

The Effect of Product Demand on Inequality: Evidence from the United States and the United Kingdom[†]

By MARCO LEONARDI*

Using Consumer Expenditure Survey data this paper shows that more educated workers demand more high-skill-intensive services and, to a lesser extent, more very low-skill-intensive services (such as personal services). Additional evidence at the Metropolitan Statistical Area (MSA) level shows that this “education elasticity of demand” mechanism can explain part of the correlation between the share of college-educated workers in a city and the employment share of service industries. The parametrization of a simple model suggests that this induced demand shift can explain around 6.5 percent of the relative demand shift in the United States between 1984 and 2002. Similar results are provided for the United Kingdom. (JEL D12, J24, J31, L84)

There is still some disagreement about the causes of the increase in wage inequality and in the college premium in the United States and in the United Kingdom. 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, but none of these explanations seems to be exhaustive (Card and DiNardo 2002; Acemoglu 2002).

The recent literature on wage inequality has highlighted the phenomenon of “wage polarization.”¹ Together with a novel view of labor demand shifts, the literature on polarization has sparked a new debate on product demand shifts. On the one hand, models of unbalanced productivity growth generate second-round product demand effects—driven by changes in relative prices that depend on the elasticity of substitution between goods in consumption (Autor and Dorn 2013; Goos, Manning, and Salomons 2014). On the other hand, other models predict changes in relative product demand because preferences are nonhomothetic or because educated workers substitute domestic chores for market-provided household services

*University of Milan and IZA, via Conservatorio 7, 20122 Milan, Italy, (e-mail: marco.leonardi@unimi.it). I would like to thank Daron Acemoglu, David Autor, Tito Boeri, Steve Machin, Enrico Moretti, and all the participants to seminars at MIT, UC Berkeley, IZA, Humboldt Berlin, Luiss Rome, SOFI Stockholm University, the IAB-BIBB TASKS conference in Bonn and the ESSLE-CEPR conference at Ammersee. This paper is a substantial extension of a working paper that first appeared in 2003 (Leonardi 2003). Part of this paper was written while I was visiting UC Berkeley, whose hospitality is gratefully acknowledged. All remaining errors are mine.

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¹See Acemoglu and Autor (2011) for a review. This literature has looked at many countries: Autor, Katz and Kearney (2006, 2008) and Autor and Dorn (2013) for the United States; Goos and Manning (2007) for the United Kingdom; Spitz-Oener (2006) and Dustmann, Ludsteck, and Schönberg (2009) for Germany; Goos, Manning, and Salomons (2009), Michaels, Natraj, and Van Reenen (2014) for Europe.

when income inequality rises (Manning 2004; Mazzolari and Ragusa 2013). There is, however, disagreement about the relative importance of these product demand effects in explaining changes in labor demand. Autor and Dorn (2013) and Goos, Manning, and Salomons (2014) look at employment shares in service occupations and find a limited impact of changes in product demand shifts, whereas Mazzolari and Ragusa (2013) argue that these effects are substantial.

This paper sheds some light on this discussion and assesses a mechanism that may explain part of the increase of wage inequality. If individuals with relatively higher education prefer to consume goods and services for which production is relatively skill intensive, then an increase in the relative supply of skilled labor can shift demand for final products and raise the relative demand for skills measured as the college premium. I refer to this mechanism as the “education elasticity of demand.”² The time-series evidence is consistent with this hypothesis. Consumer Expenditure Survey data (shown in Table A1 in the online Appendix) show that the share of heads of households with some college education went from 27.5 percent to 62 percent from 1972 through 2012. At the same time the share of total expenditure in the most skill-intensive services (defined as the sum of health services, education and personal insurance) rose from 14.4 percent in 1972 to 20.1 percent in 2012, while the combined share of expenditure on food and apparel (two low-skill-intensive products) declined from 26.1 percent in 1972 to 17.7 percent in 2012.

The main idea is presented in a static general equilibrium model with two skill levels, two sectors producing two aggregate final goods (the high-skill-intensive and the low-skill-intensive), and nonhomothetic preferences. The model relates the college premium to education elasticities of demand and assesses the importance of this mechanism on the basis of the estimates produced in the empirical part of the paper.

In the empirical part, I present two pieces of evidence for the “education elasticity of demand” mechanism: one at the economy-wide level and the second at the Metropolitan Statistical Area (MSA) level. Firstly, to translate the consumption patterns into changes in the skill composition of employment and into skilled-unskilled relative wages, I combine micro data on consumption of 38 nondurable consumption goods and services from the Consumer Expenditure Survey (CEX) with data on industry skill composition from the Current Population Survey (CPS). The estimated education and income elasticities of each consumption item are then related to the skill intensity of the industries that manufacture the final consumption good or provide the final consumption service. The results indicate that, on average, educated consumers tend to favor skill-intensive goods and services: education, health, and professional services have very large education and income elasticities. There is also the phenomenon of “consumption polarization,” i.e., very low-skill-intensive services like food preparation, cleaning, repair services also have large elasticities (although to a lesser extent than high-skill-intensive services) and give rise to a J-shaped relation between estimated elasticities and industry skill intensities. This

²The focus of this paper is on education elasticities, however, as a complementary mechanism, income elasticities of demand may also favor skill-intensive products. For this reason I will often refer to nonhomothetic preferences. There is a long-standing macro literature on structural change due to nonhomothetic preferences that focuses on income effects but ignores different consumption preferences across education groups (Clark 1957; Ngai and Pissarides 2007; Buera and Kaboski 2012).

J-shape remains significant when Input-Output tables are used to account for the skill intensity of intermediate inputs. Furthermore, and suggesting the general validity of this mechanism, I show some evidence in the same direction for the United Kingdom using Family Expenditure Survey (FES) consumption data matched with Labor Force Survey (LFS) data.

The second piece of evidence tests the implications of the theoretical model for industry employment shares using variation across MSAs and over time in US Census data. The J-shaped relation between elasticities and skill intensities implies a positive product demand effect for both high-skill-intensive and very low-skill-intensive industry shares. Therefore an exogenous increase in one MSA's skill supply (measured as the skill ratio H/L) should raise the employment share of high-skill-intensive nontradable industries with high education elasticities both through a supply and a product demand effect. While the effect of demand can be detected at the MSA level only for *nontradables* which have a local demand, the change in H/L at the MSA level is instrumented using changes in H/L in *tradable* industries at the national level projected on the MSA's industrial composition in 1980. Consistent with the model predictions, I find a positive correlation between employment share growth and education elasticities in nontradable skill-intensive industries where both the product demand effect and the supply effect are positive. In contrast the correlation, for the nontradable low-skill-intensive industries, is ambiguous because the supply effect is negative.

Finally, to establish the quantitative importance of income and education elasticities in accounting for the rise of the nationwide college premium, I parametrize the static general equilibrium model using the estimates of the relevant elasticities and of labor market aggregates of the economies of the United States and the United Kingdom. The results indicate that this consumption mechanism can explain about 6.5 percent of the total shift in relative labor demand in the United States and a similar proportion of the total shift in the United Kingdom. These results indicate that product demand shifts are not large (although they are relevant) in agreement with by Autor and Dorn (2013) and Goos, Manning, and Salomons (2014).

This paper contributes to the debate on the importance of demand shifts in the wage polarization literature, by matching data on consumption with data on industry skill intensity. The only previous paper that looks explicitly at changes in product demand using consumption data is Mazzolari and Ragusa (2013), but it is limited to the consumption of low-skill-intensive services and does not focus on education elasticities.

The second novel contribution consists in the investigation of the extent to which exogenous changes in the composition of skills at the MSA-level feedback into higher employment shares of nontradable industries through the "education elasticity" channel. This empirical evidence at the MSA level is related to the literature on local multipliers (Moretti 2010). According to this literature an exogenous increase in the number of jobs in the tradable sector in a city results in an increase in local labor demand in the service sector. This paper adds an explicit account of education elasticities to the argument that positive demand shocks in the tradable sector have large multiplier effects on the nontradable sector: I show that the effect of a shock is larger in nontradable sectors that provide services with a high education elasticity of consumption.

This paper is also related to the early literature on inequality because product demand shifts due to consumption preferences are part of between-sector shifts. That literature (Katz and Murphy 1992; Berman, Bound, and Griliches 1994; Berman, Bound, and Machin 1998) found that a large part of skill-upgrading and of the increase in wage inequality occurred mainly within sectors rather than between sectors, but never explicitly investigated the role of product demand shifts. In this paper I attempt to estimate the contribution of this mechanism to the overall increase in the college premium in the United States and the United Kingdom.

The plan of the paper is as follows. In Section I, I present the basic model whose details are in Appendix A at the end of the paper. The evidence for the relation between elasticities and skill intensities is described in Section II, while Section III looks at the evidence based on industry employment shares within cities (MSAs). Both these sections are divided in subsections which describe the data, the empirical strategy, and the results. In Section IV, I quantify the contribution of education and income elasticities to explaining the shift in relative labor demand. The interpretation of the results and the conclusions are in Section V. An online Appendix collects the details about the sample selection and the tables of descriptive statistics of the many datasets used.

I. The Model

This model is meant as a guide for the empirical part of the paper and provides a framework for qualifying the importance of the income and education elasticities of product demand (see Section IV). It is a static general equilibrium model with two commodities Y_1 and Y_2 and workers/consumers of two education levels (H skilled workers/consumers with a college degree and L unskilled workers/consumers without a college degree). Consumers' preferences vary across education groups and are non-homothetic in income. In this Section, I outline the main assumptions and describe the main predictions of the model. I refer to Appendix A at the end of the paper for all the equations and the details.

The demand functions for the two commodities have a generic form:

$$(1) \quad p_1 Y_1 = H y_1^h \left(\frac{p_1}{p_2}, w_h \right) + L y_1^l \left(\frac{p_1}{p_2}, w_l \right)$$

$$(2) \quad Y_2 = H y_2^h \left(\frac{p_1}{p_2}, w_h \right) + L y_2^l \left(\frac{p_1}{p_2}, w_l \right),$$

where $\frac{p_1}{p_2}$ is the relative price of the 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_1 as the sum of the demand by the H skilled workers and by the L unskilled workers. Equation (2) has the same interpretation for the low-skill-intensive commodity Y_2 and p_2 is normalized to one.

In this model there is a role for education elasticities because the *per capita* demand functions for both high-skill and low-skill-intensive commodities $y_1^i(\cdot)$ and $y_2^i(\cdot)$ are assumed to depend on education $i = h, l$. The hypothesis of the model (to be verified in the data) is that college-educated workers have different consumption

preferences and may spend more on specific types of goods and services, such as the education of their own children, health services, professional goods and services, books, and newspapers. Skilled and unskilled workers are also allowed to have different income elasticities (preferences are non-homothetic and income elasticities may differ from unit value).

Using the equations above, and market clearing, the elasticity of the skill premium with respect to the skill ratio can be written as:³

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

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

$R_1 = \frac{Hy_1^h(\cdot)}{Hy_1^h(\cdot) + Ly_1^l(\cdot)}$ is the share of total expenditure that skilled workers spend on the high-skill-intensive commodity, ε_{1m}^i is the income elasticity of demand for the high-skill-intensive commodity, and the index $i = h, l$ indicates that the elasticity is different for skilled and unskilled consumers.⁴ a_1, a_2 are the wage bill shares of skilled labor in the two sectors, λ_H and λ_L are the ratios of skilled and unskilled labor and σ is the elasticity of substitution (see Appendix A for details).

The model has two main predictions which I will test in the following empirical sections:

- The main prediction of the model relates education and income elasticities to the change in the skill premium. The effect of education elasticities contributes to increase the skill premium through the term R_1 . An increase in $\frac{H}{L}$ tends to increase wage inequality if skilled workers demand more of the high-skill-intensive commodity than unskilled workers, i.e., $y_1^h(\cdot) > y_1^l(\cdot)$.⁵ The traditional income elasticity is distinct from the education elasticity and works within education groups. Income elasticities (which are typically positive) contribute to explain the rise of the skill premium by reducing the denominator of equation (3). If richer workers within both education groups tend to consume more of the skill-intensive commodity (i.e., ε_{1m}^h and $\varepsilon_{1m}^l > 1$ for both skilled and unskilled workers), then an increase in the average level of income (both w_l and w_h) will also shift out the relative demand of the skill-intensive commodity and increase the college premium.

³Notice that this model improves on Katz and Murphy's (1992) key equation $\log \frac{w_h}{w_l} = \alpha + \beta t + \gamma \log \frac{H}{L}$ adding the effect of elasticities. Unlike Acemoglu and Autor (2011), who explain wage polarization with three skill levels and task-replacing technological progress, the model in this paper cannot explain polarization. I use a model with two skill levels because a model with three skill levels would imply estimating consumption elasticities of workers with a midlevel of education, which are insignificantly different from other education groups' elasticities.

⁴Due to normalization, elasticities are in relative terms with respect to commodity 2. The equation depends also from ε_{1p}^i , however in this paper I consider education as the driving force of consumption preferences and I view prices as endogenous, therefore price elasticities will not be estimated in the benchmark specification in the empirical part. Other papers focus on price effects on wage inequality, for example, Cortes (2008) and Moretti (2013).

⁵The term R_1 increases the numerator of equation (3) if $R_1 > \frac{H}{H+L}$ i.e., if $y_1^h(\cdot) > y_1^l(\cdot)$. If educated and noneducated workers had the same demand for the high-skill-intensive commodity (i.e., $y_1^h(\cdot) = y_1^l(\cdot)$), then $R_1 = \frac{H}{H+L}$ and the term $(\lambda_H - \lambda_L) \left[R_1 - (1 - R_1) \frac{H}{L} \right]$ would disappear and the numerator of equation (3) would then be unambiguously negative.

- The second prediction of the model is for sectoral employment shares. The employment share of the skill-intensive sector is $e_1 = \frac{H_1 + L_1}{H + L}$. The effect of an increase in skill intensity $d \log H$ on e_1 is positive because of the concurrent supply and demand effects: the increase in the number of skilled workers will raise employment in the sector and in turn increase demand of the final commodity produced there. This prediction of the model will be tested in Section III, studying the relation between changes in H/L and industry employment shares within cities under the assumption that services cannot be traded outside the city-specific local labor market.

II. Evidence on the Relationship between Elasticities and Skill Intensities

In this Section, I test the first prediction of the model: the education elasticity of demand mechanism may explain part of the increase in the college premium only if more educated (and richer) consumers tend to consume more skill-intensive products and services. To test this hypothesis, I first match consumption data with skill intensity data, then I regress the estimated elasticities on the skill intensities. For reasons of space, the details about the sample selection, and all tables of descriptive statistics of the US and UK data used in this section (Tables A2 to A8) are in the online Appendix. The tables of results for the United Kingdom (Tables A10 and A11) are also in the online Appendix.

A. *The Match of Expenditure and Industry Skill Intensity Data*

The data on consumption are drawn from the CEX. A consistent dataset is available at the NBER (www.nber.org/data/ces_cbo.html) from 1984 to 2003:2, while data are available online at the Bureau of Labor Statistics through 2012. Since the purpose of the paper is to assess whether education elasticities may explain part of the increase in the college premium in the United States and the United Kingdom, I select the time period between 1994 to 1997, in the middle of the period of rapidly rising inequality and run robustness checks on other time periods in Section IIF and Table 3.⁶

I use data for all items whose consumption has been consistently recorded from 1994 to 1997 (38 items). I include in total expenditure housing rent, but exclude own-property housing expenditures (property taxes, interest on house loans, and housing intermediate goods) because they cannot be easily matched with an industry and vehicle purchase (whose income elasticity is very high given that this is an infrequent purchase).⁷ Total expenditure is the sum over the 38 items and represents 84 percent of total expenditure as provided by the NBER. The final sample includes

⁶The data both in the United States (Lemieux 2006; Autor, Katz, and Kearney 2008; Heathcote, Perri, and Violante 2010) and in the United Kingdom (Machin and VanReenen 2008; Blundell and Etheridge 2010) show that the growth of the college wage premium was rapid through the 1980s and the 1990s then it slowed down.

⁷The reason that durables are often excluded is that the system of Engel curves is derived on the basis of the utility flow from consumption which can be read straight from the expenditure only for nondurables. For durables in principle we need to impute a service flow from the stock and expenditures on durables. As a robustness check I include also vehicle purchases and own-property housing to reach 100 percent of expenditure: the results regarding education elasticities are qualitatively unaltered (results available upon request).

23,268 households and their expenditure shares on 38 nondurable consumption items. The average age of the head of household is around 45 years, 52 percent of heads of household have at least some college education (defined as 13 or more years of education) and 60 percent are males (see Table A2 in the online Appendix).

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 CEX with the skill intensity of the industry, which produces the final good or service calculated from the CPS. For each matched industry in the CPS, I calculate two different measures of skill intensity: a raw measure and a measure that takes into account intermediate inputs (the results are in Tables A3 and A4 in the online Appendix).

The first measure of industry skill intensity is the share of workers who attained some college education (defined as 13 or more years of schooling). To avoid potential reverse causality skill intensity is calculated on the CPS data 1979–1980 and is predetermined to elasticities estimated in 1994–1997. Among low-skill-intensive industries there are food products, eating and drinking places, apparel production, repair services, personal services, household supplies, and household services. Among high-skill-intensive industries there are business and professional services, education, health and social services, and financial services and insurance.

The second measure is adjusted for the skill intensity of intermediate inputs using Input-Output tables in year 1995 (the 3-digit industry code of the CPS is matched with the 123-industry Input-Output industry code in Table A5 in the online Appendix). I take the intermediate inputs into account because the 38 industries that have a direct match with a consumption item represent only about 57 percent of total employment in the US economy, and input-producing industries may have a different skill intensity than those that produce the final output.

The input-adjusted skill intensity of final product j is calculated as $z_j^{INPUT} = \sum_i \frac{I_{ij}}{\sum_i I_{ij}} z_i$, where z_i is the skill intensity of intermediate industry i . The weights $\frac{I_{ij}}{\sum_i I_{ij}}$ indicate industry's i input contribution to producing one unit of product in industry j and are obtained by multiplying the input shares of each industry i by the share of total output of the same industry i that goes to salaries, i.e., the weights measure the salary-weighted contributions of workers in each industry i to output of industry j .⁸

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. This happens because the low-skill-intensive intermediate inputs, in particular the retail sector (which is an intermediate input in I-O tables), reduce the skill intensity of all final products; however, for the low-skill-intensive final

⁸ As an illustration of the construction of weights I offer the following example that I owe to an anonymous referee. Suppose that two industries have the following expenditure structure: Industry A: 40 percent salaries, 20 percent interest on capital, 20 percent purchases of inputs from industry B, 20 percent purchases of inputs from industry A (within sector trading); Industry B: 60 percent salaries, 20 percent capital, 10 percent imports from abroad, 10 percent purchases of inputs from industry A. When a consumer spends \$100 on goods of industry A, that industry will pay salaries of \$40 to its employees. It will also make purchases from industries B and A which lead to salaries of \$12 = $(100 \times 0.2 \times 0.6)$ and \$8 = $(100 \times 0.2 \times 0.4)$. Ignoring further iterations of the input-output relationships, the salary-weighted contributions of workers in A and B to output of industry A would be 80 percent = $(\$48/\$60)$ and 20 percent = $(\$12/\$60)$, respectively.

products the effect of the retail sector is offset by the contributions of other intermediate inputs that are relatively more skill intensive, such as the contribution of the public sector. The estimated correlation coefficient between the raw measure and the adjusted measure is 0.88.

B. Data for the United Kingdom

The UK sample is drawn from FES data 1994–1997 and includes 26,189 households and their expenditure on 42 nondurable consumption items (see the online Appendix for sample selection, Table A6 for descriptive statistics and Table A7 for the match with LFS data). There is a large difference between the US and the UK data in the percentage of heads of household with some college education: 52 percent in the US sample (CEX 1994–1997) and 21 percent in the UK sample (some college in the United Kingdom is defined as those who left full-time education after their eighteenth year of age). By the same token, the skill intensity of the producing industries in the United Kingdom is much lower than in the United States when measured as the share of workers with a degree-level education or more (20 percent of the total). Therefore in order to establish a better comparison with the United States, I consider for the United Kingdom also skill intensity calculated as the share of workers with more than high school (48 percent of the total). Both skill intensities are calculated on LFS 1994–1997 data (not earlier for the sake of the industry codes' consistency) and are adjusted for the use of intermediate inputs with weights that reflect the salary-weighted contribution of workers of other industries (see Table A8 in the online Appendix).

C. Econometric Specification

The empirical strategy is in two steps: first I estimate the education and the income elasticities, then I regress the estimates on the corresponding industry's skill intensity. I estimate a system of 38 equations; for each item the specification is

$$(4) \quad \omega_{ij} = a_j + b_j \mathbf{X}_i' + \gamma_j ed_i + \varepsilon_{ij} \quad \text{for } j = 1, \dots, 38.$$

$\omega_{ij} = \frac{p_j y_{ij}}{x_i}$ is the expenditure share of item j by household i , \mathbf{X}_i contains the age and sex of the head of household 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 has some college education. The 38 equations are stacked in a fixed effect regression with constraints. To be consistent with a demand system ($\sum_j \omega_{ij} = 1$), the following restrictions are imposed: $\sum_j a_j = 1$, $\sum_j b_j = 0$ for each b_j , $\sum_j \gamma_j = 0$. Standard errors are clustered at the household level. I do not include prices because 38 prices are collinear.⁹

Although the focus of the model of Section I is mainly on education elasticities, I also estimate income elasticities because they work as a complementary mechanism,

⁹ In Section IV, where I bring the theoretical model to the data, I aggregate the 38 items in two aggregate groups (high-skill and low-skill-intensive). At that point I include also a relative price index constructed as the aggregation of the single items' prices and I estimate the price elasticities needed to parametrize the model.

which may also favor skill-intensive products so that rising income will reinforce the education demand effect. In a second specification of System 4, instead of the term in the head's education level, I introduce a term in log expenditure where $\delta_j \log x_i$ is the log of real (deflated by CPI index) total expenditure of household i with restrictions $\sum_j \delta_j = 0$. Income elasticities are a more popular concept in empirical work and, while education elasticities reflect the consumption response to permanent income changes, income elasticities reflect the response to current income.

The education elasticities are equal to $\hat{\eta}_j^{ed} = \frac{\hat{\alpha}_j \times \overline{ed}}{\overline{\omega}_j}$, where $\overline{\omega}_j$ is the average budget share of item j and \overline{ed} is the percentage of heads of household who have some college education (52 percent in US data); weighted by the average share in the budget, they average to 0 across the 38 expenditure items. The budget elasticities are equal to $\hat{\eta}_j^{budget} = \frac{\delta_j}{\overline{\omega}_j} + 1$ and their weighted average is equal to one.¹⁰

D. Regression Results of Elasticities and Skill Intensities

Table 1 shows the estimated coefficients on the education dummy and on total expenditure for each one of the 38 items estimated on the CEX pooled sample from 1994–1997. The coefficients on education and total expenditure are obtained with two separate systems. For ease of interpretation, the items are ranked in ascending order according to the skill intensity of their producing industries, which is shown in the last column of Table 1. The Table also shows the education and income elasticities. Poorly educated heads of households tend to spend relatively more (i.e., low education elasticity) on food consumed at home and utilities; high-educated heads allocate a large proportion of their family budget to low-skill-intensive services such as repairs and domestic services, and an even larger share to high-skill-intensive services such as medical and business services and expenditure on education of all levels. A similar pattern is evident for income elasticities. The coefficient of correlation between income and education elasticities is 0.78 thus indicating that the effect of current and permanent income on consumption is similar.

Figure 1 plots education elasticities against skill intensity (calculated over 1979–1980), together with a linear and a quadratic fit obtained by an OLS regression weighted by the mean expenditure share of each consumption item (a measure of the importance of the item in the household budget). The coefficient on the linear weighted regression is 0.32 (0.17). When the same education elasticities are plotted against skill intensity adjusted for intermediate inputs, the results do not change much and the linear coefficient becomes 0.47 (0.27). The significant coefficients of the linear regressions of Table 2 indicate that educated individuals tend to consume, on average, more high-skill-intensive goods and services. The magnitude of the coefficient, however, is not very informative because it is expressed in elasticities

¹⁰ Income elasticities refer to quantities, while I have expenditure shares, i.e., budget elasticities. For convenience in the text and in the tables I often call them income elasticities. The theory model implies two distinct income elasticities, one by each education group, however, I estimate one common income elasticity because the coefficient estimates are rarely different across education group.

TABLE 1—ESTIMATES OF EDUCATION AND INCOME ELASTICITIES

	Education coefficient	Education elasticity	Income coefficient	Income elasticity	Skill intensity
Domestic services	0.008	0.185	0.005	1.238	0.131
Clothing and shoes	0.007	0.074	0.006	1.116	0.136
Household supplies	0.006	0.100	0.011	1.321	0.163
Food off-premises	−0.052	−0.147	−0.047	0.740	0.236
Clothing services	0.000	0.024	−0.001	0.907	0.240
Repairs, greasing, parking etc.	0.012	0.211	0.012	1.380	0.240
Jewelry and watches	0.002	0.208	0.003	1.658	0.242
Tobacco products	−0.012	−0.415	−0.004	0.716	0.255
Alcohol on-premises	0.002	0.149	0.001	1.140	0.265
Food on-premises	0.013	0.121	0.005	1.092	0.266
Barbershops, beauty parlors, etc.	0.001	0.041	0.000	0.973	0.273
Taxicab, railway, bus, and travel	0.001	0.272	0.002	1.542	0.275
Mass transit systems	−0.001	−0.073	0.000	0.914	0.277
Magazines, newspapers, and toys, etc.	0.007	0.182	−0.001	0.942	0.282
Housing	−0.025	−0.099	−0.028	0.787	0.282
Tires, tubes, accessories, and parts	0.000	−0.018	0.001	1.142	0.297
Alcohol off-premises	0.000	0.002	0.000	0.949	0.339
Water and other sanitary services	−0.001	−0.040	−0.001	0.962	0.346
Ophthalmic products	0.001	0.152	0.001	1.245	0.355
Gas	−0.003	−0.109	−0.002	0.878	0.378
Gasoline and oil	−0.007	−0.070	−0.005	0.903	0.381
Recreation and sports equipment	0.009	0.184	0.010	1.398	0.410
Electricity	−0.012	−0.141	−0.006	0.868	0.422
Other recreation services	0.013	0.176	0.010	1.242	0.441
Telephone and telegraph	−0.003	−0.040	−0.005	0.866	0.458
Drug preparations	−0.004	−0.190	−0.001	0.938	0.467
Fuel oil and coal	−0.002	−0.225	0.000	0.910	0.473
Health insurance	−0.004	−0.056	−0.004	0.910	0.532
Expense of handling life insurance	0.002	0.090	0.005	1.371	0.539
Auto insurance	0.002	0.032	0.005	1.163	0.539
Hospitals	0.000	−0.005	0.002	1.446	0.543
Airline fares	0.007	0.421	0.005	1.625	0.550
Religious and welfare activities	0.007	0.216	0.000	1.024	0.590
Business services	0.002	0.054	0.006	1.439	0.620
Physicians, dentists, and medical prof.	0.004	0.134	0.006	1.363	0.671
Other education services	0.005	0.324	0.005	1.606	0.699
Nursery, elementary and secondary education	0.002	0.435	0.001	1.422	0.719
Higher education	0.012	0.495	0.005	1.426	0.800

Notes: Income and education elasticities are estimated with two different specifications of system elasticity on 23,298 households pooling CEX data between year 1994 and 1997. Consumption items are sorted by the skill intensity of the producing industry (last column). Skill intensity is calculated from CPS 1979–1980 data. Standard errors are not shown for reasons of space.

but one needs a model to quantify how much an increase in the skill ratio is translated into an increase in the skill premium (see Section IV).

While the model implies a positive relation between elasticities and skill intensities, Figure 1 suggests a more nuanced pattern of “polarization of consumption” toward consumption items at the two extremes of the skill intensity distribution. For this reason I estimate a quadratic relation as well as a linear one. Although the elasticities tend to be higher for both low-skill-intensive and high-skill-intensive consumption items, the overall demand shift is mainly in favor of skill-intensive products and services and the shape of the relation is a J shape rather than a U shape.

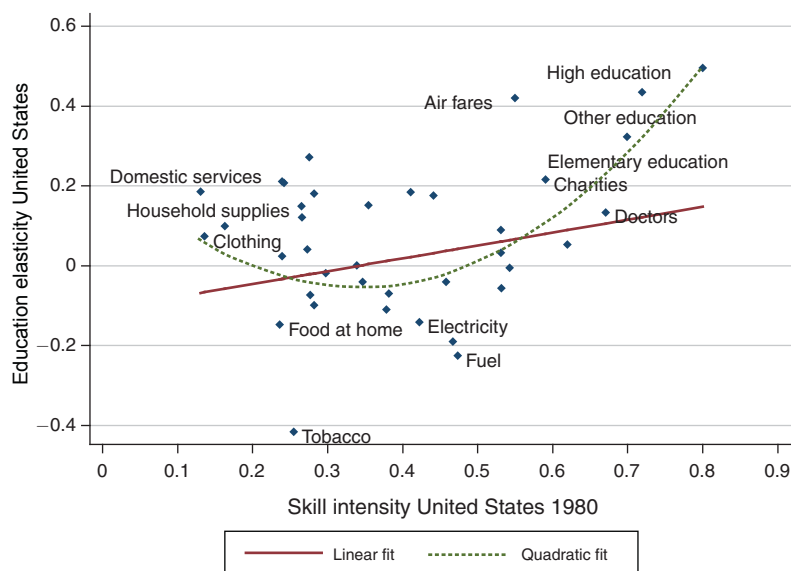


FIGURE 1. ELASTICITIES AND SKILL INTENSITIES UNITED STATES

Notes: Fitted values are predicted by a weighted OLS regression of education elasticities on industry skill intensity measured in 1980 and its square. Weights are the mean shares of the consumption items in total expenditure. Elasticities are estimated on pooled CEX 1994–1997 data, skill intensity on CPS 1979–1980 data.

TABLE 2—OLS REGRESSION OF ESTIMATED EDUCATION AND INCOME ELASTICITIES ON TWO MEASURES OF SKILL INTENSITY

Dependent variable	Education elasticity		Income elasticity	
<i>Panel A</i>				
Skill intensity 1980	0.322* (0.170)	−1.806** (0.707)	0.581** (0.264)	−2.325** (1.129)
Skill intensity 1980 squared		2.641*** (0.856)		3.607** (1.368)
Constant	−0.110* (0.063)	0.254* (0.131)	0.802*** (0.097)	1.299*** (0.209)
R^2	0.091	0.285	0.119	0.265
<i>Panel B</i>				
Adjusted skill intensity	0.468* (0.269)	−4.532*** (1.575)	0.824* (0.419)	−5.900** (2.547)
Adjusted skill intensity squared		5.865*** (1.825)		7.887** (2.953)
Constant	−0.178* (0.105)	0.826** (0.326)	0.688*** (0.163)	2.037*** (0.527)
R^2	0.078	0.288	0.097	0.250

Notes: $N = 38$. OLS regressions weighted by the mean share of the consumption item. Income and education elasticities are estimated on pooled CEX data 1994–1997. Skill intensity in panel A is the proportion of workers with some college education in total industry employment in CPS 1979–1980 data; in panel B skill intensity is adjusted using input-output tables.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 2 shows the results of the linear (and quadratic) regression:

$$(5) \quad \hat{\eta}_j = \alpha + \beta z_j + \varepsilon_j,$$

where $\hat{\eta}_j$ is in turn the education and the income elasticity for commodity j and z_j is skill intensity of industry j . All regressions are weighted by the mean share of the consumption item in total expenditure (regressions weighted by the inverse of the estimated variance yield very similar results).

In panel A of Table 2, education and income elasticities are regressed on the skill intensity z_j of the manufacturing industry in 1979–1980. The table shows that the positive relation of skill intensities with income elasticities is even stronger than the one with education elasticities: the coefficient on the linear regression is 0.58 (0.26) and 0.82 (0.42) for income elasticities. The coefficients of the quadratic regressions show that the J-shaped relation holds for both education and income elasticities. Panel B confirms the results of panel A using the adjusted skill intensity measure, which takes into account the contribution of intermediate inputs. Table A9 in the online Appendix shows some robustness checks excluding expenditure on education from the regression or separating tradable goods and nontradable services.¹¹

E. Regression Results for the United Kingdom

The results with the UK data are presented in Figure 2, which is the equivalent of Figure 1 for the United States (except that skill intensity is calculated in 1994–1997 instead of 1979–1980). The coefficient of the weighted linear regression is 0.11 (0.09). Also, in the United Kingdom, the relation between elasticities and skill intensities has a polarized shape and the results regarding income elasticities (not shown) resemble those for education elasticities.

Since skill intensity in all sectors is much lower in the United Kingdom than in the United States, in order to improve the comparison with the United States I also use a definition of skill based on high-school diploma in the United Kingdom. When this measure of skill intensity is used, the coefficient of the linear regression of education elasticities (the education dummy in the system of equation indicates heads of households with high school or more) on skill intensities becomes 0.45 (0.20) (see Tables A10 and A11 in the online Appendix for the UK results).

The validity of the positive J-shaped relation also for the United Kingdom lends credence to the consumption elasticity mechanism. The relation holds notwithstanding the differences between the United States and the United Kingdom in the share of educated workers and in the size of the public sector for education and health,

¹¹ If I exclude the expenditure item regarding education from the regression, the linear regression loses significance but the quadratic relation remains significant. Separating nontradables and tradables, the results indicate significant coefficients on the linear and quadratic terms for nontradables and insignificant coefficient for tradables. This is consistent with the fact that the hypothesis advanced in this paper applies mostly to nontraded services whose domestic demand is what matters while the demand of American traded goods is a function also of the tastes of consumers all over the world. Finally the table shows that the positive J-shaped relation holds also with coefficients rather than elasticities and therefore is not due to the transformation of the coefficients into elasticities.

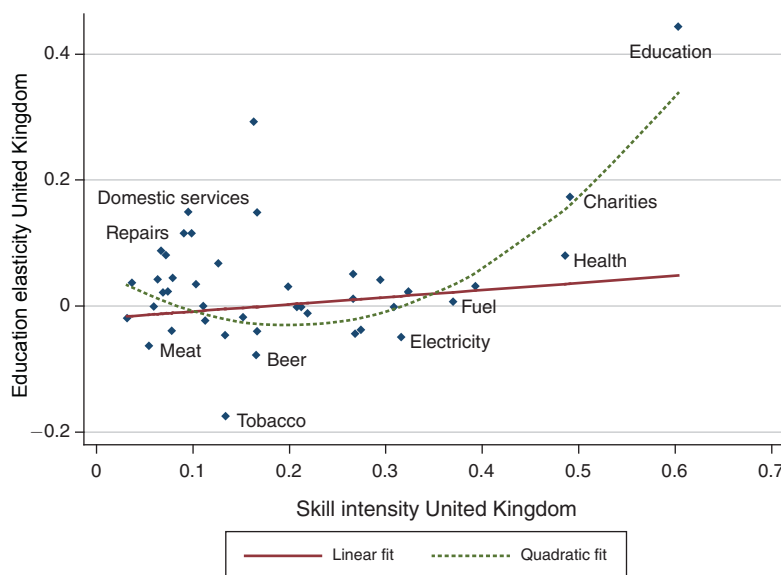


FIGURE 2. ELASTICITIES AND SKILL INTENSITIES UNITED KINGDOM

Notes: Fitted values are predicted by an OLS regression of education elasticities on industry skill intensity and its square. Skill intensity is measured as the proportion of workers with some college on LFS 1994–1997 data, education elasticities are estimated on pooled FES 1994–1997 data.

which affects the incidence of out of pocket expenditures on those services.¹² It is reassuring that the positive relation between elasticities and skill intensities holds in two countries with public sectors of different sizes.

F. Interpretation and Extension of the Results

In this Section, I discuss whether elasticity estimates may reflect composition effects or time trends, rather than a true “education effect.”

Family Type.—One may wonder whether the J-shaped relation is driven by composition effects, for example, different family types. In the recent literature on polarization, the increase in the consumption of low-skill-intensive services is attributed to the increasing education of women: more educated women have a higher opportunity cost of time and buy low-skill-intensive services on the market (Black and Spitz-Oener 2009; Cortes and Tessada 2011; Mazzolari and Ragusa 2013). Panel A of Table 3 shows that the significant relation between elasticities and skill intensities is not driven by families where the spouse is college educated. I find that there are no major differences across family types (single heads, families with college- and

¹²Consumption surveys (both FES and CEX) collect information only about private consumption, however, much of total consumption is public government consumption, which may also plausibly react to changes in the education composition of the electorate. This may reinforce or partially offset the mechanism based on private consumption highlighted here.

TABLE 3—EDUCATION ELASTICITIES: FAMILY COMPOSITION AND TIME EFFECTS

<i>Panel A. Elasticities by family type</i>						
	Singles		Spouse less than college		Spouse some college	
Adj. skill intensity	0.537** (0.264)	−4.052** (1.576)	0.201 (0.215)	−3.584*** (1.278)	0.059 (0.172)	−2.629** (1.037)
Adj. skill intensity squared		5.374*** (1.824)		4.432*** (1.480)		3.106** (1.184)
Constant	−0.201* (0.102)	0.721** (0.326)	−0.075 (0.082)	0.685** (0.265)	−0.023 (0.068)	0.521** (0.217)
R^2	0.103	0.282	0.024	0.225	0.003	0.167
<i>Panel B. Elasticities estimated over time</i>						
	Years 1984–1989		Years 1990–1995		Years 1996–2002	
Adj. skill intensity	0.396 (0.263)	−5.028*** (1.477)	0.488* (0.269)	−4.797*** (1.555)	0.555** (0.261)	−4.466*** (1.535)
Adj. skill intensity squared		6.416*** (1.727)		6.221*** (1.809)		5.853*** (1.769)
Constant	−0.149 (0.102)	0.929*** (0.303)	−0.185* (0.105)	0.872** (0.321)	−0.212** (0.103)	0.802** (0.319)
R^2	0.059	0.325	0.084	0.315	0.111	0.323

Notes: $N = 38$. Each column is the result of an OLS regression of education elasticities on skill intensity weighted by the mean budget share of the consumption item. Skill intensity is always adjusted for intermediate inputs.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

noncollege-educated spouses). The correlation between education elasticities estimated on the sample of singles and of families with low-educated (high-educated) spouses is 0.88 (0.77), while the correlation between education elasticities of families with low- and high-skilled spouses is 0.72. This suggests that the explanation based on product demand elasticities is likely to work independently of the explanation based on an increase in consumption of market-provided services because of an increase in the opportunity cost of time for women.

Time Trends.—One further concern is that the pattern of education elasticities may capture some time trends. For example, Autor and Dorn (2013) show that wage polarization appeared in the 1990s, but is not in the data in the 1980s. One could argue that if product demand elasticities contribute to polarization, then the quadratic relation between elasticities and skill intensities may follow the same timing.

In panel B of Table 3, I divide the data into three periods (1984–1989, 1990–1996, and 1997–2002) to verify whether the estimates of elasticities (or their relation with skill intensity) change over time.¹³ The coefficients of a linear regression of education elasticities on input-adjusted skill intensity are 0.396 (0.263), 0.488 (0.269),

¹³ The microdata of the Consumer Expenditure Survey are available from 1984 to 2012, but the NBER dataset with a consistent aggregation of expenditures stops in 2002. Since the purpose of this paper is to assess the effect of consumption elasticities on the increase of the college premium, the most relevant decades are the 1980s and the 1990s, while in the year 2000s the increase in inequality slowed down (Autor, Katz, and Kearney 2006, 2008).

and 0.555 (0.261) in the three periods. The pairwise correlation between education elasticities of the three periods is very high, between 0.98 and 0.99 (the same for income elasticities). The high correlation suggests that the mechanism based on elasticities is stable over time and does not simply capture some time trend.

If consumption preferences are stable over time, then an increase in skill supply should correspond to a proportional increase in consumption of skill-intensive goods and services. While in this paper I focus on cross-sectional evidence of the relation between elasticities and skill intensities, time series evidence already cited at the beginning of this paper seems to be consistent with this implication. Table A1 in the online Appendix shows the expenditure shares of the main consumption aggregates in each decade from 1972 through 2012. In the decades from 1984 to 2012, the skill supply (the share of heads of households with more than 12 years of education) grew approximately by 1 percent per year or less, and the expenditure share of skill-intensive services (the sum of health, education, and personal insurance) went up approximately by 1 percent per decade, while the share of food, tobacco, and apparel combined (two low-skill-intensive products) went down by 1 percent a decade.¹⁴

III. Evidence on Industry Employment Shares within MSAs

In this section, I test the second implication of the model of Section I using variation within cities (MSAs). The model predicts that the increase in the relative number of skilled workers will increase the employment shares of skill-intensive industries and decrease those of low-skill-intensive industries. On top of this supply effect there will be a positive demand effect on industry employment shares that will be larger the larger is the education elasticity of consumption.¹⁵

This prediction can be tested on industry data at the MSA level with two provisos. Firstly we have to focus only on nontradables: the predicted effect of education elasticities on industry employment shares is expected to be detectable within cities if we assume that services cannot be traded outside of a local labor market. In contrast there should be no effect for tradables at the local level: the market for tradables is national, and much of the additional local demand is likely to benefit other cities. For this reason I will use the tradable sectors as a control group in a specification check.

Secondly, to break down the model at the MSA level, we need some assumptions regarding cross-city labor mobility and wage adjustment. I follow the framework

¹⁴ Under the assumption that consumption preferences do not change over time, a rapid growth of skill supply should imply a more rapid shift in product demand. During the 1970s, the supply of skilled workers was increasing much faster than in later periods thanks to a vast expansion in the number and size of public institutions of higher education (Goldin and Katz 2008). In online Appendix Table A1 the share of educated heads of household rose from 27.5 percent in 1972 to 43 percent in 1984, while the expenditure share of food and apparel fell by 3 percent and the share of skill-intensive services (health, education, and personal insurance) went up only by 0.4 percent. Unfortunately there are no microdata before 1984, therefore we cannot say if education elasticities were the same in the 1970s as in later periods. Apparently in that period most expenditure shifted to housing and transportation and only partially to skill-intensive services.

¹⁵ Although the model has equivalent predictions for industry wage bill shares $\frac{w_h H_1 + w_l L_1}{H + L}$, the analysis at the MSA level is limited to employment shares because the analysis of industry wage bill shares faces an additional problem: unless skilled workers earn the same college premium across all industries, the wage bill share also will reflect the different premia across industries and not necessarily reflect increased consumption demand.

recently proposed in the literature on local multipliers (Moretti 2010). Firstly, I assume the existence of an upward-sloping local labor supply, which depends on the degree of labor mobility across MSAs, and secondly, I assume that labor is mobile across sectors within an MSA, so that the marginal products and wages of each skill group are equalized across sectors.

In consequence of a positive demand shock to the skill ratio H/L in tradable industry j in MSA m (due, for example, to an exogenous nationwide increase in skill intensity combined with the particularly favorable industrial composition of MSA m), the employment share of industry j will increase, but the shock may also affect local employment in other industries (i.e., the local multiplier effect). In fact, the shock will increase the relative wages of skilled workers in the city and will attract existing residents and new immigrants, depending on the degree of labor mobility across MSAs. On top of this supply effect, which increases the employment shares of skill-intensive industries, there will be a positive demand effect on all nontradable local industries, which will be larger the larger is the education elasticity of demand.¹⁶

In the following, I estimate the effect of an increase of H/L in *tradable* industries on the employment share of nontradable industries, allowing for labor mobility and wage adjustment at the MSA level. I use the skill ratio in tradables only because it is less polluted by reverse causality (there is a mechanical relation between the skill ratio in a MSA and employment in skill-intensive sectors in the same city). Before introducing the estimation strategy, I will briefly describe the data.

A. Census Data at the MSA Level

I use the 5 percent sample of the decennial censuses in 1980, 1990, and 2000 Integrated Public Use Microsample Series (IPUMS) files, the only data that have a sufficient sample size for MSA-level analysis (see the online Appendix for sample selection details and Tables A12 and A13 for descriptive statistics). After selecting a balanced sample of MSAs that are present in all decades and keeping only MSA-industry cells with more than 200 workers in 1980, the final dataset contains 4,130 observations on 163 MSAs each of which has a different number of industries (the observation of nontradables industries are 3,186, the rest are tradables). The observations are MSA-industry-year weighted averages (using IPUMs personal weights) and, since the regressions are in changes, the final sample includes two observations per each MSA and each industry, corresponding to the periods 1980–1990 and 1990–2000.

Because the model predicts different effects into skill-intensive sectors (where both supply and demand effects are positive) and in low-skill-intensive sectors (where the supply effect is negative), the sample is divided into high-skill and low-skill nontradables (see Table A12 in the online Appendix). A simple regression of changes in employment shares on changes in the (log) skill ratio within MSA yields a positive significant coefficient for high-skill-intensive industries, a negative significant coefficient for low-skill-intensive industries, and a insignificant coefficient for

¹⁶The general equilibrium effect on wages and prices may partially undo the effect of the increase in demand for local services making labor costs higher and reducing their supply, however, if local labor supply is very elastic, labor costs will not increase much and the offsetting effect will be small.

tradables.¹⁷ These results are consistent with the evidence of the previous section and indicate that employment shares of skill-intensive services rise more in cities where there is more skill upgrading, but they do not explicitly take into account the consumption elasticity channel.

B. The Empirical Strategy

To take into account the estimated elasticities, I estimate the following equation where, for ease of interpretation of the interaction coefficient, the sectors are grouped with a high/low education elasticity dummy (*high_j* indicates an industry *j* with education elasticity higher than the median):

$$(6) \quad \Delta Emp_Share_{jmt}^{NTR} = \alpha + \beta_0 \left(\Delta \frac{H^{TR}}{L_{mt}} \right) + \beta_1 high_j + \beta_2 \left(\Delta \frac{H^{TR}}{L_{mt}} \times high_j \right) \\ + \delta_j + \gamma_m + \eta_{1990-2000} + \varepsilon_{jmt}.$$

$\Delta Emp_Share_{jmt}^{NTR}$ is the decadal change in the share of the MSA *m*'s workforce employed in *nontradable* (NTR) industry *j* between 1980 and 1990 and between 1990 and 2000 (indicated by *t*). $\Delta \frac{H^{TR}}{L_{mt}}$ is the decadal change in the log of the skill ratio in *tradable* (TR) industries in MSA *m*: to avoid the potential reverse causality, $\Delta \frac{H^{TR}}{L_{mt}}$ is measured using changes in the skill ratio only in the tradable sector. The coefficient of interest is β_2 , which captures the differential effect on the employment share of nontradable sectors with high education elasticity. All regressions include MSA and industry fixed effects and one time (decade) dummy to control for common local, industry, and temporal shocks, and are weighted by the average employment of the industry *j* of city *m* in 1980.¹⁸ Standard errors are clustered at the MSA level.

To identify exogenous changes in the skill ratio of the tradable sector, I use as an instrument the weighted average of nationwide skill-intensity growth in tradable industries, with weights reflecting the city-specific employment share in those sectors in 1980. The instrument is $\widehat{\Delta \frac{H^{TR}}{L_{mt}}} = \sum_{j=1}^n emp_share_{jm1980} \times \Delta \frac{H^{TR}}{L_{jt}}$, where emp_share_{jm1980} is the share of industry *j* in total employment in the tradable sector in MSA *m* in 1980 and $\Delta \frac{H^{TR}}{L_{jt}}$ is the nationwide change in the skill ratio between 1980 and 1990 and between 1990 and 2000 in tradable industry *j*: if the skill ratio in a specific tradable industry increases at the national level, the MSA where that same

¹⁷ The coefficients on the log skill ratio in regressions which include decade, MSA, and industry dummies are 0.020 (0.004), -0.035 (0.017), and 0.027 (0.037), respectively. The cross-MSA average employment share of a high-skill (low-skill) intensive industry in 1980 is 7 percent (6 percent), and of a tradable industry is 5.3 percent (Table A13 of descriptive statistics in the online Appendix).

¹⁸ Time-invariant differences across MSAs are controlled for by MSA dummies but the coefficients might be biased by city-specific, time-variant shocks that are correlated with both changes in the MSA's skill ratio and changes in industry employment shares. To test the robustness of these results I include in the regressions the MSA-level changes in sex ratios, in average age, and in the share of immigrants to control for other concurrent secular changes in labor supply that may affect the growth of some industries, mainly low-skill-intensive sectors that are also intensive in female and immigrant labor. Results are qualitatively unchanged and are available upon request.

TABLE 4—CHANGES IN NONTRADABLE AND TRADABLE INDUSTRIES' EMPLOYMENT SHARES AT THE MSA LEVEL

	High-skill nontradables		Low-skill nontradables		Tradables (TR1)	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
$\Delta \log\left(\frac{H}{L}_{mt}\right)$	−0.002 (0.002)	−0.007 (0.036)	0.023* (0.013)	−0.225 (0.688)		
High elasticity	0.003 (0.002)	−0.012*** (0.003)	0.011*** (0.003)	0.025* (0.013)	0.009 (0.014)	0.060 (0.059)
$\Delta \log\left(\frac{H}{L}_{mt}\right) \times \text{High elast.}$	0.009*** (0.002)	0.045*** (0.012)	−0.026** (0.010)	−0.050 (0.036)		
$\Delta \log\left(\frac{H}{L}_{mt}\right)^{TR0}$					−0.006 (0.025)	−0.096 (0.170)
$\Delta \log\left(\frac{H}{L}_{mt}\right)^{TR0} \times \text{High elast.}$					−0.032 (0.039)	0.255 (0.174)
Observations	1,530	1,530	794	794	159	159
R^2	0.256		0.280		0.392	
P > F Excl Instrument 1		0.685		0.893		0.697
P > F Excl Instrument 2		6.03e-10		2.74e-08		0.0327

Notes: In the first four columns the dependent variable is the decadal (1980–1990 and 1990–2000) change in non-tradable (NTR) industry employment shares; the independent variable is the decadal change in the log skill ratio in tradable (TR) industries. In the last two columns, changes in employment shares in tradables group TR1 are regressed on changes in the log skill ratios in tradables group TR0. Low-skill/high-skill nontradables and tradables (group TR0 and TR1) are defined in Table A12 in the online Appendix. The instruments are a weighted sum of tradable industry decadal growth of H/L projected on initial MSAs industry structure in 1980. All models contain MSA and industry dummies and a one time dummy. The dummy “high elasticity” indicates sectors with education elasticity higher than the median = 0.09. Only MSA-industry cells with at least 200 employees in 1980 are in the sample. All regressions are weighted by the average employment of industry i in city m in 1980. Robust standard errors are clustered by MSA.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

industry employs a larger share of the tradable sector experiences a positive shock to skill intensity.

As a specification check, in the last two columns of Table 4, I use the tradable sector, where there should be no effect. Equation (6) becomes:

$$(7) \quad \Delta \text{Emp_Share}_{jmt}^{TR1} = \alpha + \beta_0 \left(\Delta \frac{H}{L}_{mt}^{TR0} \right) + \beta_1 \text{high}_j + \beta_2 \left(\Delta \frac{H}{L}_{mt}^{TR0} \times \text{high}_j \right) + \delta_j + \gamma_m + \eta_{1990-2000} + \varepsilon_{jmt},$$

where $\Delta \text{Emp_Share}_{jmt}^{TR1}$ is the employment share in a randomly selected part of the tradable sector (TR1) and $\Delta \frac{H}{L}_{mt}^{TR0}$ is the change in the log skill ratio in the rest of the tradable sector (TR0). The instrument is built in an equivalent fashion as described above using TR0 sectors.

The IV estimates establish what happens to industry employment shares in a city when the city experiences an increase in the skill ratio that is driven purely by an increase in the relative demand for college graduates. In contrast, the OLS estimate establishes the same effect when the increase in the skill ratio may be driven by either demand or supply shocks.

C. Results on Industry Employment Shares at the MSA Level

Table 4 indicates that an exogenous increase in the skill intensity in the tradable industry results in an increase in local employment in the high-skill-intensive nontradable sector in a city, particularly for those sectors that are education-elastic. The OLS and IV elasticities of the interaction term are 0.009 and 0.045, respectively (see columns 1 and 2). The latter indicates that a 10 percent increase (over one decade) in the skill ratio in the tradable sector in a city is associated with a 0.45 percentage points (over an average employment share of 7 percent) higher increase in the employment share in skill-intensive nontradables with a high education elasticity (like health and education services) with respect to those with low education elasticity.

For low-skill-intensive nontradables, the effect is null (column 4, IV coefficient on the interaction); the negative significant OLS coefficient in column 3 indicates that the negative supply effect of H/L on employment in low-skill-intensive services seems to prevail (as is contemplated in the model) when the effect of the demand shock is not isolated. As expected, due to the national nature of the demand for tradables, I find that an exogenous increase in skill intensity in one part of the tradable sector has no significant effect on employment in other parts of the tradable sector (columns 5 and 6).¹⁹

These results are consistent with Moretti (2010), who shows that an exogenous increase in the number of jobs in the tradable sector in a city results in an increase in local labor demand in the service sector, and that this effect is larger when the exogenous increase in labor demand is concentrated among skilled workers. Relative to Moretti (2010), this paper adds the explicit account of consumption elasticities to the argument that positive demand shocks in the tradable sector have large multiplier effects on the nontradable sector.

In addition to the CEX-based evidence discussed in the previous section, the results presented here constitute a second piece of evidence in favor of a role for consumption elasticities in affecting the final demand for high-skill-intensive goods and services and, through this channel, also the demand for skills (i.e., the college premium).

IV. Quantification of the Demand Shift

So far the evidence suggests that the consumption elasticity channel may contribute to the increase in the college premium, however neither the coefficients of Table 2 (at the aggregate economy level) nor of Table 4 (at the MSA level) are informative as to the extent to which an exogenous increase in education raises or decreases the overall demand for skilled labor. To answer this question, in this section I parametrize the relation between the skill premium and the skill ratio implied by the model of Section I, which for convenience I give again:

$$(8) \quad \frac{d \log w_h}{d \log H} = \frac{(1 - a_2) \left\{ (\lambda_H - \lambda_L) \left[R_1 - (1 - R_1) \frac{H}{L} \right] - \left[1 + \lambda_H + \frac{H}{L} (1 + \lambda_L) \right] \right\}}{(\lambda_L + 1)\sigma + (\lambda_H - \lambda_L)(1 - a_1)\sigma - (\lambda_H - \lambda_L)T},$$

¹⁹ The effect on the tradable sector is not necessarily zero but should be smaller than the one for the nontradable sector, and possibly even negative because the increase in wages generated by the initial shock hurts local producers of tradables.

TABLE 5—PARAMETERS OF THE MODEL

Labor market aggregates	λ_H	λ_L	a_1	a_2	$\frac{H}{L}$	σ
US CPS						
	1.96	0.45	0.80	0.43	1.22	1.4
UK LFS						
	2.70	0.84	0.43	0.13	0.24	1.4
Consumption elasticities	ε_{1m}^h	ε_{1m}^l	ε_{1p}^h	ε_{1p}^l	ε_{1p}	R_1
US CEX						
	1.09	1.08	-0.92	-0.60	-0.53	0.61
UK FES						
	1.14	1.14	-0.75	-0.82	-0.83	0.28

Notes: $\lambda_H = \frac{H_1}{H_2}$, $\lambda_L = \frac{L_1}{L_2}$, $a_1 = \frac{w_h H_1}{p_1 y_1}$, $a_2 = \frac{w_h H_2}{p_2 y_2}$, and $\frac{H}{L}$ are estimated using CPS and LFS 1994 to 1997. ε_{1p}^h , ε_{1p}^l , ε_{1m}^h , ε_{1m}^l , R_1 are estimated using CEX and FES 1994 to 1997. σ is from Katz and Murphy (1992).

where $T = \left\{ R_1 [\varepsilon_{1p}^h (a_1 - a_2) + \varepsilon_{1m}^h (1 - a_2)] + (1 - R_1) [\varepsilon_{1p}^l (a_1 - a_2) - a_2 \varepsilon_{1m}^l] \right\}$.

To bring the model to the data, I estimate income and price elasticities of two consumption aggregates from the CEX data (the high-skill-intensive aggregate sums all 19 consumption items with skill ratio greater than 0.37) and labor market aggregates from the CPS data. Table 5 summarizes the parameters' values for both the United States and the United Kingdom. In the following text I describe the main results of the parametrization of the model, while the explanation of the way the parameters' estimates have been obtained are in Appendix A at the end of the paper.

Filling in the relevant elasticities and labor market aggregates for the US economy, from Table 5 into equation (8), the final result is $\frac{d \log w_h}{d \log H} = -1.12$. This number must be compared to the counterfactual of what would have happened without the education and income effect in favor of high-skill-intensive consumption items. When solved with identical demand functions of skilled and unskilled consumers (i.e., $y_1^h(\cdot) = y_1^l(\cdot) = y_1(\cdot)$) and homotheticity in income, the model of Section I gives the following counterfactual result (which is a two-sector version of the basic framework by Katz and Murphy 1992):

$$(9) \quad \frac{d \log w_h}{d \log H} = \frac{-(1 - a_2) \left[1 + \lambda_H + \frac{H}{L} (1 + \lambda_L) \right]}{(\lambda_L + 1) \sigma + (\lambda_H - \lambda_L) (1 - a_1) \sigma - (\lambda_H - \lambda_L) \left[\varepsilon_{1p} (a_1 - a_2) + \frac{H}{H + L} - a_2 \right]},$$

whose parametrization yields $\frac{d \log w_h}{d \log H} = -1.22$.

The difference between equation (8) and equation (9) shows that education and income elasticities contribute to reduce the extent of the fall of $\frac{w_h}{w_l}$ in response to an increase in $\frac{H}{L}$ by 0.10 points (1.22 - 1.12).²⁰ To understand the magnitude of this

²⁰ The total effect can also be decomposed in different parts. The direct effect of education elasticities can be quantified in $(1 - a_2)(\lambda_H - \lambda_L) [R_1 - (1 - R_1) \frac{H}{L}] = 0.11$ in the numerator of equation (8). In the denominator

TABLE 6—QUANTIFICATION OF THE INCOME AND EDUCATION EFFECTS

	Model with income and education elasticities (1)	Model without income and education elasticities (2)	Difference (1) – (2) (3)	Demand shift $\frac{w_h}{w_l}$ (4)	Contribution of elasticities (3)/(4) (5)
US CEX					
Implied $\frac{d \log w_h}{d \log H}$	–1.12	–1.22			
Percentage terms	$(-1.12 \times 0.66) = -74\%$	$(-1.22 \times 0.66) = -80\%$	6%	80% + 13%	6.5%
UK FES					
Implied $\frac{d \log w_h}{d \log H}$	–0.87	–0.97			
Percentage terms	$(-0.87 \times 0.88) = -77\%$	$(-0.97 \times 0.88) = -85\%$	8%	85% + 14%	8%

Notes: The implied $\frac{d \log w_h}{d \log H}$ are obtained by parameterizing equation (8) and equation (9) using the parameters in Table 5. The percentage terms in columns 1 and 2 are obtained by multiplying the implied $\frac{d \log w_h}{d \log H}$ by the actual increase 1984–2002 in $\frac{H}{L}$ (in the United States, it is 66 percent and in the United Kingdom, 88 percent). The percentage terms in column 4 are obtained by 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 2, with the actual increase 1984–2002 in $\frac{w_h}{w_l}$ (in the United States = 13 percent and in the United Kingdom = 14 percent).

contribution we need to relate it to the actual increase of the college premium in the US economy. The result of this exercise is summarized in Table 6 for both the United States and the United Kingdom.

The actual skill ratio in the US economy $\frac{H}{L}$ increased by 66 percent between 1984 and 2002 and the college premium $\frac{w_h}{w_l}$ increased by 13 percent (CPS data, H is some college or more). Equation (8), 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 74 percent $(-1.12 \times 0.66 = -0.74$, see column 1 of Table 6) as a result of an increase in $\frac{H}{L}$ by 66 percent. Equation (9) with identical preferences across educated and noneducated workers implies a fall of $\frac{w_h}{w_l}$ by 80 percent $(-1.22 \times 0.66 = -0.80$, see column 2 of the table). This latter result implies that the total shift in relative labor demand is 93 percent: the actual 13 percent plus the counterfactual 80 percent implied by equation (9) (column 4 of the table). Eventually the education and income elasticities in favor of skill-intensive consumption items reduce by 6 percentage points the fall of the relative wage (74 percent instead of 80 percent) and 6 percentage points constitutes about 6.5 percent of the 93 percent total shift in the relative labor demand (see column 5).

A. Quantification of the Demand Shift for the United Kingdom

As for the United States, I estimated income and the price elasticities of two consumption aggregates from the FES data and labor market aggregates from the LFS

the effect through different price and income elasticities across skilled and unskilled workers can be quantified in the difference between $T = \left\{ R_1 \left[\varepsilon_{1p}^h(a_1 - a_2) + \varepsilon_{1m}^h(1 - a_2) \right] + (1 - R_1) \left[\varepsilon_{1p}^l(a_1 - a_2) - a_2 \varepsilon_{1m}^l \right] \right\}$ and $\varepsilon_{1p}(a_1 - a_2)$. The difference in income elasticities is calculated at $R_1(1 - a_2)\varepsilon_{1m}^h - (1 - R_1)a_2\varepsilon_{1m}^l = 0.20$. The difference in price elasticities is calculated at $R_1(a_1 - a_2)\varepsilon_{1p}^h + (1 - R_1)(a_1 - a_2)\varepsilon_{1p}^l - (a_1 - a_2)\varepsilon_{1p} = -0.016$.

data.²¹ The result of the parametrization of equation (8) is $\frac{d\log w_h}{d\log H} = -0.87$, while the parametrization of the counterfactual equation (9) yields a result of -0.97 . In the United Kingdom, the skill ratio $\frac{H}{L}$ increased by 88 percent between 1982 and 2000, and the college premium $\frac{w_h}{w_l}$ increased by 14 percent (LFS data). Equation (8) implies that the college premium should have fallen by 77 percent ($-0.87 \times 0.88 = -0.77$, see column 1 of Table 6), while counterfactual equation (9) implies a fall of 85 percent ($-0.97 \times 0.88 = -0.85$, see column 2): a difference of 8 percentage points. The total unexplained shift in relative labor demand in the United Kingdom is 99 percent (the actual 14 percent plus the counterfactual 85 percent, see column 4), therefore education and income elasticities in favor of skill-intensive consumption items can account for around 8 percent of the total shift in the relative demand for skilled labor (see column 5).

V. Conclusions

The evidence presented in this paper shows that more educated (and richer) consumers not only consume more of the very low-skill-intensive services, such as cleaning services and household services—as pointed out in Mazzolari and Ragusa (2013)—but also consume more of the high-skill-intensive services, such as education, medical, and professional services. The positive (and J-shaped) relation between the education (and income) elasticities and the skill-intensity of consumption goods and services is evident both in the United States and the United Kingdom.

At the MSA level, the positive relationship between the decadal changes in the share of skilled workers in the tradable sector in a city and the employment share of high-skill-intensive nontradable services, confirms that consumption changes based on education elasticities are likely to favor the demand for skill-intensive services.

The parametrization of a simple two-sector model suggests that overall the income and education effects in favor of skill-intensive goods and services can explain around 6.5 percent of the total increase in the college premium in the United States from 1984 to 2002. Notwithstanding the differences between the United States and United Kingdom in out of pocket expenditure in education and health services and in the share of college-educated workers, the overall results in terms of explanatory power are similar in the United Kingdom (8 percent), which is an indication of the robustness of this simple model to parameter changes.

The mechanism based on education and income elasticities can give an additional contribution besides the traditional explanations based on technology or trade to accounting for the increase in the college premium. Overall the product

²¹ Table 5 shows that while income and price elasticities are fairly similar across the United States and United Kingdom, the value of $R_1 = 0.28$, which defines the education elasticity in the model, is much lower in the United Kingdom. This is not surprising because the numerator of R_1 is the total expenditure on the 19 high-skill-intensive items by college-educated workers and the share of college-educated workers is much lower in the United Kingdom than in the United States: $\frac{H}{L} = 0.24$ in the LFS sample 1994–1997. Also the distribution of college-educated workers is much more concentrated in the skill-intensive industries in the United Kingdom rather than in the United States: hence, the higher value of $\lambda_H = \frac{H_1}{H_2} = 2.7$ and the lower value of $\alpha_2 = \frac{w_h H_2}{p_2 y_2} = 0.13$ in the United Kingdom with respect to the United States.

demand effect is not large—consistently with the findings of Autor and Dorn (2013) and Goos, Manning, and Salomons (2014), but also with the early literature on wage inequality, which emphasized the role of within-industry shifts rather than between-industry shifts (Berman, Bound, and Machin 1998). However this mechanism is of great potential interest because of the stable structure of education (and income) elasticities over time which suggests a constant bias toward the demand for high-skill-intensive services (and to a lesser extent for low-skill-intensive ones). This bias is also confirmed in the evolution over time of the shares of consumption of high-skill-intensive goods and services.

APPENDIX

Here I present the details of the model of Section I and the estimation strategy of the parameters shown in Table 5. The economy consists of H skilled workers/consumers with a college degree and L unskilled workers/consumers without a college degree. Let $Y_1 = F_1(H_1, L_1)$ and $Y_2 = F_2(H_2, L_2)$ denote, respectively, the production functions of the high- and low-skill-intensive commodity. The functions are assumed to be CES with elasticity of substitution σ . In this model there is no technical progress because the focus is on the role of product demand. For models that incorporate technical change see Autor, Levy, and Murnane (2003); Weiss (2008); Acemoglu and Autor (2011); and Autor and Dorn (2013). Labor markets are competitive and both labor inputs move across sectors to equate their marginal value. Since Y_1 is the high-skill-intensive commodity (or sector), it will have a larger skill intensity and a higher wage bill share of skilled labor, i.e., if we define $a_1 = \frac{w_h H_1}{p_1 F_1(\cdot)}$ and $a_2 = \frac{w_l H_2}{p_2 F_2(\cdot)}$ the wage bill shares of skilled labor in the two sectors, and $\lambda_H = \frac{H_1}{H_2}$ and $\lambda_L = \frac{L_1}{L_2}$ the ratios of skilled and unskilled labor, by definition $a_1 - a_2 > 0$ and $\lambda_H - \lambda_L > 0$. 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, $p_2 = 1$:

$$(A1) \quad p_1 F_1(H_1, L_1) = w_l L_1 + w_h H_1$$

$$(A2) \quad F_2(H - H_1, L - L_1) = w_l (L - L_1) + w_h (H - H_1)$$

$$(A3) \quad d \log \left(\frac{H_1}{L_1} \right) = -\sigma d \log \left(\frac{w_h}{w_l} \right)$$

$$(A4) \quad d \log \left(\frac{H - H_1}{L - L_1} \right) = -\sigma d \log \left(\frac{w_h}{w_l} \right)$$

$$(A5) \quad Hy_1^h(p_1, w_h) + Ly_1^l(p_1, w_l) = F_1(H_1, L_1).$$

The first two equations, A1 and A2, restate the constant returns assumption. Equations (A3) and (A4) are definitions of substitution elasticities in a CES technology. The last equation A5 is the market equilibrium condition for commodity Y_1 . According to Walras' law, equilibrium in the factors' market and in the market of commodity Y_1 implies that the market of commodity Y_2 clears. Taking the total differential and logs of equations A1–A5, we obtain:

$$(A6) \quad d\log p_1 = a_1 d\log w_h + (1 - a_1) d\log w_l$$

$$(A7) \quad (1 - a_2) d\log w_l = -a_2 d\log w_h$$

$$(A8) \quad d\log H_1 - d\log L_1 = -\sigma(d\log w_h - d\log w_l)$$

$$(A9) \quad (1 + \lambda_H) d\log H - \lambda_H d\log H_1 - (1 + \lambda_L) d\log L + \lambda_L d\log L_1 \\ = -\sigma(d\log w_h - d\log w_l)$$

$$(A10) \quad R_1 [\varepsilon_{1p}^h d\log p_1 + \varepsilon_{1m}^h d\log w_h + d\log H] \\ + (1 - R_1) [d\log L + \varepsilon_{1p}^l d\log p_1 + \varepsilon_{1m}^l d\log w_l] \\ = a_1 d\log H_1 + (1 - a_1) d\log L_1.$$

Assuming total labor supply is fixed, i.e., $dH = -dL$, and substituting equations (A6) to (A9) in (A10), we obtain:

$$(A11) \quad \frac{d\log w_h}{d\log H} = \frac{(1 - a_2) \left\{ (\lambda_H - \lambda_L) \left[R_1 - (1 - R_1) \frac{H}{L} \right] - \left[1 + \lambda_H + \frac{H}{L} (1 + \lambda_L) \right] \right\}}{(\lambda_L + 1)\sigma + (\lambda_H - \lambda_L)(1 - a_1)\sigma - (\lambda_H - \lambda_L)T},$$

where $T = \left\{ R_1 [\varepsilon_{1p}^h (a_1 - a_2) + \varepsilon_{1m}^h (1 - a_2)] + (1 - R_1) [\varepsilon_{1p}^l (a_1 - a_2) - a_2 \varepsilon_{1m}^l] \right\}$.²² The parameters of the equation above (which are shown in Table 5) are estimated in order to match the two-sector nature of the model. The 38 consumption items and the corresponding industries in Table 1 in the paper are divided into two aggregate consumption items and two aggregate production sectors. The high-skill-intensive (low-skill-intensive) aggregate consumption item is the sum of the expenditure shares in the 19 high-skill-intensive (low-skill-intensive) consumption items. The high-skill-intensive (low-skill-intensive) aggregate production sector is the sum of the number of workers in the 19 high-skill-intensive (low-skill-intensive) production sectors. Parameters estimated from the CPS sample

²² 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 ($\varepsilon_{ip}^l \neq \infty$).

1994–1997: $\lambda_H = \frac{H_1}{H_2} = 1.96$ ($\lambda_L = \frac{L_1}{L_2} = 0.45$) is the sum of the number of workers with (without) some college education who work in the 19 high-skill-intensive industries divided by those who work in the 19 low-skill-intensive industries. The wage bill share of workers with some college education in the 19 high-skill-intensive industries is $\alpha_1 = \frac{w_h H_1}{p_1 y_1} = 0.80$; in the 19 low-skill-intensive industries, it is $\alpha_2 = \frac{w_h H_2}{p_2 y_2} = 0.43$.²³ The skill ratio is $\frac{H}{L} = 1.22$. Parameters estimated from the CEX sample 1994–1997: the education elasticity is defined by R_1 , which is the share of expenditure on the skill-intensive aggregate consumption item by college-educated workers: $R_1 = \frac{Hy_1^h(\cdot)}{Hy_1^h(\cdot) + Ly_1^l(\cdot)} = 0.61$ (which is higher than the share of educated workers $\frac{H}{H+L} = 0.55$, and therefore increases inequality in the model). Due to the normalization in the model with respect to the low-skill sector, the elasticities ε_{1m}^i and ε_{1p}^i (where i is the education group) are expressed in relative terms and they refer to consumption of the high-skill-intensive aggregate good relative to the low-skill-intensive good. The estimation takes into account a system of two equations and the constraints imposed by the theory:

$$(A12) \quad \begin{aligned} \omega_{1i} &= \gamma_1 \mathbf{X}_i' + \beta_1 \log x_i + \theta_1 \log \left(\frac{p_1}{p_2} \right) + \zeta_1 + \varepsilon_{1i} \\ \omega_{2i} &= \gamma_2 \mathbf{X}_i' + \beta_2 \log x_i + \theta_2 \log \left(\frac{p_1}{p_2} \right) + \zeta_2 + \varepsilon_{2i}, \end{aligned}$$

where ω_{1i} indicates the sum of the expenditure shares by household i on the 19 high-skill-intensive items produced in sector 1, and ω_{2i} the sum of the expenditure shares on the 19 low-skill-intensive items produced in sector 2; $\log x_i$ is log total expenditure for household i deflated by the CPI and \mathbf{X}_i contains the age and sex of the head and the number of children in the household. Prices are aggregated using the weighted geometric mean (Stone price index) over prices, which have been normalized to one: $\log p_1 = \sum_{j=1}^{19} w_j \log p_j$ is an aggregate price index constructed using the individual commodity price series $\log p_j$ of the 19 high-skill-intensive items and their annual shares in total expenditure w_j as weights (the same holds for $\log p_2$ and the 19 low-skill-intensive items). The standard errors are clustered at the household level. The system A12 is estimated stacking the two equations in a fixed effect regression and imposing the homogeneity and symmetry constraints. To be consistent with a demand system $\sum (\omega_{1i} + \omega_{2i}) = 1$, the following restrictions are imposed: $\zeta_1 + \zeta_2 = 1$, $\gamma_1 + \gamma_2 = 0$, $\beta_1 + \beta_2 = 0$ (homogeneity in income) and $\theta_1 + \theta_2 = 0$ (homogeneity and symmetry in prices coincide given that there is a single relative price index). Two separate systems are estimated to calculate income elasticities of households with skilled and unskilled heads. The income (price) elasticities shown in Table 5 are calculated at the average household characteristics and are equal

²³ a_1 and a_2 are calculated assuming constant returns to scale, i.e., $p_1 y_1 = w_l L_1 + w_h H_1$ and $p_2 y_2 = w_l L_2 + w_h H_2$. The value of production in the high-skill and in the low-skill-intensive sector is calculated summing the wages of all workers in that sector.

to $\varepsilon_{1m} = \frac{\hat{\beta}_1}{\bar{\omega}} + 1$ ($\varepsilon_{1p} = \frac{\hat{\theta}_1}{\bar{\omega}} - 1$), where $\bar{\omega}$ is the average expenditure share. To calculate the income and price elasticities of skilled workers, I use $\bar{\omega}$, $\hat{\beta}_1$, $\hat{\theta}_1$ of the sample of workers with some-college education; to calculate the elasticities of unskilled workers, I use the corresponding parameters of the sample of workers without college education. Consistently with the predictions of the model, the income elasticities of the skill-intensive aggregate consumption item are higher than one for both education groups and both the United States and the United Kingdom.

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