment and Recreation Serv.	807-809	800-810
Higher education	College and university	858	850
Nursery, Elementary, and Sec. Education	Elementary and sec. schools	857	842
Other Education Services	Other educational Services	867	860
Religious and Welfare Activities	Social Services	877-879	861-871

Table 2: APPENDIX. UK data - The Consumption Item-Industry Match

FES consumption Item	SIC 1992 code	LFS industry name
Food		
Bread and biscuit	15.81+15.82	Bread and biscuit manufacture
Meat	15.1	Meat production
Fish	15.2	Fish processing
Edible oils and fats	15.4	Oils and fats manufacture
Milk products	15.5	Dairy products
Soft drinks	15.98	Soft drinks production
Sugar and sweets	15.83+15.84	Sugar and sweets manufacture
Fruit and vegetables	15.3	Fruit and vegetables
Food eaten out	55	Restaurants and take-away
Alcohol		
Beer	15.96+15.97	Beer production
Wine	15.93	Wine production
Spirits	15.91+15.92	Alcoholic drinks distilling
Tobacco	16	Tobacco products
Home energy		
Electricity bill	40.10	Electricity generation
Gas bill	40.2	Gas production supply
Household goods		
Furniture	36.1	Wood furniture
Home furnishings	36.15	Soft furnishings manufacture
Domestic electrical appliances	29.71	Domestic electrical appliances manufacture
Other domestic appliances	29.72	Domestic non electrical appliances manufacture
Household consumables	24.1+24.2	Pesticides and detergents manufacture
Household services		
Postage	64.1	Post services
Phone bill	64.2	Telecommunications
Domestic help	93.05	Domestic service activities
Repairs	52.7	Repairs to personal and household goods

Table 2: APPENDIX. continued

FES consumption Item	SIC 1992 code	LFS industry name
Clothing		
Men's and women's clothing	17+18	Textile manufacturing
Footwear	19.3	Footwear
Private transport		
Petrol	23.2	Mineral oil refining
Motor vehicle maintenance	50.2+50.4	Maintenance and repair of vehicles
Fares		
Bus fares	60.2	Road passenger transport
Rail fares	60.1	Transport via railways
Other fares	62.1+62.2	Air transport
Personal goods and services		
Personal articles	19.1+19.2,36.2+36.3	Luggage, jewelry and musical instr.
Soap and toiletries	24.5	Soap and toilet preparations
Drugs	24.4	Pharmaceuticals
Hairdressing	93.02	Hairdressing
Leisure goods		
Records	22.3	Reproduction of recorded media
Books	22.1+22.2	Printing and publishing
Toys	36.5	Toys production
Domestic electronic appliances	32	Electronic equipment manufacture
Leisure and other services		
Holidays in UK	55.1+55.2	Hotels and provision of lodgings
Entertainment	92.1 to 92.7	Recreational activities
Subscriptions to organizations	91.1 to 91.3	Membership organizations
Professional services fees	74.1 to 74.8	Professional services
Bank charges	65.1+65.2	Financial intermediation
Health expenditure	85.1	Human health activities
Education expenditure	80	Education

Table 3: APPENDIX. UK FES 1994-1997 Estimates of Education and Income Elasticities.

FES consumption item	education elasticity	std. err.	income elasticity	std. err.	mean share
Hairdressing	0.005	0.011	1.047	0.276	0.012
Footwear	-0.003	0.010	1.058	0.139	0.017
House furnishing	-0.015	0.018	1.080	0.412	0.012
Domestic help	0.035	0.016	1.043	0.370	0.011
Maintenance	0.031	0.009	1.045	0.109	0.020
Meat	-0.016	0.003	0.946	0.077	0.076
Fish	0.015	0.006	0.958	0.227	0.011
Food eaten out	0.003	0.003	1.032	0.013	0.059
Bus fares	0.039	0.012	0.950	0.380	0.013
Postage	0.041	0.015	0.962	0.755	0.004
Furniture	-0.038	0.032	1.127	0.665	0.011
Men's and women's clothing	-0.017	0.005	1.075	0.008	0.064
Bread and biscuits	-0.001	0.002	0.943	0.076	0.041
Holidays	-0.026	0.015	1.110	1.977	0.023
Domestic electrical appliances	-0.015	0.016	1.052	0.302	0.012
Domestic non electrical appliances	0.029	0.009	1.044	0.151	0.013
Repairs	0.092	0.034	1.027	2.018	0.005
Soft drinks	0.004	0.003	0.955	0.095	0.021
Tobacco	-0.046	0.007	0.912	0.220	0.045
Milk products	0.004	0.003	0.935	0.090	0.037
Fruit and vegetables	0.016	0.003	0.954	0.071	0.047
Sugar and sweets	-0.002	0.005	0.959	0.158	0.014
Personal articles	0.005	0.015	1.087	0.375	0.009
Rail fares	0.130	0.019	1.057	0.574	0.005
Edible oils and fats	-0.001	0.005	0.928	0.243	0.008
Beer	-0.039	0.006	0.994	0.096	0.039
Toys	-0.004	0.014	1.049	0.319	0.006
Soap and toiletries	-0.009	0.005	1.018	0.080	0.016
Books	0.022	0.004	0.981	0.087	0.038
Domestic electronic appliances	-0.005	0.022	1.070	0.534	0.007
Gas bill	0.000	0.004	0.921	0.144	0.042
Phone bill	0.018	0.004	0.936	0.111	0.034
Electricity bill	-0.003	0.004	0.907	0.137	0.055
Wine	0.060	0.008	1.047	0.161	0.010

Table 3: APPENDIX. continued

FES consumption item	education elasticity	std. err.	income elasticity	std. err.	mean share
Bank charges	0.016	0.027	1.044	1.626	0.001
Other fares	0.007	0.055	1.093	1.002	0.001
Health expenditure	0.002	0.018	1.105	0.646	0.005
Spirits	-0.003	0.012	1.047	0.333	0.010
Entertainment	-0.028	0.005	1.013	0.065	0.025
Household consumables	0.013	0.006	1.010	0.095	0.018
Records	0.014	0.010	1.049	0.250	0.006
Petrol	-0.001	0.004	1.013	0.037	0.054
Subscriptions to organizations	0.104	0.012	1.004	0.504	0.003
Professional services fees	-0.014	0.050	1.069	5.930	0.001
Drugs	0.021	0.010	0.980	0.441	0.008
Education	0.127	0.020	1.099	0.549	0.007

Notes: The 46 goods are ordered according to their skill intensity. The standard errors are calculated with the Delta method. The mean share is the average expenditure share in the FES 1994-1997.

Table 4: APPENDIX. UK LFS 1994-1997 Industry Skill Intensity

LFS Industry	(1) skill intensity	(2) adj. skill intensity interm. goods	(3) adj. skill intensity import penetration
Hairdressing	0.010	0.188	0.170
Footwear	0.019	0.123	0.172
Soft furnishing manufacturing	0.020	0.086	0.081
Domestic help	0.022	0.188	0.170
Maintenance of motor vehicles	0.023	0.126	0.119
Meat production	0.025	0.062	0.065
Fish processing	0.029	0.084	0.084
Restaurants and take-away	0.031	0.135	0.154
Road passenger transport	0.032	0.142	0.141
Post services	0.035	0.169	0.165
Wood furniture	0.042	0.086	0.081
Textile manufacturing	0.043	0.105	0.124
Bread and biscuits manufacturing	0.044	0.107	0.104
Hotels and lodgings	0.047	0.135	0.154
Domestic electrical appliances manuf	0.050	0.121	0.134
Domestic non electrical appliances manuf	0.051	0.121	0.134
Repairs of personal and household goods	0.053	0.151	0.147
Soft drinks production	0.064	0.117	0.113
Tobacco production	0.071	0.140	0.199
Dairy products	0.072	0.075	0.073
Fruit and vegetables	0.082	0.084	0.084
Sugar and sweets	0.084	0.092	0.097
Luggage, jewelry and musical instruments	0.092	0.091	0.164
Railways	0.092	0.105	0.106
Oils and fats manufacture	0.100	0.075	0.070
Beer production	0.113	0.124	0.173
Toys production	0.119	0.120	0.175
Soap and toiletries	0.133	0.144	0.182
Printing and publishing	0.139	0.134	0.133
Domestic electronic appliances	0.143	0.127	0.180
Gas supply	0.147	0.196	0.174
Telecommunications	0.156	0.161	0.159
Electricity generation	0.159	0.150	0.144
Wine production	0.166	0.124	0.173

Table 4: APPENDIX. continued

LFS Industry	(1) skill intensity	(2) adj. skill intensity interm. goods	(3) adj. skill intensity import penetration
Financial intermediation	0.167	0.189	0.197
Air transport	0.168	0.194	0.232
Human health activities	0.175	0.184	0.177
Alcoholic drinks distilling	0.189	0.124	0.173
Entertainment	0.202	0.202	0.206
Pesticides and detergents	0.206	0.149	0.150
Reproduction of recorded media	0.235	0.134	0.133
Mineral oil refining	0.238	0.207	0.235
Membership organisations	0.267	0.213	0.190
Professional services	0.294	0.228	0.230
Pharmaceuticals	0.301	0.195	0.289
Education	0.538	0.232	0.233

Notes: Skill intensity in column (1) is calculated from LFS data 1994-1997 as the share of workers in the industry with a degree-level qualification. Skill intensity in column (2) is calculated using the 1997 industry-by-industry Input-Output table. Skill intensity in column (3) is calculated using the Input-Output tables weighted for import penetration. See the text for more details.

Table 5: APPENDIX. The CPS Industry and Input-Output table Match

Sic 80	CPS Industry name	IO code	IO industry code
100-122	Food and kindred products	3110	Food manufacturing
641	Eating and drinking places	7220	Food services and drinking places
130	Tobacco manufactures	3122	Tobacco manufacturing
120	beverage industries	3121	Beverage manufacturing
641	Eating and drinking places	7130	Amusements and recreation
151-152	Apparel and other finished textile prod.	3150	Apparel manufacturing
751-760	Repair Services	812900	Other personal services
381	Watches, clocks, and devices	339910	Jewelry and silverware manuf
762-791	Personal Serv., Except Private Hous	812100	Personal care services
182	Soaps and cosmetics	3256	Soap, toiletry manuf
460	Electric light and power	2211	Power generation and supply
461	Gas and steam supply systems	2212	Natural gas distribution
470	Water supply	2213	Water, sewage and other systems
200-201	Petroleum products	3240	Petroleum and coal products manuf
440-442	Communications	5133	Telecommunications
761	Private Household Services	8120	Personal and laundry services
541	Drugs and medicines	3254	Pharmaceutical and medicine manuf
372	Optical and health services supplies	3391	Medical equip. and supplies manuf
812-830, 832-840	Health Services , Except Hospitals	6210	Ambulatory health care services
831	Hospitals	6220	Hospitals
832	Convalescent institutions	6230	Nursing and residential care facilities
711-712	Insurance and Real Estate	5240	Insurance and related activities
721-750	Business Services	5411-5419	Prof. and technical serv.
711-712	Insurance and Real Estate	5240	Insurance and related activities
351	Motor vehicles, motor vehicle equip.	336300	Motor vehicle parts manufacturing
751-760	Repair Services	8111	Automotive repair and maintenance

Table 5: APPENDIX. continued

200-201	Petroleum products	2110	Oil and gas extraction
401	Street railways and bus lines	4850	Transit and ground passenger transp.
711-712	Insurance and Real Estate	5240	Insurance carriers and related activities
401	Street railways and bus lines	4850	Transit and ground passenger transp.
400	Railroads and railway express serv.	4820	Rail transportation
421	Air transportation	4810	Air transportation
171	Printing, publishing	5111	Newspaper, book, and directory publishe
172	Newspaper publishing and printing	511120	Periodical publishers
371-382	Professional and photographic equip.	339920	Sporting and athletic goods manufacturi
800-810	Entertainment and Recreation Serv.	71A0+7130	arts entert. and recreation
850	College and university	611A00	Colleges, universities, and junior colleges
842	Elementary and secondary schools	611100	Elementary and secondary schools
860	Educational Services	611B00	Other educational services
861-871	Social Services	813A	Religious, social advocacy organizations

Table 6: APPENDIX. US CEX 1994-1997 data - Income and Price Elasticities of low-skill intensive and high-skill intensive items: System Estimates.

	system (1) non-college educated heads		system (2) college educated heads	
	expenditure share 20 low-skill items	expenditure share 20 high-skill items	expenditure share 20 low-skill items	expenditure share 20 high-skill items
age of head	-0.013	0.005	-0.007	0.002
	[0.001]***	[0.001]***	[0.000]***	[0.001]***
sex of head	-0.039	-0.074	0.012	-0.034
	[0.017]**	[0.016]***	[0.013]	[0.013]***
number children	0.109	-0.028	0.024	0.003
	[0.008]***	[0.007]***	[0.006]***	[0.005]
log total exp.	-0.059	-0.034	-0.041	-0.028
	[0.004]***	[0.004]***	[0.004]***	[0.003]***
log total exp. sq.	0.003	0.002	0.002	0.001
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
log price index	-0.022	0.022	-0.026	0.026
low skill goods	[0.003]***	[0.002]***	[0.002]***	[0.002]***
log price index	-0.019	0.019	-0.015	0.015
high skill goods	[0.005]***	[0.004]***	[0.002]***	[0.003]***
Constant	0.397	0.156	0.311	0.141
	[0.019]***	[0.021]***	[0.019]***	[0.019]***
Observations	196458		249958	
R-squared	0.59	0.23	0.54	0.19

Notes: The 20 high-skill-intensive items are defined according to the first column of Table 2. The price index of high- and low-skill-intensive goods is defined as $\log p_{h,lt} = \sum_{j=1}^{20} w_{jt} \log p_{jt}$ where $\log p_{jt}$ are the individual commodity price series of the 20 high- or low-skill-intensive goods and w_{jt} their monthly shares in total expenditure. Fixed effect for each item included. System estimation implies constraints on the coefficients such that $\varepsilon_{hm} = 1 - \varepsilon_{lm}$ and (price symmetry) $\theta_{h1} = -\theta_{l1}$ and $\theta_{h2} = -\theta_{l2}$ in each system. See the text for details.

Table 7: APPENDIX. UK FES 1994-1997 data - Income and Price Elasticities of low-skill intensive and high-skill intensive goods: System Estimates.

	system (1) non-college educated heads		system (2) college educated heads	
	expenditure share 23 low-skill items	expenditure share 23 high-skill items	expenditure share 23 low-skill items	expenditure share 23 high-skill items
age of head	0.004	-0.004	0.002	-0.002
	[0.000]***	[0.000]***	[0.001]**	[0.001]**
sex of head	0.157	-0.163	0.082	-0.082
	[0.010]***	[0.010]***	[0.032]***	[0.031]***
number children	0.067	-0.066	0.048	-0.048
	[0.004]***	[0.004]***	[0.010]***	[0.010]***
log total exp	0.002	-0.002	0.002	-0.002
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
log total exp. sq.	0.000	-0.000	-0.000	0.000
	[0.000]**	[0.000]	[0.000]	[0.000]
log price index	-0.008	0.008	-0.008	0.008
low-skill goods	[0.001]***	[0.001]***	[0.003]***	[0.002]***
log price index	-0.006	0.006	-0.008	0.008
high skill goods	[0.002]***	[0.001]***	[0.003]***	[0.002]***
Constant	0.023	0.020	0.024	0.017
	[0.000]***	[0.000]***	[0.001]***	[0.001]***
Observations	690995		81569	
R-squared	0.14	0.19	0.13	0.12

Notes: The 23 high-skill-intensive items are defined according to the first column of Table 4. The price index of high-skill-intensive goods is defined as $\log p_{h,lt} = \sum_{j=1}^{23} w_{jt} \log p_{jt}$ where $\log p_{jt}$ are the individual commodity price series of the 23 high- or low-skill-intensive goods and w_{jt} their monthly shares in total expenditure. Fixed effect for each item included. System estimation implies constraints on the coefficients such that $\varepsilon_{hm} = 1 - \varepsilon_{lm}$ and (price symmetry) $\theta_{h1} = -\theta_{l1}$ and $\theta_{h2} = -\theta_{l2}$ in each system. See the text for details.