

Economic Liberalization and Rising College Premiums in Mexico: A Reinterpretation

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Summary. — Mexico's college premium rose in the 1990s. Studies employing structural decomposition analyses treat the college premium as the relative price of "skilled" to "unskilled" workers. They find that reallocations of labor across industries and occupations cannot account for rising college premiums, and often attribute them to widely observed trade-induced increases in skills demand within the manufacturing sector. In contrast, using a reduced-form decomposition that moves beyond a binary definition of skill and allows for inter-occupation wage differentials, we show that employment shifts across occupations and industries *can* account for the increase in the college premium. We link the rising premium, and differences in its trajectory by gender and cohort, to the growth of specific professions that produce services, not manufactured goods.

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1. INTRODUCTION

Many developing economies that liberalized trade and Foreign Direct Investment (FDI) in the 1980s and early 1990s experienced an increase in the relative wages of skilled workers. This occurred even as the relative supply of skilled workers expanded, which implies that the relative demand for skilled labor grew. The simplest Heckscher–Ohlin thinking would have predicted declining relative demand for skilled labor since developing countries were expected to specialize in low skill products upon opening up to trade. A large literature has therefore emerged that asks why the demand for skills increased rather than decreased. This literature, in which Mexico is perhaps the most studied country, provides compelling evidence that the liberalization of trade and FDI policies increased the relative demand for skilled workers within the manufacturing sector (e.g., Feenstra & Hanson, 1997; Revenega, 1997; Robertson, 2004; Verhoogen, 2008). However, to what extent these trade-induced increases in demand for skills within the manufacturing sector are actually responsible for driving skill premiums up in the economy as a whole (i.e., including the nonmanufacturing sectors) remains an open question. We take up this question, using Mexican census data from 1990 and 2000, taking the wage-ratio of college to high-school graduates as our estimate of the skill premium.

We will begin by reviewing the evidence that rising demand for college graduates within manufacturing, or within sectors more generally, is central to the rise in the college-premiums economy-wide. We will argue that this evidence almost all comes from decompositions that split an estimate of the shift in relative skills demand into a "between-sector" and a "within-sector" component. The between-sector demand shift is the increase in relative skills demand imputed, under certain aggregation assumptions, from changes in the employment shares of occupations and industries of differing skill

intensities. It is larger when employment shifts into sectors that typically hire more college graduates. The within-sector demand shift is simply the residual difference between the estimated demand shift and the imputed between-sector shift.¹ The imputed between-sector demand shifts are usually very small (Robertson, 2000, 2004), if not negative (Katz & Murphy, 1992; Kijima, 2006; Sanchez-Paramo & Schady, 2003), and this finding has led to the conclusion that some force acting within sectors is responsible for driving up the college premium economy-wide. The literature largely appears to assume implicitly that this indicates a role for the trade-induced increases in skills-demand observed within manufacturing (see Section 2).

We will then critique the aggregation assumptions underlying the above analysis. Most importantly, we note that workers reporting the same education level in different occupations possess different skills, and therefore earn different wage rates. The standard decomposition analyses ignore these differences between occupations. This permits skill to be treated as one-dimensional, and analysis to be carried out in terms of the "relative quantity" and the "relative price" of "skilled" labor. We show that in Mexico the standard aggregation assumptions are not empirically justifiable, casting doubt, *ex ante*,

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on structural (supply and demand) models of the skill premium.

Of course, even incorrect simplifying assumptions may be harmless if they do not affect the *ex-post* outcome of the analysis. We will therefore ask what happens when we drop the assumption that workers within education classes are broadly homogenous. Doing so requires us to treat the college premium simply as a summary statistic, and not as the relative price between two factors of production. We split the employee pool into groups (or “sectors”) defined by their occupation and industry of employment, and note that the college premium is just the difference between the average log-wage of all the different groups of workers holding college degrees and that of all the different groups of workers holding high-school degrees. Under this more empirically conservative interpretation, it is natural, as is common with other inequality measures, to decompose it, and to decompose its change over time.

We will therefore use a reduced-form decomposition to examine, counterfactually, how the observed changes in sectors’ employment shares over-time would have shifted the college premium, holding the wage and educational profiles of sectors constant. Intuitively, we will ask whether the college premium rose because structural transformations permitted more college graduates to shift from poorly paid professions (e.g., secretaries) to well-paid ones (e.g., managers). As we will see, these counterfactual between-sector shifts in the college premium track the actual shifts in the premium remarkably well. This is in stark contrast to the traditional approaches in which between-sector shifts explain very little of the increase in the college premium. Moreover, between-sector shifts using this reduced form decomposition explain differences in the trajectory of the college premium between genders and cohorts. It follows that large within-sector forces need not be assumed to explain most of the rise in the college premium.

We will then identify the key occupations and industries responsible for the increase in skill premiums. These are a small group of professional occupations that primarily produce services and not manufactured goods. Moreover the employment shares and relative wages of these service professionals both increased. This suggests that rising demand for professional services was the main driver of rising college premiums economy-wide, not trade- or technology-induced changes in skills demand within manufacturing.

This distinction is policy-relevant. If rising college premiums reflect trade- or technology-induced scarcities, then it may be appropriate to supply more technical education in order to equip workers to produce new tradable goods and master new technologies. On the other hand, if rising college premiums reflect rising demand for the same old better-paid professions, then bottlenecks in professional training become crucial for efficiency. Moreover, from a sociological perspective, encouraging more (and usually less socially advantaged) students to pursue technical education when the returns are increasingly in high-status professions risks entrenching differences between status groups.

We present our argument as follows: Section 2 reviews the literature on rising skill premiums focusing for clarity on the Mexican case. Section 3 introduces the data. Section 4 presents our methodological argument. Section 5 shows that the college premium increased, and that it increased faster for women than for men despite faster growth in the share of women with college degrees. Section 6 uses a standard shift-share decomposition to describe changes in the employment situation of educated workers. Section 7 applies a reduced form decomposition approach to account for trends in Mexico’s college premiums. Section 8 concludes and provides directions for future research.

2. LITERATURE REVIEW

Mexico’s rising skill premiums have been widely examined, usually in the context of its increased exposure to foreign markets. Mexico reduced its trade barriers in the late 1980s when it joined the GATT. It liberalized rules on FDI in manufacturing more incrementally beginning in the early 1980s, and gradually eased the requirements for the establishment of maquiladoras (factories that may import inputs to the manufacture of exports duty free). The implementation of NAFTA, over 10 years starting in 1994, eliminated tariffs on trade with Canada and the US, and committed Mexico to maintaining earlier unilateral liberalizations of FDI.² Skill premiums rose during 1985–94 (when the Tequila crisis hit) and stabilized for the rest of the 1990s (Robertson, 2000, 2004; Rojas, 2006). Generalizing somewhat, the initial run-up in skill premiums has been attributed to some mix of FDI and trade liberalization (Hanson, 2003), although debate continues regarding the specific mechanisms driving skill premiums and how to interpret the experience since 1994 (Esquivel & Rodríguez-López, 2003).

We now review literature on the causes of rising college premiums, arguing that the evidence that they were driven up economy-wide by within-sector shifts comes from the decompositions whose assumptions this paper examines, and that the literature has primarily used data on the manufacturing sector and focused on explanations related to trade and technology. We focus on the Mexican experience to contextualize our findings.

(a) Evidence for within-sector demand shifts

The evidence for the importance of within-sector demand shifts is of three varieties. First, several authors seeking evidence of labor reallocations consistent with the Stolper–Samuelson Theorem have found reallocations across manufacturing industries to be small (Feliciano, 2001; Hanson & Harrison, 1999; Revenga, 1997). This implies that the adjustments giving rise to the higher utilization of skilled workers in manufacturing occurred within industries, and rules out not only Stolper–Samuelson effects, but also Hicks-neutral sector-biased changes (Berman, Bound, & Griliches, 1994). Notwithstanding its implications for trade theory, this finding sheds no light on the reasons for changing wage-inequality outside manufacturing.

Second, skill intensity rose within most industries, even as the relative wages of skilled workers increased, implying rising demand for skilled labor within those industries. Evidence of within-industry increases in skills demand has been found in the maquiladora “industry” (Mollick, 2008), in manufacturing sub-sectors (Esquivel & Rodríguez-López, 2003), and in many industries not limited to manufacturing (Airola & Juhn, 2008; Cragg & Epelbaum, 1996). This is credible evidence that within-sector demand shifts occurred, but does not imply that they are necessary for explaining rising college premiums economy-wide.

The third type of evidence for important within-sector shifts comes from the application of two types of decompositions. Studies utilizing these decompositions have been unable to link rising college premiums to shifts of workers between sectors, and have therefore concluded that within-sector shifts must have been more important. A key contribution of this paper is to show that these approaches may be predisposed to reach this conclusion. We will therefore discuss the findings of studies applying these decompositions more fully in Section 4.

(b) *Focus on manufacturing and trade*

We have found nineteen empirical papers that focus on Mexico's rising skill premiums in the 1980s and the 1990s. Nine of these conduct their main analysis on manufacturing data, and provide explanations for rising skills demand in the manufacturing sector. Of these, some explain that the rise in skills demand occurred because low-skill products lost more protection (Hanson & Harrison, 1999; Harrison & Hanson, 1999; Revenga, 1997; Robertson, 2004). Others show that products outsourced to Mexico were skill-intensive relative to Mexico's initial product mix (Feenstra & Hanson, 1997), or that trade and FDI brought capital—which is complementary to skill, and skill biased technical change (Esquivel & Rodríguez-López, 2003; Mollick, 2008, 2009). Other papers argue that it is not the types of products that are produced or how they are produced, but rather which firms produce them, and go on to provide reasons why high-paying, high-skill firms survive (Verhoogen, 2008). Five of the other ten papers, whose empirical analyses are not restricted to the manufacturing sector, cite the above explanations when interpreting their results. Thus the bulk of the literature links rising skill premiums to the manufacturing sector and external policy.

Our work builds directly on three of the remaining studies. Cragg and Epelbaum (1996) note that returns to occupation can explain almost half of the growth in wage dispersion, and conclude that the rising relative wages of "Professionals and Administrators" "supports the theory that the rapid pace of change in the economy increased the demand for individuals that can enact change" (p. 108). However, because their occupational classification is a bit crude, they cannot offer further insight into this intriguing possibility. Moreover, despite underscoring the role of occupation-specific skills, they conclude, from an analysis that does not permit occupation wage premiums, that import competition in manufacturing played an important role in lifting relative skills demand. Airola and Juhn (2008) suggest that evidence of increased skills demand within sectors is as strong outside manufacturing as it is within it, and urge further investigation of this finding. Chiquiar (2008) presents evidence, using the same data that we use, that skill premiums actually declined in the sectors and regions of Mexico most exposed to trade in the 1990s. He also notes that skill premiums rose fastest in Mexico City, suggesting that processes driving it are urban.

Our data offer the large samples and disaggregated industrial and occupational classifications necessary to follow these leads. We will show, consistent with Cragg and Epelbaum's (1996) finding for the 1980s, that rising demand for professionals lifted the college premium in the 1990s. Moreover, we will identify which specific occupations account for the increase in college premiums. Contradicting Cragg and Epelbaum's conclusion on the role of import competition, and accounting for Airola and Juhn's finding that skills demand rose more in services, we will show that most of these occupations produce services, not goods. Many of these services are likely to be at least nontraded, if not nontradable. The fact that the professions involved tend to be urban helps explain Chiquiar's findings.

3. THE DATA

This paper uses Mexico's 1990 and 2000 Censuses of Population and Housing (Minnesota Population Center, 2011). The censuses were conducted by the Instituto Nacional de Estadística y Geografía (INEGI) and obtained through IPUMS-

International. They provide detailed information on personal characteristics including workers' earnings, age, education, industry, and occupation of employment. They are among the largest nationally representative surveys of a developing economy labor force in existence, covering roughly 10% of the population (2.3 million sampled members of the workforce in 1990 and 3 million in 2000), and feature four-digit occupational and industrial classifications. These classifications change during 1990–2000, but can be concurred with relatively few assumptions and some aggregation. IPUMS-International provides a clean concordance between 40 industries and nine occupations. With a handful of conservative judgment calls (and therefore a small loss of accuracy) we worked out an 89-industry classification and a 115 occupation classification. Thus, we can measure highly disaggregated wage and employment distributions with reasonable precision.

We use a quantity and a wage sample drawn from the Census data. The quantity sample includes all members of the labor force aged 16–65, and is used for analyzing how the joint distribution of workers across education classes and sectors of the economy has shifted. Individuals not reporting their industry, occupation, or years of schooling are dropped. The wage sample is a sub-sample of the quantity sample. It excludes the unemployed and self-employed because their labor income is unobserved. It also excludes public employees, workers that hold specialized teaching degrees, as well as those who are classified by occupation as teachers or professors, because their wages are almost always institutionally determined.³ We drop workers whose wages are institutionally determined because we wish to understand the growing education premium in the private sector. This is, after all, where trade and technological change are presumed to have had the greatest effect.⁴ Moreover, a focus on the private sector may be more policy relevant from a political-economy perspective (Iversen & Wren, 1998), given that Mexico's tight fiscal position probably precludes the use of public sector employment to reduce inequality.

Those with lower- and upper-secondary technical education are also dropped in order to compare the wages of college graduates with those of a class of workers that is consistently defined over time. Only employees with positive work hours and income are included. Hourly wages are constructed by dividing monthly earnings by weekly hours and multiplying by 7/30. Those top-coded as working 140 h per week are dropped, because their hourly wages cannot be reliably calculated since their true weekly hours are unknown.⁵

The wage sample is used for examining education wage premiums. Only those with exactly a primary, lower secondary, upper secondary, and college degree are included in the main analysis.⁶ A Mexican college education can take 4 or 5 years, depending on the course of study and other factors, and the share of college graduates with 4 rather than 5 year degrees rose from 47.5% in 1990 to 54.5% in 2000. In order to keep the type of education whose shifting returns we analyze roughly constant over time, we analyzed the returns to 4 and 5 year college degrees separately. The tables and discussion presented here are drawn from a sample of 4-year college graduates (i.e., the sample excludes 5-year college graduates). Results of the analysis on 5 year graduates alone were not qualitatively different, and are available upon request.

Some workers report unrealistically low wages. Loosely following Hanson (2003), who uses a 10% sample of our data set, we drop the workers with wages below 10 pesos per month, and then trim the bottom 0.5% of the remaining samples in both years.⁷ Lastly, we separate the analysis for men and women since their labor market and education experiences are very different.

4. METHODOLOGIES

This section compares three approaches to linking changes in skill premiums, skills demand, and the composition of employment. We first explain how college premiums are measured, and then introduce the three decompositions used to examine why they rose and consider their relative merits.

While it is traditional to report returns from wage regressions in order to control for potential labor market experience and other worker characteristics, our large sample sizes permit us to calculate premiums without running regressions. To do this we simply assign workers to groups based on their gender and years of potential work experience, and then divide each group into cells based on workers' educational attainment. We then estimate the wage premium to education level e in a particular group from the difference in the mean log-wage of workers with education level e , and that of those with the next highest level of education. For example, the college premium (per year of education) is calculated simply as the difference between the mean-log-wage of all 4-year college graduates and that of all upper secondary graduates, divided by four, for a group of workers in a particular experience and gender group. Upper secondary premiums similarly reflect annualized log-wage differentials between upper- and lower-secondary graduates, and so forth. We prefer to do this, rather than using regressions with polynomials in years of education and experience for two reasons. First, it avoids assumptions about functional forms. Second, these log-wage differences, being arithmetically simple, can be decomposed as shown in Section 4(c).

(a) *Between-within analysis of skill absorption*

This commonly used decomposition asks whether the growing supply of educated workers was absorbed by a shift of employment from less to more education intensive sectors, or whether it resulted in education levels rising within sectors. Denote the share of the workforce with at least education level e by $F(e)$; the employment share of sector s by $F(s)$, and the share of workers in sector s with at least education level e by $F(e|s)$. Then an increase in the share of workers with at least education level e , $\Delta F(e)$, can be absorbed as follows:

$$\Delta F(e) \equiv \underbrace{\sum_s F(e|s)\Delta F(s)}_{\text{Between Sector Effect}} + \underbrace{\sum_s F(s)\Delta F(e|s)}_{\text{Within Sector Effect}} \quad (1)$$

If the between sector effect is positive (negative), then we must conclude that the composition of employment shifted in a more (less) skill-intensive direction.

Some authors interpret the absorption of educated workers between sectors as an indicator of an increase in education demand driven by the changing composition of employment. We argue that this interpretation can be misleading since this decomposition considers no information regarding wage differences across sectors. However, the decomposition provides an extremely useful way of organizing and presenting information on where the influx of educated workers has found employment. We will apply it for this purpose in Section 6.

(b) *Katz and Murphy's demand shift index*

Katz and Murphy (1992) propose to account for shifts in the college premium with the following decomposition:

$$\Delta \ln \left(\frac{W_c}{W_h} \right) \equiv \frac{1}{\sigma} [\Delta D_t - \Delta \ln(x_c/x_h)] \quad (2a)$$

$$\Delta D_t \equiv \sum_s \left[\frac{E_{c,s}}{E_c} - \frac{E_{h,s}}{E_h} \right] \frac{\Delta E_s}{E_s} + \text{Within Sector Demand Shift}; \quad (2b)$$

where W_c and W_h , respectively, are the wages of college and high-school graduates, $\Delta \ln(x_c/x_h)$ is the percentage shift in the relative supply of college graduates in efficiency units; and σ is the elasticity of substitution between college and high-school graduates. The E_s captures employment by type ($c = \text{college}$, $h = \text{high-school}$), and/or sector (s) in efficiency units. Labor supplied by workers of differing age groups is aggregated into efficiency units in proportion to the relative wages of different age groups. Critically, the efficiency labor units offered by workers of each education class are assumed invariant to industry or occupation. This assumption is critical because it can suppress the role of occupation-specific skills. Sectors are defined by a combination of industry and occupation. The shift in relative demand attributable to shifts in the composition of employment between sectors is given by the summation in (2b). The "within sector demand shift" is the residual demand shift necessary to reconcile the supply shift and the compositionally expected demand shift with the change in college premium.

We ran this decomposition on our data, and found that the between-sector demand shifts it identifies cannot account for rising college premiums in our data. Details are presented in the Appendix. However, the key result is that even after making a series of assumptions rigged to yield the maximum possible between-sector demand shift, we would still have to assume within-sector demand shifts that are over three times the size of the estimated between-sector shift to reconcile the large increase in the relative supply of college graduates with the increase in the college premium. Previous studies from various countries applying this method reach similar conclusions.⁸

We argue that this inability to link shifts in employment composition to increases in college premium arises because the demand shift index is insensitive to movements from low to high-wage occupations with similar education profiles. To illustrate, suppose (for simplicity) that the numbers of college graduates working as librarians ($s = L$) and managers ($s = M$) are the same ($E_{c,L} = E_{c,M}$), and that all librarians and managers have college degrees ($E_{h,L} = E_{h,M} = 0$). Then, if some number of college graduates switch from being librarians to being managers, and nothing else changes, the projected between-sector shift in relative demand will be zero (see identity (2b)). However, so long as managers earn higher wages than librarians, the switch will raise the college premium, and a spurious "within-sector" increase in skills demand will be detected residually.

(c) *The arithmetic identity approach*

We now turn to a set of simple wage-premium decompositions. Restrict attention to the wage-sample. Denote the share of employees with exactly education level e by $P(e)$; the share of employees in sector s by $P(s)$, and the share of employees with exactly education level e who are employed in sector s by $P(s|e)$. By "sector" we mean any categorization of workers, whether by industry, occupation or both. Let $\bar{w}_{s,e}$ be the average log wage of employees with education level e ($= c$ or h for college or high-school) in sector s . One can then decompose the college premium as a sum of the contributions of each sector ($C_{s,c}$) as follows:

$$\ln(W_c/W_h) \equiv \sum_s [P(s|c)\bar{w}_{s,c} - P(s|h)\bar{w}_{s,h}] \equiv \sum_s C_{s,c} \quad (3)$$

Holding wages constant, a sector's contribution to the college premium is large if it employs a large fraction of college graduates or a small fraction of high-school graduates. Holding these fractions constant, a sector's contribution is large if it pays college-educated workers well or high-school educated workers badly.

It follows from (3) that the contribution of a sector to shifting the college premium is $\Delta C_{s,c}$ —the change in the sector's contribution to the static premium:

$$\Delta \ln \left(\frac{W_c}{W_h} \right) \equiv \sum_s \Delta C_{s,e} \quad (4)$$

Next, we divide each sector's contribution to the college premium by its employment share to present the contributions per job, $\tilde{C}_{s,c} = \frac{C_{s,c}}{P(s)}$ (each job has probability mass zero). Thus, multiplying and dividing (3) and (4) by $P(s)$ yields:

$$\ln(W_c/W_h) \equiv \sum_s P(s) \tilde{C}_{s,c} \equiv \sum_s P(s) \frac{C_{s,c}}{P(s)} \quad (5)$$

$$\begin{aligned} \Delta \ln \left(\frac{W_c}{W_h} \right) &\equiv \sum_s \Delta [P(s) \tilde{C}_{s,c}] \\ &\equiv \underbrace{\sum_s \tilde{C}_{s,c} \Delta P(s)}_{\text{Compositionally Expected Shift in Premium}} \\ &\quad + \underbrace{\sum_s P(s) \Delta \tilde{C}_{s,c}}_{\text{Residual Shift in Premium}} \end{aligned} \quad (6)$$

Identity (5) expresses the college premium as an employment-weighted average of the contribution per job of each sector. Intuitively, small increases in employment in high contribution-per-job sectors (those positions that hire lots of college graduates or pay them especially well) will lift college premiums. The *compositionally expected* shift in the college premium in (6) is the change in wage premium expected due to changes in employment shares holding contributions per job constant. Changes in college-premium can be accounted for by movements between sectors if the compositionally expected shift approximates the observed shift in college premium. Returning to our previous example, the shift of employment out of badly paid librarian positions into better paid managerial positions predicts an increase in the college premium.

To implement this approach, we split the wage sample into cells by occupation, industry, gender, education, and experience brackets, and use the average wages in each cell and the distribution of workers across cells to estimate the components of identities (3)–(6). We discuss these results in Section 7.

(d) *Pros and cons*

We now consider the relative merits of Katz and Murphy's structural approach (identity (2)) and the reduced-form approach (identity (6)) to understanding shifts in college premiums. As always, the tradeoff between structural and reduced form approaches hinges on the usefulness of the structural representation, the plausibility of its assumptions, and the availability of the data required to estimate its parameters. We consider each in turn.

The usefulness of a supply and demand representation of skill prices is beyond question. The representation is simple, intuitive, and readily illuminates policy discussions. For example, our reduced form approach cannot shed light on the effects of education expansions on skill prices. Nor does it lead to statements about shifts in skills demand.⁹

Our principle concern is with one of the assumptions of the structural approach—that equally educated workers in different sectors provide the same level and type of skill, and so will earn similar wages. If wages vary across sectors because workers in different sectors are different—most obviously they may possess different types and quantities of human capital—then it is unclear what the “relative quantity” or the “relative price” of college to high-school graduates actually means, because these are simply amalgams of heterogeneous groups of workers with heterogeneous skills. This problem will be compounded whenever the distribution of workers (within an education class) across sectors changes over time. As we have already shown logically, the assumption could predispose the structural approach to attribute rising college premiums to within-sector forces.

These concerns appear to be empirically relevant. Wage regressions with occupation fixed effects reveal that in 2000, the standard deviation of inter-occupation wage differences was 38% (31%) of the average wage among college-educated men (women). This implies that it is indeed difficult to define a college premium as the relative price between two properly defined factors each receiving roughly uniform pay.¹⁰ Inter-occupation wage differentials are similarly confirmed among upper-secondary graduates. Moreover, we strongly rejected the null hypothesis that the occupational mix is independent of college completion in every group of workers (defined by experience and gender); and also strongly rejected the null, in every education-gender-experience group, that the occupation mix remained the same over time.¹¹ Together, these results imply that if we wished to treat the college premium as some sort of weighted average of the college premiums across occupations, we would not be able to propose meaningful weights.

The above discussion leads us to consider a different interpretation of the college premium when (measurably) equally educated workers possess different skills. The premium can no longer be thought of as a relative price, because there are no longer only two factors being priced relative to each other. It is now simply a summary statistic describing one feature of the wage distribution. The reduced form decompositions simply tell us which changes in the components of this summary statistic are most instrumental in making it move.

Finally—data availability. Every developing country study applying the Katz and Murphy approach has lacked the high-frequency datasets and variability in the growth rate of relative skill supplies needed to estimate σ . They have therefore assumed values for it derived from US data (Kijima, 2006; Richter, 2006; Sanchez-Paramo & Schady, 2003). This assumption drives these models' predictions about the effects of education expansion on college premiums.

5. THE GROWING SUPPLY OF COLLEGE GRADUATES AND THE COLLEGE PREMIUM

Table 1 presents education wage-premiums per year of schooling, calculated as explained in Section 4. We define low-experience workers to have 3–7 years of potential labor market experience, and high-experience workers to have 18–22 years. We use 5-year experience brackets to leave a large enough sample size to permit an accurate decomposition analysis. Reducing the width of the experience bracket or using measures of education wage premiums derived from regressions does not alter the estimated premiums in economically significant ways.

College premiums rose sharply while premiums on secondary education increased slightly for some groups and

Table 1. *Simple returns to education level, by gender, year and experience cohort*

Education level	Low experience			High experience		
	1990	2000	Change	1990	2000	Change
<i>Men</i>						
Lower secondary	.035 (.002)	.047 (.002)	.011 (.002)	.066 (.003)	.065 (.002)	.000 (.003)
Upper secondary	.097 (.002)	.098 (.002)	.001 (.003)	.101 (.005)	.115 (.003)	.014 (.006)
College	.162 (.003)	.203 (.003)	.041 (.004)	.177 (.007)	.200 (.004)	.023 (.008)
<i>N</i>	92,604	115,894	–	49,499	84,324	–
<i>Women</i>						
Lower secondary	.053 (.002)	.057 (.002)	.004 (.003)	.097 (.005)	.078 (.003)	– .019 (.006)
Upper secondary	.121 (.003)	.110 (.002)	– .011 (.004)	.136 (.009)	.165 (.005)	.029 (.010)
College	.152 (.004)	.204 (.003)	.051 (.005)	.094 (.011)	.155 (.005)	.062 (.012)
<i>N</i>	47,585	68,495	–	13,547	28,079	–

Note: Changes in annualized returns that are statistically significant at the 1% level are in bold type. Standard errors are shown in parentheses. The low experience cohort consists of wage employees who have 3–7 years of potential labor market experience. The high experience cohort consists of wage employees who have 18–22 years of potential labor market experience. The wage samples are used and include employees ages 16–65.

decreased slightly for others (Table 1). Thus, as happened in other developing economies that opened up to international markets, the log-wage-education profile became more convex. We also note that women's college premiums were lower than men's in 1990, but grew much faster.

Table 2 provides the cumulative distribution of education in the quantity sample by year and gender. Educational attainment rose for both genders: each distribution in 2000 dominates its 1990 comparator in the first-order sense. This combination of rising college premiums and rising supplies of college graduates implies that demand for college graduates rose relative to demand for high school graduates.

Similarly, the female labor force is more educated than the male labor force in both years. Women's secondary- and college-education completion rates grew faster than men's, although men narrowed the gap in post-graduate and basic education. Differential rates of supply increase are therefore unlikely to explain why women's college premiums rose faster than men's, as the supply shifts were larger for women.

The remainder of this paper is dedicated to examining whether the increase in the relative wages of college-educated labor, and its faster increase for women, can be accounted for by changes in the occupational and industrial composition of employment, and if so, where in the economy the relevant changes occurred. This sheds light on the importance of trade- or technology-induced increases in skill demand within sectors relative to other explanations of rising college premiums.

6. THE CHANGING COMPOSITION OF EMPLOYMENT

We now describe changes in the composition of employment to underscore two points: (1) manufacturing probably employs too few skilled workers to have driven skill premiums; and (2) neither of the standard between-within decompositions shed light on why college premiums rose, or on why they rose faster for women.

Table 2. *Cumulative distribution of highest education level completed, by gender and year*

Education level	1990			2000			Change in gender difference
	Men	Women	Gender difference	Men	Women	Gender difference	
None (%)	11.60	6.80	4.80	5.60	4.30	1.30	–3.50
Incomplete primary (%)	35.30	18.70	16.60	23.00	15.20	7.80	–8.80
Primary (%)	57.70	39.10	18.60	42.60	31.70	10.90	–7.70
Incomplete lower secondary (%)	62.90	42.80	20.10	48.00	35.40	12.60	–7.50
Lower secondary (%)	79.90	72.80	7.10	68.90	55.50	13.40	6.30
Incomplete upper secondary (%)	84.20	77.00	7.20	73.90	61.10	12.80	5.60
Upper secondary (%)	89.10	83.40	5.70	83.90	76.60	7.30	1.60
Incomplete college (%)	91.60	87.40	4.20	87.50	82.80	4.70	0.50
College (%)	93.80	91.90	1.90	92.00	90.70	1.30	–0.60
Some graduate (%)	100	100	0.00	100	100	0.00	0.00
<i>N</i>	1,632,741	498,460	–	2,116,255	783,903	–	–

Note: The gender difference is the female–male gap in the cumulative distribution of educational attainment. The change in gender difference is calculated as the difference over time of the female–male gap. The distribution is estimated using the quantity sample.

Table 3. Sectoral employment shares, by gender and year

Sector	Men			Women		
	1990	2000	Change	1990	2000	Change
Agriculture	0.265	0.192	-0.073	0.029	0.035	0.006
Construction	0.091	0.117	0.026	0.008	0.009	0.001
Mining	0.011	0.008	-0.003	0.004	0.002	-0.002
Utilities	0.008	0.006	-0.002	0.004	0.003	-0.001
EI manufacturing	0.097	0.106	0.009	0.091	0.091	0.000
EU manufacturing	0.105	0.095	-0.010	0.115	0.110	-0.005
EI services—FIRE	0.013	0.011	-0.002	0.027	0.019	-0.008
EI services—nonFIRE	0.116	0.138	0.022	0.323	0.309	-0.014
EU services	0.264	0.311	0.047	0.376	0.412	0.036
Unemployed	0.030	0.016	-0.014	0.022	0.011	-0.011
Aggregate	1.000	1.000	-	1.000	1.000	-

Notes: Employment shares are derived using the quantity sample. EI = education intensive; EU = education un-intensive. See text for operational definitions.

Table 3 shows the composition of employment in each year. The manufacturing and service sectors were each split on the basis of education intensity, with those sub-sectors whose average years of schooling exceed the sector-wide mean categorized as Education-Intensive (EI), and the remainder designated as Education-Unintensive (EU). The education-intensive services were further divided into Finance, Insurance, and Real-Estate (FIRE) and the rest (nonFIRE), given that long term cycles and regulatory regimes have been found to affect wages in the financial sector differently (Philippon & Reshef, 2009).

Several features stand out. The manufacturing sector's employment share among men and women remained constant at around 20%. Outside manufacturing, the story is more gender specific. Agricultural employment declined sharply for men, falling to 20%, while agriculture already employed only 3% of the female labor force in 1990. Construction and mining are also male dominated industries, together employing 12.5% of men, and only 1% of women. As a result, most women work in services, and this trend is deepening: Services employed

72.6% of women in 1990 and 74% in 2000. In contrast, by 2000, the share of men working in services was only 46.8%. Thus, from an employment perspective, Mexico is a service economy, especially for women. This underscores the possibility that increases in demand for college graduates originate outside manufacturing.

Finally, while employment in education-intensive services declined for women, it rose for men. This suggests that the composition of employment became less education-intensive for women, but more education-intensive for men. To investigate this last suggestion more carefully, we apply the between-within analysis discussed in Section 4 (identity (1)) to examine where the influx of college graduates was absorbed.

The results, presented in Table 4 confirm our suspicions from Table 3: the employment composition became more education-intensive for men (all entries, except those corresponding to changes between the 51 service sub-sectors, are positive), but became less education-intensive for women. Moreover, this result appears to be invariant to the level of disaggregation so long as manufacturing and services are

Table 4. Between-within sector analysis: percent between shifts, by gender and education level for different levels of sector disaggregation

	Men			Women		
	LS	US	College	LS	US	College
<i>Industrial classification</i>						
3 + 1 industries	0.209	0.165	0.271	-0.020	0.003	0.008
6 + 1 industries	0.173	0.145	0.251	-0.029	0.001	0.005
9 + 1 industries	0.178	0.144	0.251	-0.208	-0.055	-0.104
29 + 1 industries	0.193	0.149	0.258	-0.205	-0.060	-0.115
57 + 1 industries	0.168	0.137	0.255	-0.328	-0.095	-0.149
89 + 1 industries	0.174	0.124	0.206	-0.343	-0.104	-0.168
22 manufacturing sub-sectors	0.131	0.078	0.216	0.031	-0.027	-0.126
51 service sub-sectors	-0.042	-0.030	-0.020	-0.442	-0.115	-0.176
<i>Occupational classification</i>						
9 occupations	0.191	0.146	0.249	-0.433	-0.084	-0.109
115 occupations	0.182	0.167	0.339	-0.474	-0.023	0.168

Note: Figures represent the between sector shift in college intensity, calculated per identity (1). The three industries are agriculture, industry, and services. The 6-industry classification splits industry into manufacturing, utilities and construction. The 9-industry scheme splits manufacturing further into education intensive (EI) and un-intensive (EU) subsectors and services into EU, FIRE (Finance, Insurance, and Real Estate) and nonFIRE EI services. The 29-industry scheme begins with the 9-industry scheme and splits manufacturing into 22 sub-sectors. The 57-industry scheme begins with the 9-industry scheme and splits services into 51 sub-sectors. The 89-industry scheme is derived from a concordance at roughly the three-digit level provided by IPUMS-International. "+1" refers to the unemployed. The 9-occupation classification is the one-digit International Standard Classification of Occupations. The 115 occupation scheme is defined at the three or four digit level, as feasible.

partitioned into education intensive and unintensive sub-sectors. Even within services, which absorbed far more men than women in the 1990s, the educational de-intensification is much more pronounced for women. The only exception to this characterization is for the classification involving 115 occupations, but even here the employment composition became education intensive faster for men than for women.¹² This reduction in the education intensity of female employment deepens the mystery of why women's college premiums rose at all, and why they rose faster than men's.

We also used identity (1) to reveal where the net influx of new college graduates have found work. Fully 91.7% of the female net influx and 85.5% of the male influx found jobs in services. The corresponding figures for manufacturing are only 10% for men and 6.9% for women. Moreover, within services, the absorption is not dominated by the FIRE sectors. Thus, whatever explains the growing employment of college graduates appears to go beyond both the demand for financial services, and changes in tradable goods production (manufacturing). Increased demand for college graduates in nonfinancial services is suggested.

7. ACCOUNTING FOR THE INCREASE IN COLLEGE PREMIUMS

(a) *Between-sector or within-sector effects?*

We have so far demonstrated that neither the Katz and Murphy scheme, nor a between-within analysis of the absorption of college graduates, can link Mexico's rising college premiums to changes in the composition of employment. We now demonstrate that the between-sector component of the reduced form decomposition can account for trends in the college premium.

Table 5 compares the actual and compositionally expected shifts in college premiums derived from identity (6). Between-industry shifts (rows 1–6) imply little change in college premiums. This result is invariant to the degree of industrial disaggregation, and implies that college premiums do not arise mainly from shifting employment across even fairly narrowly defined industries. However, using only nine different occupations (row 7), compositional shifts account for the entire increase in college premiums for workers averaging 20 years of experience (.026 *versus* .023 for men, 0.062 *versus* 0.062 for wo-

men), and some of the shift for those averaging 5 years of experience. This compares favorably with the results using the same occupation classification but the between-within decomposition of absorption in Table 4, in which between-sector shifts actually reduced demand for college educated women.

Applying identity (5), we find that the contribution per "Professional" job for all experience-gender pairs is in the range (1.77, 2.09), which is ten times the average contribution for the entire employee pool (which ranges from 0.09 to 0.18). In other words, *ceteris paribus*, more jobs as professionals would boost the college premium significantly. This expectation is confirmed in row 8 of Table 5 where we split the workforce into 14 sectors: our usual nine industries with jobs in the five manufacturing and services sub-sectors split into professional and nonprofessional positions. The compositionally expected shift accounts for over 78% of the actual shift in the college premium for all gender-experience groups. Analogous decompositions account for 45–50% of the shift in the 5-year college premium for men, and 85–98% for women (results available on request).

One potential concern is that between-within decompositions might attribute all shifts to between-sector movements if the number of sectors is made arbitrarily large, as this leaves little room for within-sector variation. Row 9 of Table 5 suggests that this is not what is driving our results. Going from 14 to 81 industry-occupation pairs does not bring the compositionally expected shift closer to the actual. And in any case, each premium is estimated from a sample of several thousand workers, so it is unlikely that the number of sectors drives the results. The 14-sector split into professional/nonprofessional workers by industry therefore appears to be a powerful one for accounting for growth in the college premium.

(b) *Which sectors matter?*

Table 6 presents the contributions (defined in identity (4)) of our 14 sectors to the shift in college premiums. It shows that the occupation-industry pairs explaining most of the increase in the college premium are in services, not manufacturing. Moreover, it is professionals in nonFIRE education-intensive services that matter most.

To understand which occupations changed in ways that generated changes in the college premium, we ran our decompositions on our 115 occupation classification. To achieve the

Table 5. *Compositionally expected versus actual change in annualized return to college education*

		Men		Women	
		Low experience	High experience	Low experience	High experience
<i>Compositionally expected shift in college return</i>					
(1)	3 industries	0.006	0.004	0.001	0.003
(2)	6 industries	0.004	0.000	0.001	0.003
(3)	9 industries	0.021	0.009	0.008	-0.001
(4)	29 industries (9 and disaggregated mfg.)	0.013	0.008	0.000	-0.002
(5)	57 industries (9 and disaggregated serv.)	0.011	0.000	0.012	0.001
(6)	89 industries	0.000	-0.003	0.007	-0.003
(7)	9 occupations	0.014	0.026	0.032	0.062
(8)	14 sectors: 9 industries—5 of them split by professional/not	0.032	0.025	0.045	0.052
(9)	81 industry-occupation pairs	0.020	0.036	0.037	0.070
<i>Actual shift in college return</i>		0.041	0.023	0.051	0.062

Note: Figures represent the compositionally expected shift in college premium calculated using identity (6). Definitions of sector classifications appearing in rows (1)–(7) are the same as in Table 4. Classifications in rows (8) and (9) are explained in the text.

Table 6. Which industry-occupation pair shifted college returns? $\Delta C_{s,c}$ by gender and experience cohort

Sector		Men		Women	
		Low experience	High experience	Low experience	High experience
Agriculture	N.A.	0.001	0.002	-0.001	0.000
Mining	N.A.	-0.002	-0.003	0.000	0.000
Utilities	N.A.	0.001	-0.002	0.000	-0.002
Construction	N.A.	0.001	0.002	0.002	0.001
EU Mfg.	Nonprofessional	-0.002	-0.001	0.003	0.000
	Professional	0.000	-0.001	0.000	0.001
EI Mfg.	Nonprofessional	-0.005	-0.004	0.000	0.000
	Professional	0.003	0.003	0.005	0.002
EU Services	Nonprofessional	0.008	0.004	0.007	0.004
	Professional	0.002	0.003	0.003	0.001
FIRE	Nonprofessional	0.004	0.004	0.008	0.001
	Professional	0.002	0.002	0.003	0.001
NonFIRE EI Services	Nonprofessional	0.007	0.002	-0.006	0.010
	Professional	0.020	0.011	0.028	0.043
Aggregate		0.041	0.023	0.051	0.062

Note: Contributions to the shift in college returns are defined in identity (4). The largest contributions are in bold.

Table 7. Top ten occupations by contribution to shifting the returns to college. 5–35 years of experience

Occupation	Contribution to shifting the college premium	Change in employment share (%)	Change in occupation wage premium (%)	Shift in relative demand (%)
<i>Women</i>				
1 Medical professionals	0.026	63.5	12.5	76.0
2 Directors, managers, and administrators in private and social sectors	0.006	5.6	8.6	14.2
3 Miscellaneous dept. heads and supervisors within services	0.006	20.1	7.6	27.6
4 Sales supervisors	0.006	24.2	-1.1	23.0
5 Architects and engineers	0.003	42.2	8.7	50.9
6 Sales agents	0.003	29.1	-3.9	25.3
7 Accountants/bookkeepers	0.003	63.5	-9.5	54.0
8 Professional social scientists and educators	0.002	20.4	5.9	26.3
9 Other professionals, nec	0.002	163.9	13.5	177.3
10 Professional artists, choreographers, decorators and designers	0.002	10.9	5.7	16.6
Total for top 10 occupations	0.059			
Total shift in returns	0.060			
<i>Men</i>				
1 Architects and engineers	0.006	6.6	-5.6	1.1
2 Sales supervisors	0.005	23.8	-13.8	10.0
3 Accountants/bookkeepers	0.005	29.6	-14.4	15.2
4 Medical professionals	0.004	-22.1	21.0	-1.1
5 Miscellaneous dept. heads and supervisors within services	0.004	1.7	-5.7	-4.0
6 Other professionals, nec	0.003	108.8	6.2	115.0
7 Technicians, mostly in engineering	0.002	-10.9	-0.2	-11.1
8 Lawyers	0.002	3.3	-2.9	0.4
9 Chemists/pharmacists	0.001	12.6	-4.0	8.6
10 Marketing professionals, economists, and other related researchers	0.001	18.9	2.3	21.2
Total for top 10 occupations	0.033			
Total shift in returns	0.039			

Note: Contributions to the shift in college returns are defined in identity (4).

sample size needed to accommodate this higher level of disaggregation, we expanded the experience levels under consideration, including workers with between 5 and 35 years of potential work experience. Comparing Tables 1 and 7 reveals that broadening the experience sample does not result in qualitatively different shifts in estimated premiums.

Table 7 provides the shifts in college premium to be accounted for, and the contributions of the 10 most important

occupations to those shifts, per decomposition (4). Usefully, the top 10 occupations account for 5.9 out of the 6.0 point increase in college premium for women and 3.3 out of a 3.9 point increase for men. Particularly intriguing is the massive contribution of the medical profession for women, which accounts for over 40% of the increase in the female college premium. Employment of male medical professionals fell. Consistent with this, previous studies (Aguilar, Nigenda,

Mendez, & Knaul, 2003; Harrison, 1998; Knaul, Frenk, & Aguilar, 2000) have noted a massive feminization of the Mexican medical profession in the 1990s.¹³

Next, to investigate whether the contributions of these occupations are demand driven, we implement a strategy for estimating occupational demand shifts adapted from Murphy and Welch (1993). We began by collapsing the quantity and wage samples for each year into 55,200 possible cells, defined by 115 occupations, two genders, 40 years of experience groups and six education categories. We then converted the hours of work by each cell into efficiency units by multiplying them by the average wage in the 2 years of workers in its education-experience-gender group. Next, for each year, we defined gendered occupation by a combination of gender and our 115 occupations, and added up the efficiency units provided by each gendered-occupation to calculate their employment shares in the compressed quantity sample. The log-difference over time in employment share is the employment growth rate of this gendered occupation (2nd column of Table 7). Then, using the compressed version of the wage-sample for each year separately, we regressed log-wages on average years of schooling, 78 gender-experience dummies, and 229 gendered-occupation dummies. We used the procedure of Haisken-DeNew and Schmidt (1997) to obtain normalized occupation wage differentials (in percentage terms). Their shift over time is the percent change in relative occupation wages (3rd column). Finally, assuming unit-elastic relative demand for occupations, we added the percentage shift in quantity and price (4th column). This is positive, indicating that demand grew for all of the top ten occupations shifting college premiums for women, and for seven of them for men.¹⁴ We also note that when we conducted the same exercise using only nine occupation groups instead of 115, we found a substantial increase in the relative demand for professionals (results available on request).

Finally, we find that by 2000, 89% of the women and 79% of the men in the occupations appearing in Table 7 worked in the services sector. Only 10% of the women and 16% of the men in these occupations were employed in manufacturing that year.

8. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

We have treated the college premium as a decomposable measure of wage inequality across educational classes, dropping the assumption that it is a relative price between two roughly homogeneous factors of production. We have shown that using this more empirically conservative approach permits us to link the growth in Mexico's college premium in the 1990s to a shift in employment between sectors (occupations and industries). This contrasts with standard structural approaches that treat the premium as a relative price and can only account for its increase by invoking within-sector increases in skills demand. Our result therefore suggests that within-sector increases in skills demand, such as skill-biased technological change, may not be central to the rise in college premium as is often thought. We have also shown that the occupations most arithmetically responsible for the rise in the college premium produce services, many of which are nontraded, rather than tradable manufactured goods. Moreover, it appears that demand for most of these occupations rose. This suggests that changes in the wages and employment of workers in the tradable sector—the focus of much of the literature on globalization and wages—may not be as central to the increase in Mexico's college premiums as commonly presumed.

The contribution of our paper is therefore to point out that the search for explanations of rising skill premiums needs to be broadened. In particular, it should examine the demand for professional services more thoroughly in order to arrive at new theories that can explain why skill premiums might rise in response to economic liberalization. We note that liberalization typically brought not just freer trade and international investment, but also greater capital intensity, more market-driven modes of transacting, deregulation, changes in the distribution of firm sizes, and (usually) faster growth in average incomes. Any or all of these changes may be important.

We conclude by offering some thoughts, as suggestions for future research, on why demand for the specific occupations identified in Table 7, central to the increase in college premiums, may have grown. We begin with growth. According to the World Development Indicators, Mexican real per capita GDP rose 19.5% during 1990–2000. While the literature has recognized that liberalization may boost inequality by spurring growth (e.g., Goldberg & Pavcnik, 2007, p. 41), the idea has not, to our knowledge, received focused attention in the empirical literature on wage inequality. To investigate this connection from liberalization to wage inequality, the mechanism underlying it must be more clearly spelled out. Most obviously, there may be Engel effects—rising incomes may lift consumers' demand for the professional service occupations listed in Table 7. While we have been unable to find estimates of the income elasticity of demand for professional services in developing economies, services in general in developed economies are income elastic (Curtis & Murthy, 1998), and professional services should be especially income elastic. The growing demand for medical professionals is certainly consistent with this. Future research should examine the income elasticities of demand for occupations.

Another effect of growth may be to enhance the returns to occupations engaged in tasks subject to increasing returns. This is, of course, related to Cragg and Epelbaum's (1996) idea that in a liberalizing economy, workers who can enact change will receive wage increases. For example, liberalization may raise talented managers' rents by increasing the size of the firms they manage (Lucas, 1978). It might also increase the marginal productivity of those who can innovate technologically (Nelson & Phelps, 1966) as those innovations can be more widely implemented. This may explain why managers, department heads, engineers, scientists, and technicians appear in Table 7. Matched employer-employee data that pay due attention to the *occupation-specific* effects of firm size and technology adoption on wages in services would be illuminating.

Institutional explanations based on transaction costs are also possible. Economies based on specialization and exchange must dedicate more resources to making transactions occur than more inward-oriented economies (North, 1989). Coase (1937) enumerates several transactional tasks that are plausibly undertaken by some of the occupations listed in Table 7. Demand for these tasks is likely to rise as markets, whether foreign or domestic, are liberalized. First, somebody needs to find mutually agreeable prices at which trade can take place—a role that marketing professionals, sales agents, and their supervisors might perform. As firms' trading partners become more numerous, distant and less well-known, this role becomes increasingly important. Second, information asymmetries must be overcome in order to establish trust. Accountants often help do this. Third, enforceable contracts must be written, and this role is readily associated with lawyers. Given that transaction costs are notoriously heterogeneous and

difficult to quantify, a case study approach to assessing the plausibility of these stories would be helpful.

In summary, we cannot yet settle on one specific theory of why college premiums rose. The answers may or may not go beyond trade and investment liberalization. However, we have

shown that they go far beyond the employment conditions of workers producing tradables. To figure out why, future studies will need to cast a wider net, looking in detail at services, and do so in a way that captures the different roles that ostensibly equally educated workers play in a liberalizing economy.

NOTES

1. The two most popular decompositions are presented in Katz and Murphy (1992) and Katz and Autor (1999). We discuss their interpretations in detail in Section 4.

2. For a useful overview of Mexican trade, FDI, and exchange rate policy in the wake of the debt crisis see Krueger (2000), Graham and Wada (2000), and Ten Kate (1992).

3. The teachers union in Mexico has more than a million members and wields great political influence (Santibañez & Rabling, 2007).

4. It is certainly likely that changing demand within the public sector would alter the number and quality of workers available for private work. However such general equilibrium effects are not relevant to our primary *reduced form* result—that we can link changing college premiums in the private sector to the changing employment composition of private sector employment. They are, however, relevant to our finding that the standard *structural* decomposition approach cannot account for the increase in college premium, and we have accordingly established this result with and without public employees (see the Appendix).

5. Some researchers have noted that the Census may have underestimated wages. This problem is thought to be greater in 2000 than in 1990, and, as usual (e.g., Banerjee & Piketty, 2005) is thought to be more severe higher up the income and education distributions. If so, we may underestimate the increase in the college premium.

6. Sheepskin effects were found to be economically insignificant (also see Mehta & Villarreal, 2008). The annualized education premiums are therefore not significantly altered by the exclusion of high-school or college dropouts (who comprise 19% of primary-educated employees).

7. Hanson (2003) also drops the top of the wage distribution. We do not since doing so would potentially drop a large portion of individuals from high-paying sectors.

8. Katz and Murphy (1992, p. 72) note that “measured demand shifts explain about one third of the implied trend demand shifts consistent with the series of price and quantities.” Similar calculations based on the work of Kijima (2006) and Rojas (2006) are available from the authors on request.

9. The reduced form approach is, however, helpful for taking sociological approaches to inequality to data. For example, sociologists studying education and inequality are interested in the role of education in the formation and enrichment of status groups, which of course relates to occupational change (Attewell, 2010).

10. We obtained these estimates as follows. Restricting attention to private employees of a particular gender with college degrees, we regressed log wages on eight (one-digit level) occupation dummies, a constant, years of potential work experience and its square. We then applied the procedure of Haisken-DeNew and Schmidt (1997) to calculate the standard deviation of log wages across the nine occupations.

11. Equality of the occupational distributions across education classes and over time were both tested using Pearson χ^2 tests. We ran the tests for two education classes (upper secondary and college graduates), and separately by gender, four experience groups defined by 10 year intervals, and nine occupations defined at the one-digit level. All *p*-values are less than 0.001.

12. These trends are unaltered if the between-sector relative demand shift is considered by adjusting for the between-sector shift in high-school demand. Note that the share of workers with exactly education level *e* is $P(e) = F(e) - F(e + 1)$. Denote college by *c* and high-school by *h*. Then, ignoring those with graduate degrees, (who are few in number), so that $F(c) \approx P(c)$, the expected between-sector shift in demand for college graduates relative to high-school graduates is: $E_{Between} \Delta[P(c) - P(h)] = 2E_{Between} \Delta F(c) - E_{Between} \Delta F(h)$.

13. From 1986 to 1994, the number of new female medical students increased by 53%, compared to only 2% for men, and medical school completion rates for women remained stable while men's fell by 38% (Harrison, 1998).

14. To ensure that these demand shifts do not simply reflect feminization of the labor force, we also conducted the exercise on separate male and female samples (with 115 nongendered occupations in each). In this analysis demand increased for eight of the top 10 occupations for women, and nine of them for men.

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APPENDIX

Implementing the Katz and Murhpy decomposition

We split the labor force into 400 supply cells defined by gender, five education categories, and 40 years-of-experience categories. The hours of labor supplied by these 400 cells are converted into efficiency units by scaling them by their relative wages. We estimate relative wages by averaging the earnings of the employees in each supply cell over 1990 and 2000 to obtain time-invariant scaling factors. These supplies of efficiency labor units are then aggregated up to 10 gender \times education supply-cells. Next, we measure the average (over time) utilization of efficiency labor from each of these aggregate supply cells in 178 industry-occupation cells (these are sectors comprised of 89 industries and two occupation groups—professional and not), and the total efficiency labor units utilized in each year in each sector. These measures are combined to yield the supply shift and the between-sector demand shifts (per Eqn. (2b), sectors defined by industry or industry-occupation) for each of the aggregated supply cells.

Table 8 shows that for most supply cells, supply grew at a higher rate than demand. The exceptions are men who have not finished high-school and women who have not finished primary school, for whom demand fell, and supply fell faster. This suggests that, so long as the weights used to convert these supply cells into college- and high-school-graduate equivalents are “reasonable” (e.g., a high-school dropout must be treated more like a high-school graduate than like a college graduate), the aggregate supply of college graduates relative to high-school graduates grew faster than the between sector demand shift. The bottom panel of Table 8 verifies this using two alternative weighting schemes: the first row treats every efficiency unit produced by a worker with 12 or less (13 or more) years of schooling as one provided by a high-school (college) graduate; the second treats every unit from a worker with less than 16 years of schooling as one from a high-school graduate. Choosing “reasonable” weights (between 0 and 1) to maximize the difference between the demand-shift index and the relative supply shift yields the solution in the first row of the lower panel of Table 8.

No matter what weights are selected, between-sector (industry \times occupation) shifts are much smaller than supply shifts, but are larger than between-industry shifts. One would therefore expect college premiums to have fallen absent within-sector demand shifts. Seeking a lower bound for $\Delta \ln(W_c/W_k)$, we calculate four values for it from the results in Table 1, and use the smallest value: 12.3%. Assuming that $\sigma = 0.5$ (the lowest

Table 8. *Katz and Murphy's demand shift index*

Supply cell:		Supply relative to labor force			% change in relative demand between	
Sex	Education	1990 (%)	2000 (%)	% change	Industries	Industries and occupations
Male	0–5 years	19.1	10.8	–57.1	–11.2	–11.7
	6–11 years	37.5	36.3	–3.4	–0.6	–2.5
	12 years	5.3	8.0	42.2	–1.6	–3.8
	13–15 years	3.7	3.9	5.1	–1.1	–1.1
	16+ years	14.9	16.5	10.1	–2.9	4.4
Female	0–5 years	3.1	2.6	–16.8	11.1	12.7
	6–11 years	9.7	11.5	17.0	13.5	12.3
	12 years	1.7	3.0	56.5	4.9	1.1
	13–15 years	1.4	1.5	9.8	3.9	1.7
	16+ years	3.7	5.9	47.5	4.5	11.4
Shifts in supply and demand of “college” relative to “high-school” graduates						
		% change in relative supply			% change in relative demand between	
					Industries	Industries and occupations
College (13+ years), high-school (0–12 years)		22.1			–0.6	6.4
College (16+ years), high-school (0–15 years)		23.9			–1.0	7.6

parameter value considered in previous studies to our knowledge), we find that, given the results in the lower panel of Table 8, one would have to assume a within sector demand shift of 21.9–22.9% to account for this increase in the college premium. These underestimates of the required within-sector shift are over three times the size of the estimated between sector shift.

In order to facilitate comparison with results in the rest of this paper, the results discussed above are calculated from

our wage sample. This excludes the self-employed and public employees. To allow a full range of general equilibrium effects, we have also made the calculations using the quantity sample in order to include these workers when calculating quantity information. Doing so leads to an even greater gap between the relative college-high school supply shift and the demand-shift index than we document here. Results are available on request.

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