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Rising College Premiums in Mexico: How Important Is Trade?

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Abstract

The literature on wage inequality in liberalizing developing economies has largely attributed rising skill premiums to trade-induced increases in the demand for skilled labor within "sectors" (industries, occupations, or industry-occupation pairs). Although there is strong evidence from many countries of trade-induced increases in skill demand within manufacturing, we show that in Mexico, the most studied country in this literature, economy-wide increases in college premium can be explained without reference to these demand shifts. Evidence that skill premiums have increased because of within-sector increases in skill demand mostly comes from decompositions that suppress differences in wages across occupations. We show that this is unduly restrictive, for example if incomes change and Engel curves for services are non-linear. Mexico's college premiums were lifted by increased demand for professional services, many of which are not directly tradeable. This explanation also reconciles gender differences in the changes in skill premium with changes in employment composition. Job opportunities in non-traded sectors may matter more for wage inequality than trade policy. [JEL: F16, O15, J21]

Key words: Skill premium, employment composition, trade liberalization

1. Introduction

Like many other developing economies that liberalized trade and foreign direct investment (FDI) in the 1980s and early 1990s, Mexico experi-

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enced a rise in the wages of high-skilled relative to low-skilled labor. This was unexpected, at least based upon the simplest Heckscher-Ohlin thinking, since Mexico is abundant in low-skilled labor. Many studies have therefore looked for an explanation for Mexico's rising skills premiums.[1] These studies have produced evidence that the liberalization of trade and FDI policy led to increases in the relative pay and utilization of skilled workers in the manufacturing industry (e.g. Revenga, 1997; Feenstra and Hansen, 1997; Robertson, 2004; Verhoogen, 2008). However, to what extent these trade-induced changes within the manufacturing sector are actually responsible for driving skill premiums up *economy-wide* remains unknown. This paper aims to shed light on this issue.

We take college premiums as our measure of skill prices, and examine their rise between 1990 and 2000. Our key substantive finding is that the increase in the economy-wide college premium, and differences by sex in that increase, can be mostly accounted for without reference to any changes in the manufacturing sector. Instead, an increase in the demand for professional services accounts for the increase in the economy-wide college premium. The specific services involved are not likely to be traded.

We argue that the evidence that within sector skills demand shifts (trade-induced, or otherwise) are responsible for rising skill premiums economy-wide is flawed. This evidence all comes from decompositions that ask whether the demand shifts necessary to reconcile rising education levels with rising skill premiums can be generated from between-sector shifts in employment shares. Regardless of whether sectors are defined as industries, occupations, or industry-occupation pairs, the standard decompositions generate a between-sector shift that is either smaller than the observed shift (e.g. Robertson, 2000, 2004; Berman et al., 1998) or negative (e.g. Rojas 2006, Kijima 2006).[2] Much, or all, of the rise in skill premiums is therefore attributed residually to forces operating within sectors. The implicit assumption in the literature appears to be that this indicates a role for the trade-induced changes observed within manufacturing (see Section 2), although some authors have proposed alternative explanations (Cragg and Epelbaum, 1996; Airola and Juhn, 2008).

We show that these decompositions are predisposed to find large within-

[1] Goldberg and Pavcnik (2007) provide an excellent summary of the literature on trade and inequality in developing economies. Mexico is the most extensively studied country in this literature.

[2] The two most popular decompositions are presented in Katz and Murphy (1992) and Katz and Autor (1999). See Section 2.

sector increases in skill demand, because they suppress occupation wage premiums. If college educated lawyers earn more than college educated retail managers, an increase in the share of college graduates who are lawyers will lift the observed college premium. However, because the decomposition assumes that both wages in the two occupations are equal, the imputed effect of this "between-sector" shift on the college premium will be zero. The rising college premium will therefore be attributed residually to forces operating within sectors.

Instead, we show that if the decomposition allows for occupation wage differentials, between-sector shifts account for most of the increase in college premiums. This moves the forces behind an important shift in economic inequality out of the 'residual' column: it is possible to account for rising college premiums based on observables. The accounting reveals that they rose simply because professionals are paid more and more Mexican college graduates became professionals. Wages and employment in these professions rose simultaneously, suggesting that demand for these professionals increased. Because these professionals largely sell services to Mexicans, changes in trade policy are not the most obvious explanation for rising college premiums economy-wide. We present three alternative explanations, the simplest of which is that professional services are luxury goods, so that income growth lifted the college premium through Engel effects.

Our findings therefore suggest that the emphasis on trade-induced within-sector demand shifts in the literature may stem from an inappropriate imposition of the law of one price. We emphasize that this empirical decomposition result does not hinge on any assumption about the causes of occupation wage-differentials.

This paper is structured as follows: Section 2 surveys the literature on rising skill premiums focusing for clarity on the Mexican experience. It shows that standard decompositions are predisposed to attribute rising skill premiums to forces acting within sectors, and also that the literature on Mexican skill premiums has focused overwhelmingly on the possible effects of trade policy on manufacturing. Section 3 introduces the data. Section 4 demonstrates that the relative demand for college graduates increased, and did so faster for women than for men. Section 5 documents changes in employment composition, and demonstrates that standard decompositions cannot explain the gender differences in the trends in college premiums. Section 6 introduces our own decompositions which can link the rising college premium to shifts in employment structure, and account for its more rapid rise amongst women. Section 7 documents which specific occupations experienced the demand growth that appears to have driven college premiums up

and presents possible interpretations of these results. Section 8 concludes.

2. Literature review and calculation

Mexico's rising skill premiums have been widely examined, usually in the context of its increased exposure to foreign markets. Mexico slashed 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, gradually easing the requirements for the establishment of maquiladoras.[3] The implementation of NAFTA, over ten years starting in 1994, eliminated tariffs on trade with Canada and the US and committed Mexico to maintaining earlier unilateral liberalizations of FDI.[4] Skill premiums rose between 1985 and 1994 (when the Tequila crisis hit) and stabilized thereafter (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 and Rodríguez-López, 2003).

We now review evidence that relative skills demand within sectors increased, and that such shifts are necessary to explain rising economy-wide skill premiums. The review underscores two points. (1) The evidence that within-sector shifts are necessary to explain why economy-wide college premiums have risen may be questionable because it relies on decompositions that suppress occupation-wage-differentials. (2) The majority of studies of the causes of within-sector shifts work with data from the manufacturing sector and/or attribute rising skill-premiums to the effects of changes in external policy on the manufacturing sector. Both points are important because we will show that growing demand for high-paying occupations that mainly operate outside the manufacturing/ tradeables sector can account for the shift in Mexico's college premiums.

2.1. Evidence for within-sector demand shifts

The evidence offered for within-sector demand shifts is of three varieties. We summarize them here as they apply to Mexico in order to contextualize our own findings.

[3] Maquiladoras are manufacturing units that may import inputs to the manufacture of exports duty free.

[4] For a useful overview of Mexican trade, FDI and exchange rate policy see Krueger (2000), Graham and Wada (2000) and Ten Kate (1992).

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 and 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 et al., 1994).

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 skill demand has been found in the maquiladora "industry" (Mollick, 2008), in manufacturing sub-sectors (Esquivel and Rodríguez-López, 2003), and in many industries not limited to manufacturing (Airola and Juhn, 2008; Cragg and Epelbaum, 1996). This is credible evidence that within-sector demand shifts exist, but does not imply that they are necessary for explaining rising college premiums economy-wide.

The third type of evidence for within-sector shifts involves the application of the methods of Katz & Murphy (1992), or a simpler between-within analysis. Katz & Murphy propose the following scheme to account for shifts in the college premium:

$$\Delta \ln\left(\frac{w_c}{w_h}\right) = \frac{1}{\sigma}\left[\Delta D_t - \Delta \ln\left(\frac{x_c}{x_h}\right)\right] \tag{1a}$$

$$\Delta D_t = \sum_s \left[\frac{E_{c,s}}{E_c} - \frac{E_{h,s}}{E_h}\right]\frac{\Delta E_s}{E_s} + \text{within-sector demand shifts;} \tag{1b}$$

where w_c and w_h are the wages of college and high-school graduates. $\Delta \ln\left(\frac{x_c}{x_h}\right)$ is the percentage shift in relative supply of college graduates in efficiency units; and σ is the elasticity of substitution between college and high school graduates. The Es capture employment by type (c =college, h =high school), and/or sector (s) in efficiency units. Critically, the efficiency labor units offered by workers of each education class are assumed to be invariant to their industry or occupation. The shift in relative demand imputed from shifts in the composition of employment between sectors is the demand shift index given by the summation in (1b). 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.

Studies utilizing this methodology define sectors as occupation-industry pairs, rather than as industries (e.g. Katz and Murphy, 1992; Kijima, 2006;

Rojas, 2006), and arrive at estimated between-sector demand shifts that are much smaller than the observed supply shifts. Thus, they lead to the conclusion that the shifting employment composition cannot explain why the college premium rose at all.

We demonstrate this through a back of the envelope calculation using Mexican data: Rojas (2006) imputes relative demand shifts in efficiency units from Mexican employment shifts between 44 "sectors" (occupation-industry pairs) between 1990 and 1999. These work out to less than 0.11 for all age groups. From our own data, and without converting labor inputs into efficiency units, we estimate the relative supply shift between 1990 and 2000 of 0.41. Because college graduates contributed some 80% more efficiency units of labor per unit time than high school graduates, and supply only slightly fewer hours, the supply shift would be even larger if measured in efficiency units. By (1a), the college premium should have fallen substantially in the absence of increases in skills demand within sectors because the supply shift is larger (in fact, over three times larger) than the imputed between-sector demand shift. Even for small values of σ, one must assume that within-sector demand shifts were at least five times as large as the between-sector shift in order to replicate the observed rise in college premiums in Mexico .[5]

We maintain that the reason this index projects such a small between-sector demand increase is that it assumes that college graduates are paid the same irrespective of which occupation they pursue. To return to the earlier example, suppose that all lawyers and all retail managers initially had college degrees and supplied an equal quantity of labor. In this case, the weights given to employment changes in these sectors (the term in the bracket in (1b)) would be identical. Now suppose the labor supply of lawyers rose by exactly the same percentage as that of retail managers fell, and nothing else changed. Per (1b) the effects in these two sectors would cancel out, and the between-sector demand shift index would imply no increase in skills demand at all. Further, suppose lawyers command higher wages than retail managers. This information is not reflected in the between-sector demand shift index. Nevertheless, the shift in employment composition would increase the average wage of college-graduates and therefore the college premium. However, because the between-sector shift in (1b) is zero, one would have to conclude, incorrectly, that a large "residual" "within-sector" shift in labor demand had occurred. This example is of course artificial, but the

[5] More detailed calculations are available on request.

problem will nevertheless arise whenever college graduates shift from low to high paying occupations that have similar measured education profiles.

Similar problems can arise when interpreting the between-within decomposition of the employment shares of college graduates (e.g. Autor et al., 1998; Robertson, 2000; Berman et al., 1994; Berman et al., 1998): because the importance of a sector for driving demand for college graduates is imputed only from the employment share of college graduates, shifts in overall employment between sectors that hire the same proportion of college graduates would not generate "between-sector" increases in skills demand, even if one sector pays its graduates substantially more. We apply these decompositions to Mexican data in Section 5 and interpret them conservatively.

2.2. Focus on Manufacturing and Trade

We have found nineteen empirical papers on rising skill premiums in Mexico in the 1980s and 1990s. Nine of these conduct their main analysis on manufacturing data, and are crudely categorized in Table 1 according to their primary explanation for rising skills demand in the sector. Each explanation involves changes in the type of tradable goods produced, how they are produced, or which firms produce them. Five of the other ten papers, whose analyses are not restricted to the manufacturing sector, cite the explanations offered in Table 1 when interpreting their results. Thus the bulk of the literature links rising skill premiums to the manufacturing sector and external policy.

Of the remaining five papers, three are closely related to our work. 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. Cragg & 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 can offer no further insight into this intriguing possibility. 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 explains that his results differ from those of previous studies because he examines a later period with adequate allowance for regional wage premiums. While he does not seek to account for rising skill premiums, he notes that they rose fastest in Mexico City, suggesting that urbanization plays a key role.

Our data offer the large samples and disaggregated industrial and occupational classifications necessary to follow these leads. We will show, in keeping with Cragg & Epelbaum's (1996) finding in 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. Their identity hints at what 'individuals who can enact change' do. Accounting for Airola and Juhn's (2005) finding, we will show that most of these occupations produce services, not goods. Many of these services are likely to be at least non-traded, if not non-tradable. The fact that the professions involved tend to be urban confirms Chiquiar's suspicion that rising skill premiums in Mexico City are responsible for the rising skill premiums nationwide.

3. The Data

This paper uses Mexico's 1990 and 2000 Censuses of Population and Housing (Minnesota Population Center, 2009). 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 earnings, age, education, industry and occupation of employment, and employment status. They are amongst 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, 3 million in 2000), and feature 4-digit occupational and industrial classifications. Thus, we can measure highly disaggregated wage and employment distributions precisely.

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. A concordance between the 1990 and 2000 industrial classifications was obtained through IPUMS-International. The samples also use very similar occupational classifications, so that with minimal adjustment, we were able to concord these at the 3-4 digit level (see Section 6). This was a major reason for working with these years.

The wage sample is a sub-sample of the quantity sample. It does not include the unemployed, self-employed, or public employees, whose market wages are unobservable. Workers holding specialized teaching degrees, as well as those who are classified, by occupation, as teachers or professors, are

also excluded from the sample, because their wages are almost always institutionally determined.[6] 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 hours per week are dropped because their hourly wages cannot be reliably calculated as their true weekly hours are unknown,.

The wage sample is used for examining education wage premiums. Only those with exactly a primary, lower secondary, upper secondary and college degrees are included in the analysis.[7] While college degrees in Mexico can take 4 or 5 years to complete, out of those workers in our quantity sample who completed four of five years of college, roughly three-quarters completed only four years. In order to maintain a consistent definition of college degrees and estimates of college premiums that are comparable between 1990 and 2000, we therefore drop those workers holding five-year college degrees.

Some observations in the 2000 Census and even more of them in 1990 have unrealistically low levels of reported income. 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.[8] Further, we separate the analysis for men and women since their labor market and education experiences are very different.

4. Rising relative demand for college graduates

Table 2 presents education wage-premiums in annualized terms. The college premium is calculated simply as the difference in mean-log-wages between four-year college graduates and upper secondary graduates, divided

[6] The teachers union in Mexico has more than a million members and wields great political influence (See Santibañez and Rabling, 2007).

[7] Sheepskin effects were found to be economically insignificant (also see Mehta and Villareal, 2008). The annualized education premiums are therefore unaffected by the exclusion of dropouts. Nevertheless, our results are representative only of those who completed their education at the end of a school level. This is, on average, 81% of the pool of employees with at least an elementary degree.

[8] 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.

by four, for a group of workers in a particular experience bracket. Upper secondary premiums similarly reflect annualized log-wage differentials between upper- and lower-secondary graduates, and lower-secondary premiums reflect differences between lower-secondary and elementary school graduates. Our large sample sizes permit us to estimate these premiums directly, controlling for potential labor market experience by focusing on sub-samples of workers by experience. 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. And second, these directly calculated wage premiums are easily and perfectly decomposable (see Section 6). Low-experience workers have 3-7 years of potential labor market experience, and high-experience workers have 18-22 years. We use a five year experience bracket 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 decreased slightly for others (Table 2). 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 3 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. This interpretation is subject to the caveat that college and high school graduates are sufficiently homogenous that it makes sense to treat them as a single factor of production.

Similarly, the female labor force is more educated than the male labor force in both years, and women's dominance in secondary and college education completion grew (men narrowed the gap in post-graduate and basic education). Differential rates of supply increase therefore cannot explain why women's college premiums rose faster than men's, as the relative supply shifts were larger for women.

The remainder of this paper is dedicated to examining whether the increase in the relative demand for 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-induced changes in manufacturing relative to other explanations of rising college premiums.

5. Changes in the skill intensity of the job pool

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) A between-within decomposition of the changes in college intensity that does not admit wage differentials across sectors cannot account for different trends in college premiums by sex.

Table 4 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 skill-intensive. The skill-intensive services were further divided into finance, insurance and real-estate (FIRE) and the rest (non-FIRE), in deference to findings in the literature that long term cycles and regulatory regimes affect wages in the financial sectors differently (Philippon and Reshef, 2009).

Several features stand out. The manufacturing sector's employment share among men and women fell slightly, to around 20%. Outside manufacturing, the story is more gender specific. Agricultural employment declined sharply for men, falling to 20%, while, according to the census, 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 the issue more carefully, we introduce the simplest standard shift-share decomposition discussed in Section 2. 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 the net influx of at least e-educated workers into the labor force or into some sector, $\Delta F(e)$, can be absorbed as follows:

$$\Delta F(e) \equiv \overbrace{\sum_s F(e|s)\,\Delta F(s)}^{\text{Between Sector Effect}} + \overbrace{\sum_s F(s)\,\Delta F(e|s)}^{\text{Within Sector Effect}} \tag{2}$$

A positive (negative) between sector effect indicates that the composition of employment shifted in a more (less) skill-intensive direction.

The results presented in Table 5 confirm our suspicions from Table 4: the employment composition became more education-intensive for men (all entries, except those corresponding to changes between the 51 services subsectors, 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 partitioned into high- and low-skill subsectors. 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 124 occupations, but even here employment composition became education intensive faster for men than for women. These trends are unaltered if the between-sector *relative* demand shift is considered by adjusting for the between-sector shift in high-school demand.[9] 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 use identity (2) to reveal where the net influx of new college graduates have found work (Table 6). 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 non-financial high-skill services is suggested.

[9] Note that the share of workers with exactly education level e is $P(e) = F(e) - F(e+1)$ and 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 between sector shift in demand for college graduates relative to high-school graduates is: $E_{Between}\Delta[P(c) - P(h)] = 2E_{Between}\Delta F(c) - E_{Between}\Delta F(h)$.

6. Accounting for the increase in college premiums

We now show that the rise in the college premium, and its faster pace for women, can be accounted for by shifts in the composition of employment, by using a scheme that allows for occupation-wage-differentials. We use a set of wage-premium decompositions detailed in Mehta et al. (2009). Restricting attention to the wage-sample only, 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 in sector s with exactly education level e by $P(e|s)$. By 'sector' we mean any categorization of workers, whether by industry, occupation or both. Let $w_{e,s}$ be the average log wage of employees with education level e ($= c$ or h for college or high-school) in sector s. We can then decompose the college premium as a sum of the contributions of each sector :

$$\ln\left(\frac{w_c}{w_h}\right) \equiv \sum_s \left[P\left(s|c\right) w_{s,c} - P\left(s|h\right) w_{s,h}\right] \equiv \sum_s C_{s,c} \tag{3}$$

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:

$$\Delta \ln\left(\frac{w_c}{w_h}\right) \equiv \sum_s \Delta C_{s,c} \tag{4}$$

Next, we divide sectors' contributions to the college premium by their employment shares to present the contributions per job, (jobs have probability mass zero). Thus, (3) and (4), become:

$$\ln\left(\frac{w_c}{w_h}\right) \equiv \sum_s P\left(s\right) \widetilde{C}_{s,c} \equiv \sum_s P\left(s\right) \frac{C_{s,c}}{P\left(s\right)} \tag{5}$$

$$\Delta \ln\left(\frac{w_c}{w_h}\right) \equiv \underbrace{\sum_s \widetilde{C}_{s,c} \Delta P\left(s\right)}_{\text{Compositionally Expected Change}} + \underbrace{\sum_s P\left(s\right) \Delta \widetilde{C}_{s,c}}_{\text{Residual Change}} \tag{6}$$

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 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 observed employment shares holding contributions per job constant. If it approximates the observed shift in college premium then changes in college-premium are explained by movements between sectors.

The critical departure from the Katz and Murphy between-sector demand shift index examined in Section 2 is that in the current scheme wages in each cell depend on both the level of education and the sector of employment, rather than solely upon the level of education. Therefore, in one dimension, our scheme is more general than theirs. On the other hand, because their scheme incorporates supply movements directly and ours does not, it does not nest theirs. The inference that their analytical framework assumes away valuable information on the effects of changing employment compositions therefore relies on the fact that between-sector movements can approximate the change in college premium under our scheme, but not under theirs.

Table 7 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 derive mainly from shifting employment across even fairly narrowly defined industries.

However, using only 9 different occupations (row 7), compositional shifts account for the entire increase in college premiums for workers averaging 20 years of experience, and some of the shift for those averaging 5 years of experience. This compares favorably with the results using the same classification but the standard decomposition in Table 5, in which between-sector shifts actually *reduced* demand for college educated women.

One of the 9 occupation groups stands apart from the others: for all experience-gender pairs the contribution per "Professional" job is in the range (1.77, 2.09), which is ten times the average contribution for the entire employee pool (which range from 0.09 to 0.18). In other words, *ceteris paribus*, more jobs as professionals would boost the college premium significantly. This prediction is borne out in row 8 of Table 7: if 14 sectors are considered by taking our usual 9 industries and splitting jobs in the five main manufacturing and services sub-sectors into professional and non-professional positions, the compositionally expected shift accounts for over

80% of the actual shift in the college premium for all gender-experience groups.

Between-within decompositions will 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 7 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/non-professional workers by industry therefore appears to be a very powerful one for accounting for growth in the college premium.

Table 8 presents the contributions of these 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.

7. The occupations that matter

To understand which services experienced demand shifts that generated changes in the derived demand for skill, we ran our decompositions on detailed occupational classifications. A clean concordance between the 1990 and 2000 classifications leaves us with 115 occupations. To achieve the sample size needed to accommodate the high level of disaggregation, we expanded the experience levels under consideration. We include workers with between 5 and 35 years of potential work experience. Comparing Tables 2 and 9 reveals that broadening the experience sample does not result in an economically significant change in the estimated shift in premiums.

Table 9 provides the shifts in college premium to be accounted for, and the contributions of the 10 most important occupations, 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. By 2000, these occupations account for some 22% of the male and female wage sample, 45% of the male college educated wage sample, and 64% of the female college-educated wage sample. Moreover, almost all of these occupations were substantially smaller in 1990 than in 2000 and in total grew by some 25% in the intervening decade. This implies that the rise in the college premium is disproportionately related to increases in the demand for these occupations.

But what should we make of the specific occupations that matter? Most importantly, most of them operate almost entirely in services. This rein-

forces the view that college premiums may not have risen because of shifts in the types of tradable goods produced or because of changes in the manner in which they are produced. Beyond this, the high contributions of these specific occupations to shifting college premiums are consistent with at least three theoretical perspectives.

The most obvious one emphasizes Engel effects. According to the World Development Indicators, Mexican real per capita GDP rose 19.5% between 1990 and 2000. A high income elasticity of demand for professional services might plausibly explain the role of all the occupations listed in Table 8. This story is most compelling, in our view, for medical professionals, who account for just under half of the increase in women's college premium. We also note that under the PROGRESA conditional cash transfer program, initiated in 1997, the Mexican government greatly increased the number of doctors and nurses working in rural health clinics, and their wages (IFPRI, 2000). The literature on structural change has highlighted the importance of income elasticity and the composition of goods demand for growth. Our findings are consistent with the view that the income elasticity and composition of services demand is extremely important for distribution. While this Engel effect driven explanation for rising college premiums is clearly not new (e.g. Goldberg & Pavcnik, 2007, p.41) , it has not, to our knowledge, received much attention in the empirical literature on inequality.

A second possibility is that computers raised the marginal productivity of workers from these occupations in performing non-routinizable tasks. If so, then, falling costs of computing power would enhance their productivity and wages (Autor et al., 2003). Assuming that the task composition of Mexican and US occupations are similar, we mapped each of these top 10 occupations (crudely) to their US counterparts, and found that their US non-routine cognitive task scores[10] tend to exceed the median for the US workforce. We do not have data on computerization in Mexico, and so cannot carry tests of this interpretation further.

A third perspective emphasizes Cragg and Epelbaum's (1996) idea that in a liberalizing economy, workers who can enact change will receive wage increases. This has straightforward neoclassical interpretations: liberalization may raise rents on managerial talent by increasing the size of firms they manage (Lucas, 1978); or the marginal productivity of those who can innovate technologically (Neslon and Phelps, 1966). It is also consistent with an institutional perspective. In this view, economies based on specialization

[10] Drawn from data made available by David Autor and used in Autor et al. (2003)

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 9. Demand for these tasks is likely to rise as trade, whether foreign or domestic, is 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 help to do this. Third, enforceable contracts must be written, and this role is readily associated with lawyers. Finding that lawyers' earnings rise as rent-creating economic restrictions are scaled back suggests, as institutional economists argue, that they have a productive role to play in facilitating transactions.

8. Conclusions

We have revisited the debate over trade and changing skill premiums in Mexico. While we have no reason to doubt that trade induces important shifts in skills demand within the manufacturing industry, we have provided evidence that rising college premiums in Mexico can be accounted for without reference to these trade-induced demand shifts. In particular, we have shown that by allowing for the fact that college graduates earn more in some occupations than others (e.g. college-educated lawyers earn more than college-educated receptionists), practically the entire increase in college premiums in Mexico can be accounted for by the emergence of a professional class as the types of services demanded shift. This explanation has the added attraction that it can explain why college premiums rose faster for women than for men, even though women were initially more educated than men, and this supply gap grew while women moved into jobs that had previously hired few college graduates. Because shifts within manufacturing do not account for the increase in college premiums, we suspect that trade-induced changes in the types of goods produced, or in how they are produced, may not be the primary reason that college premiums rose economy-wide. This is a potentially important new argument in the continuing debate over skill-biased technical change (e.g. Card and Dinardo, 2002).

A note of caution is in order: Decompositions are useful for revealing the *proximate* causes of phenomena. However, they cannot be used to falsify

any theory of its *structural* causes. Thus, it may be possible to write a theory in which trade-induced changes in the manufacturing sector yield the changes in the wage distribution and employment composition that we document. This said, we have shown that all of the evidence that such change did in fact drive economy-wide college premiums also comes from decompositions; and that these decompositions carry implicit assumptions that are restrictive in important ways.

Finally, a theory that generates our results from trade-policy induced changes within manufacturing would probably be complex. Ocam's razor would recommend simpler theories based on, for example: economy-wide technical change due to computerization; increasing returns to managerial talent or the ability to innovate or reduce transaction costs in a more market-oriented economy; or simple Engel effects as a growing middle class demands more sophisticated services. Developing economies change rapidly as they grow, and rising skill premiums may simply reflect this, rather than changes in the policies governing a sector that directly employs a minority of workers.

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Table 1

Explanations for rising witin-sector skills demand offered by studies of manufacturing data

Low-skill goods lost more protection	Revenga (1997), Hanson & Harrison (1999), Harrison & Hanson (1999), Robertson (2004)
Outsourcing and capital mobility introduce more skill-intensive products	Feenstra & Hanson (1997)
Trade/FDI bring capital (complementary to skill) and technological change	Esquivel & Rodriguez-Lopez (2003), Mollick (2008, 2009),
Export-induced creative destruction: high-paying, high-skill firms survive	Verhoogen (2008)

Table 2
Simple Returns to Education
Men and Women, by Year & Experience Cohort

	Men					
	Low Experience			High Experience		
Education Level	1990	2000	Change	1990	2000	Change
Lower Secondary	.035	.047	**.011**	.066	.065	.000
	(.002)	(.002)	(.002)	(.003)	(.002)	(.003)
Upper Secondary	.097	.098	.001	.101	.115	**.014**
	(.002)	(.002)	(.003)	(.005)	(.003)	(.006)
College	.162	.203	**.041**	.177	.200	**.023**
	(.003)	(.003)	(.004)	(.007)	(.004)	(.008)
N	*92,604*	*115,894*	-	*49,499*	*84,324*	-

	Women					
	Low Experience			High Experience		
Education Level	1990	2000	Change	1990	2000	Change
Lower Secondary	.053	.057	.004	.097	.078	**-.019**
	(.002)	(.002)	(.003)	(.005)	(.003)	(.006)
Upper Secondary	.121	.110	**-.011**	.136	.165	**.029**
	(.003)	(.002)	(.004)	(.009)	(.005)	(.010)
College	.152	.204	**.051**	.094	.155	**.062**
	(.004)	(.003)	(.005)	(.011)	(.005)	(.012)
N	*47,585*	*68,495*	-	*13,547*	*28,079*	-

Note: Changes in annualized returns that are statistically significant at the 1% level are denoted by * and are in bold type. Standard errors are shown in parentheses. The low experience cohort consists of wage employees who have 3 to 7 years of potential labor market experience. The high experience cohort consists of wage employees who have 18 to 22 years of potential labor market experience. The 1990 and 2000 wage samples are used and include employees ages 16 to 65.

Table 3

Cumulative Educational Attainment

Cumulative Distribution of Highest Education Level Completed (Quantity Sample)

Men and Women, by Year

	1990			2000			Change in Gender Difference
Education Level	Men	Women	Gender Difference	Men	Women	Gender Difference	
None	11.6%	6.8%	4.8%	5.6%	4.3%	1.3%	-3.5%
Incomplete Primary	35.3%	18.7%	16.6%	23.0%	15.2%	7.8%	-8.8%
Primary	57.7%	39.1%	18.6%	42.6%	31.7%	10.9%	-7.7%
Incomplete Lower Secondary	62.9%	42.8%	20.1%	48.0%	35.4%	12.6%	-7.5%
Lower Secondary	79.9%	72.8%	7.1%	68.9%	55.5%	13.4%	6.3%
Incomplete Upper Secondary	84.2%	77.0%	7.2%	73.9%	61.1%	12.8%	5.6%
Upper Secondary	89.1%	83.4%	5.7%	83.9%	76.6%	7.3%	1.6%
Incomplete College	91.6%	87.4%	4.2%	87.5%	82.8%	4.7%	0.5%
College	93.8%	91.9%	1.9%	92.0%	90.7%	1.3%	-0.6%
Some Graduate	100.0%	100.0%	0.0%	100%	100.0%	0.0%	0.0%
N	*1,632,741*	*498,460.0*	-	*2,116,255*	*783,903.0*	-	-

Note: The gender difference is the female-male gap in cumulative educational attainment. The change in gender difference is calculated as the difference over time of the female-male gap in each year.

Table 4
Sectoral Employment Shares

	Men			Women		
Sector	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 - Non-FIRE	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: shares are derived from the quantity sample and include all members of the labor force.

Table 5

Between-Within Sector Analysis

Percent Between Shifts

Men and Women, by Education Level for different levels of Sector Disaggregation

	Men			Women		
	LS	US	College	LS	US	College
Industrial Classification						
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
Occupational Classification						
9 Occupations	0.191	0.146	0.249	-0.433	-0.084	-0.109
124 Occupations	0.182	0.167	0.339	-0.474	-0.023	0.168

Note: LS = Lower Secondary. US = Upper Secondary. The 3 industries/sectors are Agriculture, Industry, Services. The 6-sector classification splits industry into manufacturing, utilities and construction. The 9 sector scheme splits manufacturing further into high- and low-skill subsectors and services into low-skill, FIRE (Finance, Insurance and Real Estate) and non-FIRE high-skill services. The 29-sector scheme begins with the 9-sector scheme and splits manufacturing into 22 subsectors. The 57-sector scheme begins with the 9 sector scheme and splits services into 51 subsectors. The 89-sector scheme derives from a concordance at roughly the 3-digit level provided by IPUMS International. '+1' refers to the unemployed. The decomposition over 22 manufacturing subsectors is calculated using manufacturing workers only. The decomposition over 51 services subsectors is analogous. The 9 occupation classification is a standard occupational classification created by IPUMS. The 124 occupation scheme is defined at the 3 or 4 digit level.

Table 6

Where did the net influx of college graduates find work?

	Percent of Net New College Grads Absorbed	
Sector	Men	Women
Agriculture	-1.5%	-0.3%
Construction	6.6%	1.3%
Mining	-1.0%	-0.4%
Utilities	0.1%	0.2%
EI Manufacturing	7.5%	4.8%
EU Manufacturing	2.5%	2.1%
EI Services - FIRE	2.1%	3.2%
EI Services - Non-FIRE	59.8%	71.7%
EU Services	23.6%	17.0%
Unemployed	0.2%	0.5%
Total	100.0%	100.0%

Note: Figures represent the share of the net increase in college graduates accounted for by each sector using identity (1).

Table 7

Compositionally Expected vs. Actual Shifts in College Returns
Change in Annualized Return to Education
Men and Women, by Experience Level for different levels of Sector Disaggregation

		Men		Women	
		Low Experience	High Experience	Low Experience	High Experience
Shift in aggregate return					
Compositionally Expected Shift in College Return:					
(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 & disaggregated mfg.)	0.013	0.008	0.000	-0.002
(5)	57 Industries (9 & disagregated 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	0.032	0.025	0.045	0.052
(9)	81 Industry-Occupation Pairs	0.020	0.036	0.037	0.070
Actual Shift in College Return		*0.041*	*0.023*	*0.051*	*0.062*

Note: Definitions of sector clasifications appearing in rows (1) - (7) are the same as in Table 5. Classifications in rows (8) and (9) are explained in the text.

Table 8

Which Industry-Occupation Pair Shifted College Returns? ($\Delta C_{s,c}$)

		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
Low skill Mfg.	Non-Professional	-0.002	-0.001	0.003	0.000
	Professional	0.000	-0.001	0.000	0.001
High-Skill Mfg.	Non-Professional	-0.005	-0.004	0.000	0.000
	Professional	0.003	0.003	0.005	0.002
Low-Skill Services	Non-Professional	0.008	0.004	0.007	0.004
	Professional	0.002	0.003	0.003	0.001
FIRE	Non-Professional	0.004	0.004	0.008	0.001
	Professional	0.002	0.002	0.003	0.001
Non-FIRE HS Services	Non-Professional	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)

Table 9

The Ten Occupations By Contribution to Shifting the College per identity (4). 5-25 years of experience

Women

Occupation	Contribution to Shifting Returns	Percentage of Employee Pool in 2000	Percentage of College-Educated Employee Pool in 2000
1 Medical Professionals	0.026	1.55%	16.50%
2 Directors, managers and administrators in private and social sectors	0.006	1.38%	10.14%
3 Miscellaneous dept. heads and supervisors within services	0.006	2.28%	10.94%
4 Sales supervisors	0.006	12.64%	3.66%
5 Architects and Engineers	0.003	0.27%	2.91%
6 Sales agents	0.003	1.32%	2.43%
7 Accountants/Bookkeepers	0.003	0.99%	10.72%
8 Professional social scientists & Educators	0.002	0.38%	4.14%
9 Other Professionals, nec	0.002	0.09%	0.97%
10 Professional artists, choreographers, decorators & designers	0.002	0.35%	1.90%
Total for top 10 occupations	*0.059*	*21.25%*	*64.31%*
Total Shift in Returns	0.060		

Men

Occupation	Contribution to Shifting Returns	Percentage of Employee Pool in 2000	Percentage of College-Educated Employee Pool in 2000
1 Architects and Engineers	0.006	0.65%	9.73%
2 Sales supervisors	0.005	7.46%	4.79%
3 Accountants/Bookkeepers	0.005	0.57%	8.80%
4 Medical Professionals	0.004	0.20%	2.83%
5 Miscellaneous dept. heads and supervisors within services	0.004	2.41%	11.70%
6 Other Professionals, nec	0.003	9.00%	1.32%
7 Technicians, mostly in engineering	0.002	1.51%	2.75%
8 Lawyers	0.002	0.13%	1.99%
9 Chemists/Pharmacists	0.001	0.05%	0.71%
10 Marketing professionals, economists, and other related researchers	0.001	0.04%	0.58%
Total for top 10 occupations	*0.033*	*22.02%*	*45.20%*
Total Shift in Returns	0.039		