Globalization, Structural Change, and Human Capital Investment[1]

Emily Blanchard[2] William W. Olney[3]

November 13, 2014

Abstract

This paper proposes a new strategy for evaluating the extent to which investment in human capital responds to structural change within an economy. Using detailed trade data and a gravity based IV technique, we identify the causal impact of changes in the pattern of a country's exports on subsequent educational attainment. In a study spanning forty-five years and more than a hundred countries, we find that exports of low-skill-intensive goods depresses average years of schooling – particularly at the primary level – while exports of skill-intensive goods increases years of schooling – particularly at higher rungs of the educational ladder. Our findings provide new insights into which types of sectoral growth are most beneficial for long term human capital formation and suggest that trade can exacerbate initial differences in factor endowments across countries.

Keywords: Exports; Education; Structural Change; Human Capital; Non-monotonic Skill Response

JEL Codes: F14; F16; J24

---

[1] We are grateful to Nina Pavcnik and seminar participants at UC Santa Cruz, Santa Clara, Cal Poly, Pompeu Fabra, the European Soceity of Population Economics, Williams, Colby, Wellesley, BU, and Amherst for helpful comments and suggestions.

[2] Tuck School of Business, Dartmouth College, Hanover, NH 03755 (email: emily.blanchard@tuck.dartmouth.edu)

[3] Department of Economics, Williams College, Williamstown, MA 01267 (email: william.w.olney@williams.edu). This project was supported by the Class of 1945 World Fellowship grant at Williams College.

1 Introduction

Human capital ranks among the most important drivers of growth and income,[4] yet its determinants remain poorly understood. It is notoriously difficult to ascertain the extent to which investment in human capital responds to economic features such as structural change or the evolution of the returns to education within an economy (Banerjee and Duflo 2005). Country specific event studies have a difficult time drawing broad conclusions, while the lack of consistent wage data makes cross-country studies virtually impossible (Goldberg and Pavcnik 2007). Endogeneity and difficult-to-measure confounding factors pose additional challenges for establishing a causal relationship outside of the narrowest case studies. Thus, despite the powerful implications for growth, inequality, and potential cross-country divergence, the literature still struggles to provide robust cross-country evidence on the causal relationship between what countries produce and their citizens' educational attainment.

We propose a unique solution to these issues by focusing on exports as a way to identify how changes in the structure of production within the local economy affects educational attainment. A body of theoretical work formalizes the underlying mechanisms,[5] but the intuition is straightforward: export markets influence labor market opportunities and wages, which in turn determine individuals' incentives to go to school. Concomitantly, the skill intensity of exports plays a central role: skill-intensive exports can sharpen workers' incentives to acquire more training and education, while expanded opportunities in less skill-intensive sectors may exacerbate school attrition and drop out rates. By separately measuring exports by skill composition, we propose a strategy to disentangle the effects of the *composition* of exports apart from the overall volume of trade. In the process, we reconcile the conflicting country-level findings of Atkin (2012) and Hickman and Olney (2011), who demonstrated (respectively), skill-downgrading in response to trade liberalization in Mexico, and skill-upgrading in the U.S.

Our export-focused approach offers several appealing features. First, it allows us to

[4] Indeed, in a recent contribution to the *American Economic Review*, Jones (2014) argues that differences in the stock of human capital could account for potentially *all* of the variation in income between rich and poor countries.

[5] The seminal contribution is Findlay and Kierzkowski (1983). More recent theoretical work on endogenous human capital responses to trade includes Vogel (2007), Jung and Mercenier (2008), and Blanchard and Willmann (2013).

circumvent the sporadic and often poor cross-country wage data, by relying instead on trade data to identify changes in the structure of production (and thus implicitly wages and job opportunities) within and across countries. As Atkin (2012) demonstrates, educational decisions may be shaped as much by unobserved job opportunities (e.g. vacancies) as by wages. Thus, our focus on a key driver of labor market demand (exports), rather than hard-to-measure labor market outcomes such as wages and vacancies, allows us to capture a broader set of potential labor market changes.

Second, focusing on exports provides a unique opportunity to identify *exogenous* drivers of structural change. We construct an instrument that identifies variation in exports that is unrelated to potentially confounding domestic factors, including domestic political reforms, local technological changes, and (crucially) educational attainment itself. Following a gravity technique developed by Frankel and Romer (1999) and Feyrer (2009), we exploit variation in bilateral trade that is driven by exogenous geographic factors and conditions in each of a country's trading partners. Aggregating across trading partners yields a set of exogenous instruments for the pattern of a country's exports. Focusing on only this exogenous variation in exports alleviates concerns that unobserved domestic factors or reverse causality could be driving the observed relationship between exports and educational attainment.

Finally, exports provide a consistent measure of economic activity across countries and a relatively clean separation of different classes of production by skill-intensity. This separation allows us to examine how educational decisions depend on the skill-intensity of different types of exports. Specifically, we can test whether exports of less skill-intensive goods (e.g. agricultural products) reduces educational attainment by workers who would face a higher opportunity cost of schooling. And likewise, we can test whether exporting skill intensive goods (e.g. skill-intensive manufactured products) induces greater investment in human capital. Thus, the detailed trade data allow us to move past simply examining the impact of total exports on education to focus on how specific types of exports alter individual-level incentives to go to school.

Our analysis proceeds in three stages. First, we briefly outline the theoretical basis that allows us to circumvent poor cross-country wage data, using existing models to link the pattern of a country's exports directly to human capital acquisition. With that background in place, we then combine data on exports and educational attainment spanning 104 countries and 45 years to examine the relationship between the pattern of a country's exports and educational attainment. We test whether skill-intensive exports and unskill-intensive exports affect both average years of schooling and school completion rates at the primary, secondary, and tertiary levels. Throughout, we use five-year lags, a rich set of controls including country and year fixed effects, and an IV approach to address potential endogeneity concerns. In the third section of the paper, we work through a series of extensions and robustness checks to develop additional insights into the underlying mechanisms, the key sources of variation driving the results, and the broader applicability of our findings.

We find that exports have a significant and robust impact on educational decisions. But it is not total exports that matter, but rather the *skill-composition* of exports that proves to be important. Specifically, agricultural and low-skill manufacturing exports reduce average years of schooling while exports of skill-intensive manufacturing goods increases schooling.[6] These contrasting findings reconcile the conflicting results in Atkin (2012), who finds that globalization reduces schooling in Mexico, and Hickman and Olney (2011), who find that globalization increases schooling in the U.S. Consistent with our hypothesis, when export opportunities reward low-skill labor, as in Atkin's setting in Mexico, dropout rates rise; but when instead globalization increases the relative returns to skilled work, individuals in the U.S. go back to school as in Hickman and Olney's study. Our results offer additional evidence to support this common-sense idea that schooling responses depend on individual level incentives. Furthermore, we show that this mechanism holds across a much broader sample of countries and years.

Using more detailed data on primary, secondary, and tertiary education levels, we find that different types of exports affect educational attainment at different points within the schooling system. Specifically, unskill-intensive exports reduce primary schooling, while skill-intensive exports increase schooling higher up the educational ladder. In other words, the results are strongest where we expect the relationships to be most important. The differ-

[6] For instance, doubling agricultural exports is estimated to decrease average years of schooling by 0.6 years, while doubling skill-intensive manufactured exports increases schooling by 0.3 years on average.

ential responses in educational attainment by workers at various points on the educational ladder are both intuitive and consistent with existing theoretical predictions (Blanchard and Willmann 2013).

To better understand the underlying mechanisms, we utilize different dimensions of the data to conduct a series of extensions. We find that the impact of exports on schooling is similar across genders[7] but differs according to the level of development of the country. Perhaps unsurprisingly, we find that the negative impact of agricultural exports on average years of schooling is limited to less developed countries. In contrast, the impact of manufactured exports on educational attainment is similar across rich and poor countries, although slightly larger in magnitude in developed countries.

Finally, we conduct a number of robustness checks. A placebo test confirms that exports have no effect on the educational decisions of older individuals, which offers additional support for our posited mechanism. Other tests demonstrate the robustness of our results to alternate lag structures and the inclusion of a variety of additional controls, including both national spending on education and foreign direct investment. Lastly, as a further check on our IV strategy, we reconstruct the instrument in a variety of different ways to alleviate potential concerns about the validity of the exclusion restriction.

Together, our findings raise a troubling possibility. Taken to the logical conclusion, our results suggest that the impact of trade on educational attainment could induce economic divergence. Less developed countries that export agricultural goods may experience further declines in educational attainment, which will only sharpen comparative advantage in agricultural goods. At the same time, developed countries that tend to export skill-intensive manufactured goods will experience an increase in educational attainment, further increasing comparative advantage in those goods. This is particularly troubling in light of recent work that suggests human capital is the most important driver of economic growth (Jones 2014). Our empirical findings support the stark theoretical predictions of Ventura (1997) and Bajona and Kehoe (2010), who demonstrate that incorporating trade into standard growth models can dramatically change the convergence prediction to the detriment of

[7] We find modest evidence that unskilled manufactured exports have a more negative impact on male educational achievement than female achievement; differences in the responsiveness to agricultural and skilled manufacturing exports are negligible.

poor countries.[8] The policy implications are immediate and sobering.

To the best of our knowledge, the only other papers that have pursued a cross-country examination of the relationship between trade and educational attainment are Wood and Ridao-Cano (1999), Redding and Schott (2003), and Galor and Mountford (2008).[9] Our analysis differs and improves upon these previous studies in a number of important ways. For one, our panel setting allows us to control for unobservable country and year specific factors, which offers immediate advantages relative to the cross-sectional analyses in Redding and Schott (2003) and Galor and Mountford (2008). Additionally, we use a direct measure of exports in our analysis which differs from existing studies. Wood and Ridao-Cano (1999) and Galor and Mountford (2008) use a country's initial factor endowments or level of development to make assumptions about the types of goods they export. Commensurately, our study uses an IV approach to identify the *causal* impact of exports on educational attainment. This additional step is crucial given the immediate likelihood of both reverse causality and omitted factors that could simultaneously drive both exports and educational attainment.

Our findings and results also relate to an important body of country and industry specific event studies that demonstrate how educational decisions respond to the growth of local industries (trade-induced or otherwise). Jensen (2012), Shastry (2012), and Oster and Steinberg (2013), find compelling evidence that school enrollments in India increased with local IT jobs, while Heath and Mobarak (2014) find that enrollments in Bangladesh increased in response to manufacturing growth. Emphasizing the impact of labor-saving technology, Foster and Rosenzweig (1996) found that educational attainment increased in India with technological change in agriculture. On the other side of the globe, Black, McKinnish, and Sanders (2005) show that enrollments in Appalachian states within the U.S. decreased with the coal boom.

Several more closely related studies focus explicitly on the link between trade and educa-

[8] In closed economy growth models, convergence occurs because poor countries have less physical capital or human capital and thus have higher returns to these factors that are important for growth. However, trade alters the terms of trade, decreases the returns to these factors, and thus reduces the tendency of poorer countries to converge.

[9] In a related cross-country level analysis, Pavcnik and Edmonds (2006) find evidence that openness leads to less child labor.

tional attainment. Edmonds, Pavcnik, and Topalova (2009, 2010) find that imports reduce educational attainment in both rural and urban areas within India, operating primarily through a negative income effect.[10] Finally, as noted earlier, Atkin (2012) and Hickman and Olney (2011), find evidence of trade-induced changes in educational attainment in Mexico and the U.S., respectively, both of which are consistent with the results of our study. Taken together, these papers offer a series of clear, well-defined case studies in which education has responded in logical ways to changing labor market opportunities. But by definition, the narrowness of the lenses that offer such clean empirical results also limits broader applicability. Our paper takes an alternative but complementary approach, sacrificing some of the precision of case-studies in order to generate a broad cross-country long-horizon set of results that ultimately knit together the existing literature on educational attainment and local labor market changes.

The next section presents the theoretical justification for our approach, based largely on existing work in the trade literature. Section 3 lays out the reduced-form empirical specification. Section 4 introduces the data and describes our instrumentation strategy. Section 5 presents the baseline empirical results, while section 6 discusses a number of extensions and robustness checks. Section 7 concludes.

2 Theory

In this section, we outline the theoretical basis that underpins our empirical approach. We use existing work in trade theory to sketch how the pattern of exports drives local investment in human capital. Knitting together several modeling approaches, we first formalize the intuition driving our basic empirical strategy and then draw out additional predictions that arise in a richer framework. This modeling exercise thereby provides a useful way of motivating and setting up the empirical analysis that follows; it should not be interpreted as a stand-alone contribution of the paper.

We begin by clarifying the link between the skill-intensity of exports and human capital

[10] We find little evidence of an aggregate income effect using our cross-country panel data. While we are unable to identify income and substitution effects at the individual household, our aggregate results suggest that the latter effect dominates. See the discussion in Section 3.

investment using a model of endogenous skill acquisition (Findlay and Kierzkowski 1983). Intuitively, trade affects the relative wages paid to skilled versus unskilled workers through standard Stolper-Samuleson (SS) effects. Trade induced wage changes subsequently alter the incentives to go to school and hence equilibrium schooling decisions. In the absence of reliable cross-country wage data, this mechanism thus provides a theoretical foundation for studying the empirical relationship between exports and schooling outcomes directly.

A short second subsection then summarizes additional insights from more recent work in the trade literature. In particular, we demonstrate the possibility of non-monotonic skill change – the idea that increased trade could both increase and decrease educational attainment at different points along the educational ladder. We use this basic insight to inform how we measure skill attainment within and across countries.

2.1 A Simple Model of Exports and Skill Acquisition

In what follows, we present a simplified version of Findlay and Kierzkowski (1983) to demonstrate the mechanism by which trade drives incentives for human capital investment. Begin with a standard two country, two good, two factor Heckscher-Ohlin (HO) model. Two countries, Home and Foreign, produce and trade two goods, agriculture, A, and manufactures, M. Production of both goods requires skilled-labor (L_S) and unskilled labor (L_U). Following custom, assume that the manufactured good is relatively skill-intensive.[11]

The population consists of finitely-lived agents who endogenously choose to become skilled or unskilled based on expected future earnings. At each instant, a mass of N individuals is born, each of whom live for time T. A given individual can remain unskilled and immediately start earning the prevailing unskilled wage for the rest of his life, or she can go to school for an exogenous period of time θ after which she will earn the prevailing skilled wage.

At any point in time there are NT (atomistic) individuals who can be divided into three

[11] That is, for any internal vector of factor prices, the ratio of skilled-to-unskilled labor use is higher for production of M than A.

types according to:

$$NT = UT + E\theta + E(T - \theta), \tag{1}$$

where UT is the number of unskilled people, $E\theta$ are individuals who are currently in school, and $E(T - \theta)$ are skilled workers who have completed school.

A (non-traded) education sector converts individuals into skilled workers via the following production function:

$$Q = F(K, E; \theta), \tag{2}$$

where Q is the output of skills, measured in efficiency units, K is the exogenous educational input which reflects teachers, classrooms, facilities, etc., and E is the number of students, each of whom spend θ time in school. Assuming constant returns to scale with θ fixed, the production function may be rewritten as $q = f(k)$, where we let $q \equiv Q/E$ represent the number of skill units a student acquires (i.e. the per-capita skill level) if she has access to $k \equiv K/E$ units of the educational input for the entire θ period of her education. Assume that the returns to education are diminishing in k so that: $f'(k) > 0$ and $f''(k) < 0$.

Definitionally, $Q = f(k)E$. Thus:

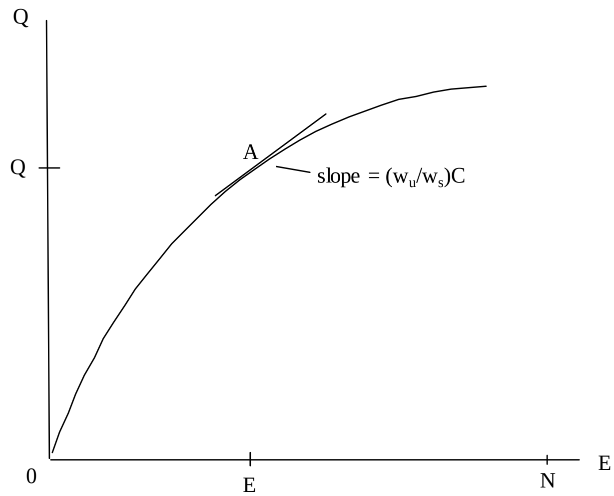
$$\frac{\partial Q}{\partial E} = f(k) - f'(k)k > 0 \text{ and} \tag{3}$$

$$\frac{\partial^2 Q}{\partial E^2} = \frac{1}{E}k^2 f''(k) < 0. \tag{4}$$

Or in other words, the output of skills is increasing with the number of skilled workers, but at a diminishing rate as more students squeeze into the fixed educational facilities, K. Figure 1 presents a graphical representation of Q as a function of E. Notice that determining where on this curve the economy operates in equilibrium will pin down the values of E and Q.

FIGURE 1

Total efficiency units of skill (Q) and number of educated workers (E)



2.1.1 Education Decisions

Each individual decides whether to acquire skills by weighing the future benefits of education against the direct and opportunity costs of going to school. Following Findlay and Kierzkowski (1983), we assume that the (direct) equilibrium school fees associated with going to school from time 0 to θ are equal to the present discounted value of marginal product of school over the skilled workers life, from θ to T.

Let w_u denote the (endogenous) wage paid to unskilled workers, and w_s denote the price of a unit of skill. An unskilled worker then earns income of w_u, while a skilled worker with a skill level of $f(k)$ earns $w_s f(k)$. Taking the wages, E, $f(k)$, and the market interest rate, r, as given, each individual chooses to go to school if the lifetime benefits outweigh the cost:

$$(5) \qquad \int_\theta^T w_s f(k) e^{-rt} dt - \int_\theta^T w_s f'(k) k e^{-rt} dt \geq \int_0^T w_u e^{-rt} dt.$$

The first term on the left reflects the present value of all future income earned as a skilled worker from θ to T, while the second term represents the direct school fees over the period 0 to θ. The term on the right hand side reflects the opportunity cost of education– i.e. the present discounted value of a lifetime of unskilled income (from 0 to T).

The net benefit of education can be defined as the present value of future skilled wages minus the direct costs of school and foregone unskilled wages. Using π to denote this net benefit of education, equations (5) and (3) can be combined to yield:

(6) $$\pi = \frac{1}{r}\left[w_s \frac{\partial Q}{\partial E}(e^{-r\theta} - e^{-rT}) - w_u(1 - e^{-rT})\right].$$

The net benefit of education is increasing with the skilled wage, decreasing with the unskilled wage, and decreasing with the number of educated workers E.[12] This latter condition and free entry implies that the equilibrium net benefit of education is zero. Thus, setting (6) to zero and rearranging generates the following expression:

(7) $$\frac{\partial Q}{\partial E} = \frac{w_u}{w_s}\underbrace{\frac{(1 - e^{-rt})}{(e^{-r\theta} - e^{-rT})}}_{\equiv C} = \frac{w_u}{w_s}C.$$

Thus, in equilibrium the slope of the curve in Figure 1 is equal to the relative wage scaled by a constant, C. Equation (7) therefore pins down the equilibrium value of E. The horizontal distance $0E$ reflects the number of individuals that choose to become educated, while $U = N - E$ individuals choose to remain unskilled.

2.1.2 Trade

Suppose that both Home and Foreign have identical technologies, tastes, and educational sectors, but differ in their educational input such that $K < K^*$. Home has weaker educational facilities, teachers, etc. It is immediate that in autarky, Home will be relatively abundant in unskilled labor, which (by the HO theorem) gives Home a comparative advantage in agriculture. Therefore, opening to trade, Home exports agriculture while Foreign exports manufactures, since (in the short run) the country's endowment of human capital is initially fixed.

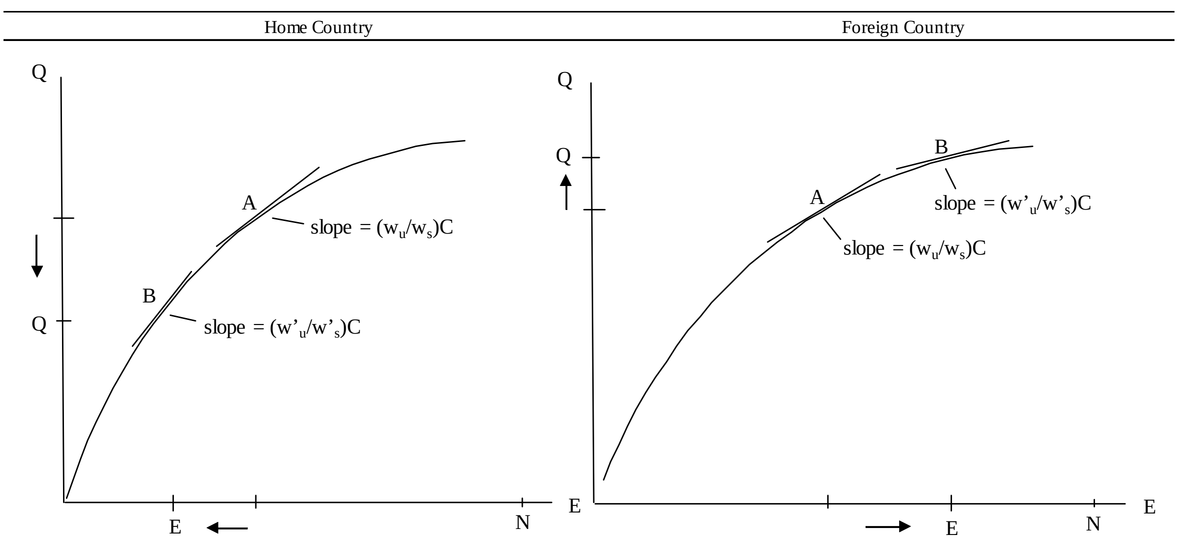
With trade, world relative prices converge to some point in between the two autarky relative prices. Opening to trade thus causes the relative price of agriculture to increase at Home and decrease in Foreign. These price changes translate directly to changes in relative

[12] Specifically, $\frac{\partial \pi}{\partial w_s} > 0$ and $\frac{\partial \pi}{\partial w_u} < 0$ and $\frac{\partial \pi}{\partial E} < 0$.

wages. By the SS Theorem, the relative unskilled wage increases in Home and decreases in Foreign. From equation (7) it follows immediately that educational attainment will decline at Home and rise in Foreign.

Figure 2 illustrates the impact of trade on the educational decisions in both Home (on the left) and Foreign (on the right). At Home, as the relative unskilled wage increases, the point of tangency shifts to the left, commensurate with a fall in educational investment. Exporting less skill-intensive agriculture reduces the equilibrium number of skilled workers E. The intuition is straightforward. As the relative unskilled wage increases after trade, the opportunity cost of going to school increases, and thus fewer individuals decide to become skilled. The opposite effect arises in the Foreign country, where the relative skilled wage increases, driving up the equilibrium education level, E.

FIGURE 2



The relationship between the output of efficiency units of skill (Q) and the number of educated workers (E) in the Home and Foreign countries. Point A represent the autarky equilibrium point while B represents equilibrium after trade in each country.

These contrasting results in Home and Foreign generate important testable predictions. Countries that export less skill-intensive agricultural goods will see a decline in average educational attainment. However, countries that export skill-intensive manufactured goods will experience an increase in educational attainment. The key insight is that trade alters relative wages and thus changes the incentives to go to school. The remainder of the paper examines whether there is empirical evidence supporting these common-sense predictions.

2.2 Educational Ladders and Non-Monotonic Skill Responses to Trade

Our empirical approach is motivated primarily by the SS intuition formalized above. Before we continue to the empirical specification, however, we pause to introduce two more empirical predictions that we can also test, following the recent theoretical work by Blanchard and Willmann (2013).

Blanchard and Willmann develop a model of trade and endogenous skill acquisition with the same fundamental mechanisms found in Findlay and Kierzkowski (1983) and outlined above. In place of dynamics, their model allows for ex-ante heterogenous agents and a continuum of sectors (or 'occupational tasks'), each of which requires a specific skill level. Relative to the framework reviewed in the previous subsection, their model offers two additional insights relevant for our empirical analysis.

First, trade liberalization can induce simultaneous skill upgrading and skill downgrading in a many-sector model. Intuitively, a country can have comparative advantage at multiple points along the job-skill ladder – for instance, in high tech pharmaceuticals and also in fresh produce. Trade liberalization will increase relative wages in these export sectors, which can induce some workers to upgrade skills (entering into pharmaceuticals) while others to reduce skill attainment (entering agricultural work).

A second closely related point is that the incentive effects of trade will affect different workers differently. In Blanchard and Willmann's model, individuals face ex-ante heterogeneous costs of education: some workers find skill upgrading relatively easy, while others do not. These individual level differences affect both the equilibrium self-selection of agents into different skill levels and occupations, and the aggregate response to trade liberalization. Even a substantial increase in the average return to skill upgrading may not be sufficient to induce some agents to acquire more education.

From here we draw two insights that shape our subsequent empirical approach. First, we expect that an increase in exports may induce both an increase and decrease in educational attainment in the same country, at the same time. It is the skill-composition of exports – not the volume of trade itself – that should matter for educational attainment. Indeed, it is entirely possible that regressing educational outcomes on total exports could yield evidence of no causal relationship even if the underlying effects of trade are acute: aggregate exports can obscure trade's true effects. Thus, our empirical work focuses on the skill composition of exports at the country-level.

Second, we expect that exports may influence labor markets only for particular groups of workers. Just as we might not expect the school dropout to reenroll following an increase in pharmaceutical research, nor the valedictorian to drop out following an improvement in potato exports, we anticipate the effects of export composition to influence educational attainment at relevant points along the educational ladder. We predict that changes in exports of low skill-intensity goods are likely to manifest at lower rungs of the educational ladder while changes in exports of more skill-intensive goods are likely to influence educational outcomes at higher rungs. Empirically, we therefore measure educational attainment not only by average years of schooling at the country level, but also by primary, secondary, and tertiary completion rates.[13]

3 Empirical Specification

We use the following reduced form specification to test the extent to which the composition of a country's exports affects its residents' educational attainment:

$$(8) \quad Educ_{it} = \beta_0 + \beta_1 \ln Agr\_Exp_{it-5} + \beta_2 \ln Man\_Exp_{it-5} + \beta_3' X_{it-5} + \gamma_i + \gamma_t + \varepsilon_{ct}.$$

Educational attainment is measured as either the average years of schooling in country i in year t or, in later specifications, the rate of school completion at the primary, secondary, and tertiary levels. The key independent variables of interest are the (log of) agricultural exports, Agr_Exp_{it-5}, and manufacturing exports, Man_Exp_{it-5}, of country i in year $t-5$. The vector X consists of time-varying country-level control variables including imports, GDP, population, death rate, and migrant share, that could influence educational attainment. The independent variables are lagged five years to account for the time that it

[13] As we discuss later, definitions of 'primary', 'secondary,' and 'tertiary' vary somewhat across countries. Our categories of exports by skill-intensity are also sufficiently coarse that we cannot make more specific predictions. To improve upon the specificity afforded by cross-country data would require a country-specific case study, along the lines of Atkin (2012).

takes for economic factors to affect average years of schooling. In addition, equation (8) is estimated at five year intervals.[14] In all specifications, we include time and country fixed effects, indicated by γ_i and γ_t. Standard errors are clustered at the country level throughout to address the potential for serial correlation.

Theory predicts that an increase in agricultural exports reduces the incentive to go to school, so that $\beta_1 < 0$, while an increase in manufactured exports induces greater educational attainment, $\beta_2 > 0$. Note that if exporting leads to a positive income effect that increases demand for education, then both coefficients should be positive. While the income effect has been found to be important in other settings (Edmonds and Pavcnik 2005; Edmonds 2006; Edmonds, Pavcnik and Topalova 2009), controlling for GDP minimizes concerns that our coefficients are inadvertently picking up an aggregate income effect. The relative strength of income and substitution effects at the household level is an important empirical question, but it lies outside the scope of our aggregate level analysis.

In the theory, we adopted the customary assumption that agriculture is unskilled-intensive and manufacturing is skill-intensive. Although this seems plausible (at least in the developing world), the empirical analysis further decomposes manufactured exports into those that are skill-intensive and those that are unskill-intensive using standard industry classifications. To the extent that the skill intensity of agricultural and manufacturing exports varies across countries or over time, the country fixed effects and year fixed effects control for these differences. Finally, we address the potential that the skill intensity of industries could vary systematically between developed and less-developed countries in an extension.

While the lag structure and the inclusion of numerous controls and fixed effects alleviates some of the concerns about omitted variable bias and reverse causality, they may not completely eliminate endogeneity. Thus, we rely on an instrumental variable approach to identify the causal impact of exports on educational attainment. The specific construction of the instrument will be discussed in greater detail in the next section of the paper. (The general idea is to use the gravity model to identify the variation in a country's exports that

[14] This is because education data is only available every five years. However, given the nature of our question five year intervals is probably preferable to a high frequency annual analysis.

is uncorrelated with domestic factors.)

4 Data

4.1 Educational Attainment

Data on educational attainment come from Barro and Lee (2013) and are appealing for a number of reasons. First and foremost, it has educational attainment data for over one hundred countries over five year intervals from 1950-2010. The broad scope of countries included and the time period covered is central to the spirit of this cross-country, long horizon analysis.

Second, it offers educational attainment data for different age cohorts. In the baseline specification, we focus on average years of schooling of 15-29 year olds. This younger cohort is the focus of the empirical analysis, because, by definition, these are the individuals in the process of making their educational decisions. Younger workers are also more sensitive to changing economic conditions since they have their full working careers ahead of them. Utilizing data on older individuals, we also pursue a placebo test where we examine how exports affect the average years of education of older individuals.

One more key attribute of the Barro and Lee (2013) data is the inclusion of average schooling years and completion rates at the primary, secondary, and tertiary levels. The data also break out educational attainment by gender, which we study in another extension.

4.2 Export Data

Trade data come from the World Trade Flows data set constructed by Feenstra et al. (2005). This data set has export data by country and by 4-digit SITC revision 2 industry for the years 1962-2008.[15] Values are reported in nominal U.S. dollars and are converted to real U.S. dollars using the Consumer Price Index (CPI) provided by the Bureau of Labor Statistics.

The data report bilateral trade flows, which we need to construct the instrument, and

[15] We utilize a version of this data that has been extended to 2008 by Robert Feenstra and Gregory Wright.

also industry-level trade flows, which we need to decompose the skill-composition of exports. We define agricultural exports as the sum of exports in SITC industries 0, 1, 2, and 4. Manufacturing exports are defined as the sum of exports in SITC industries 6, 7, and 8. We further decompose these manufacturing industries into those that are unskill-intensive and those that are skill-intensive using data UNCTAD data (Basu forthcoming) on the skill and technology content of HS 6 digit industries and a HS - SITC concordance from the Center for International Data at UC Davis.[16] We also tried using the NBER-CES U.S. Manufacturing Industry Database to define manufacturing industries as skilled and unskilled and found the results little changed.[17]

Finally, relative to the raw UN Comtrade data, a number of corrections and improvements have been made in this data set. These include, among other things, using importer records rather than export reports when possible, relying on the more accurate U.S. trade data, and correcting a number of inconsistencies in the UN data (Feenstra et al. 2005).[18]

4.3 Control Variables

We control for both country and year fixed effects throughout. To account for factors that may vary over time within a country, the empirical specification adds addition time varying country-level control variables. The set of potential controls is limited by data availability; relatively few data series span the set of countries and years included in the education and trade data. Thus, we face a trade-off between maximizing the set of control variables and maximizing sample size. We begin by including in the baseline analysis those control variables that are most relevant to our study and also the most comprehensive. Then in Section 6.4 we include additional controls that may be important but whose coverage is

[16] Specifically, SITC 2-digit manufacturing industries are defined as unskill intensive if they primarily consist of "Non-Fuel Primary Commodities", "Resource-Intensive Manufactures", or "Mineral Fuels." If the SITC 2-digit manufacturing industry primarily consist of "Technology-Intensive Manufacturing", then they are defined as skill-intensive manufactured industries. In contrast, the agricultural group of industries are completely uniform. All 2-digit SITC industries that constitute the Agricultural sector defined above are classified as "Non-Fuel Primary Commodities" by UNCTAD.

[17] The downside of using the NBER U.S. Manufacturing database is that it relies on data from the U.S. which is less relevant for many countries in our sample. For instance, according to the U.S. data, cars (i.e. "road vehicles" SITC 78) are defined as an unskilled industry whereas UNCTAD, which takes a more global view, defines car production as skill intensive.

[18] These adjustments have not been made to the 2001-2008 data, but the results that follow are remarkably similar if the post 2000 trade data is excluded.

poor.

Specifically, the set of controls in the baseline analysis consists of: real imports, which are obtained from the World Trade Flows data set; real GDP and population, from the Penn World Tables; the death rate per 1,000 people, from the World Development Indicators (WDI) data produced by the World Bank[19]; and the immigrant share of the population, also from the WDI.[20] All control variables are logged and lagged five years.

4.4 Descriptive Statistics

Combining these different variables generates an unbalanced panel data set that spans the years 1965-2010 at five year intervals. Educational attainment span the years 1970-2010 while the trade and control variables are lagged five years and thus span the years 1965-2005. This lag structure makes the best use of the available trade data; later, we show that the results are robust to other lag specifications.

Following Hanson et al. (2013), we exclude extremely small countries from our baseline sample.[21] In addition, we drop countries that report a decline in manufacturing or agricultural exports of over 85% from one five year period to the next, to avoid potential contamination by conflict-driven outliers.[22] Our results are robust to alternate samples of countries, but we find this cut of the data to be the most sensible.

Table 1 reports summary statistics for the variables included in our baseline sample. To demonstrate the extent of cross-country variation in schooling and export patterns, Table 2 reports the average years of schooling and average exports over the 1965-2010 period by country.

The top panel of Figure 3 offers a first look at the data, plotting the average years of schooling against the natural logarithm of lagged total exports. A clear positive and significant relationship is evident. This should be interpreted with caution, however, since

[19] The death rate in a country could capture a variety of negative shocks, such as wars, health epidemics, and natural disasters, that could affect both exports and educational attainment

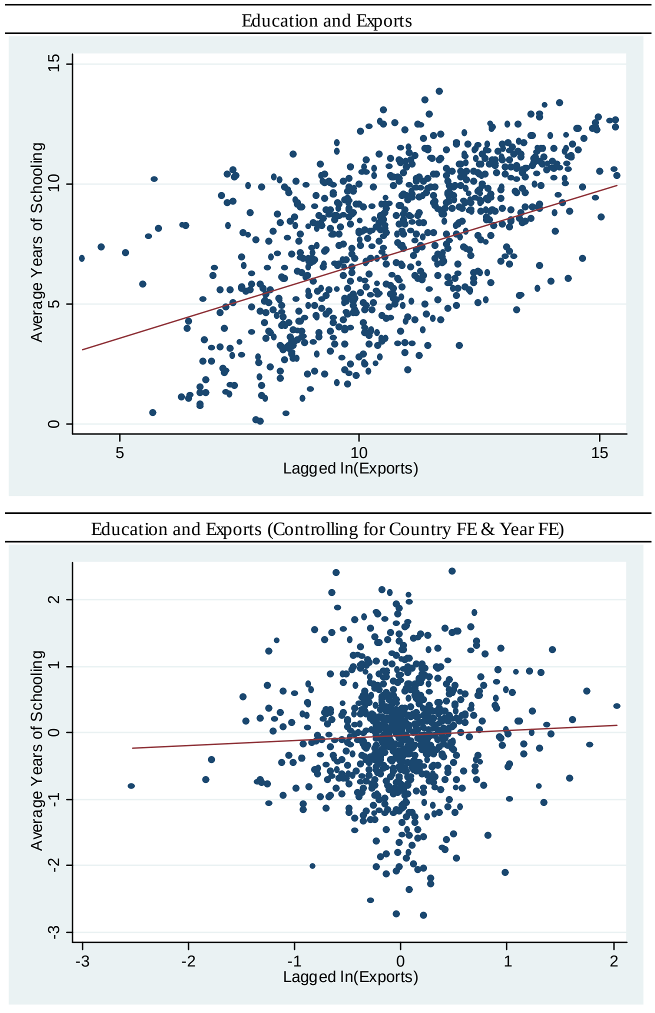
[20] The WDI has an enormous number of variables but relatively few span the countries and years used in this analysis.

[21] Countries with less than a million people or with GDP of less than five million dollars on average were dropped.

[22] For instance, conflict and wars in Iraq, Cambodia, and Nicaragua led to a dramatic decline in exports in these countries at various points in time.

it is likely that exports and average years of schooling are higher in more developed countries and higher in more recent years. To account for this most obvious source of bias, we regress exports and years of schooling on country and year fixed effects, and plot the residuals in the bottom panel of Figure 3. These residuals represent the variation exploited in our empirical analysis and show that there is no significant relationship between years of schooling and total exports. Therefore, in this raw cut of the data there is little evidence that exports generate an income effect which increases educational attainment. The positive relationship between exports and educational attainment observed in the top panel is largely due to fixed country and year factors. Together these two panels highlight the importance of controlling for country and year fixed effects, something the previous literature has not always done.

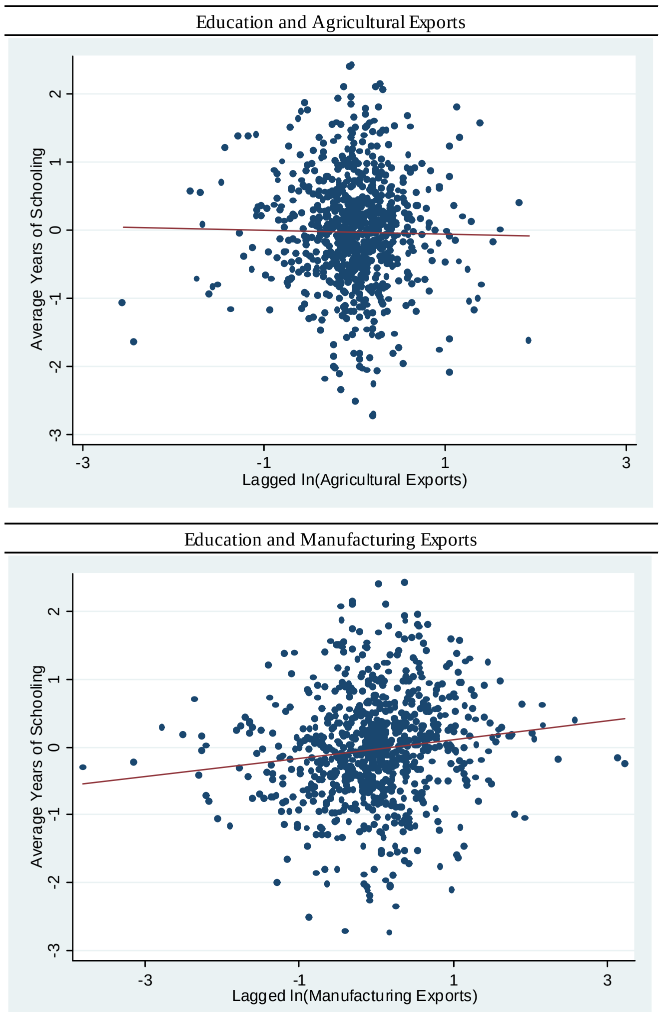
FIGURE 3



The top panel plots average years of schooling of 15-29 year olds against lagged real exports. The bottom panel is an anologous scatter plot after controlling for country fixed effects and year fixed effects. Schooling data is from Barro and Lee (2013) and the trade data is from the NBER-UN Trade Dataset.

The theory predicts that the composition, not the overall volume, of exports is what matters for educational attainment. Accordingly, Figure 4 plots agricultural exports and manufacturing exports separately against average years of schooling, controlling for country and year fixed effects. The top panel reveals a negative relationship between agricultural exports and average years of schooling, while the opposite holds in the bottom panel, where manufacturing exports and schooling are positively correlated. These opposing relationships are exactly what the theory predicts: agricultural exports increase the opportunity cost of education and thus decrease educational attainment, while manufactured exports drive up the returns to skill and thus increase educational attainment. It is encouraging that these predictions are confirmed in such a raw cut of the data. Next we examine whether these relationships can survive more rigorous econometric analysis.

FIGURE 4



Average years of schooling of 15-29 year olds is plotted against lagged real agricultural exports in the top panel and against lagged real manufacturing exports in the bottom panel. Both scatter plots control for country and year fixed effects. Schooling data is from Barro and Lee (2013) and the trade data is from the NBER-UN Trade Dataset.

4.5 Instrument

Our instrumentation strategy is based on a well-established method of constructing an instrument using the gravity model (Frankel and Romer 1999 and Feyrer 2009 among others). This section describes specifically how the instrument is constructed using bilateral data; later, we use this instrument in our standard two-stage least squares (2SLS) estimation procedure. The results from this section thus represent a preliminary step necessary to construct the instrument and should not be confused with the typical first-stage and second-stage IV results that will follow afterwards.

The gravity model is one of the most successful empirical relationships in economics and is remarkably good at predicting bilateral trade flows (Anderson 2011, Anderson and van Wincoop 2003). Fundamentally, the gravity model predicts that bilateral trade flows are a function of exporter characteristics, importer characteristics, and resistance factors such as distance. In the present context, variation in bilateral trade that is due to exporter characteristics is potentially problematic because it could be correlated with educational attainment. Thus, our goal in constructing an instrument for export volumes is to eliminate any variation in bilateral trade that is driven by exporter characteristics. The instrument therefore relies on only the variation in trade due to more plausibly exogenous factors such as geography and economic conditions in a country's foreign trading partners.[23]

Anderson and van Wincoop (2003) derive the following theoretically consistent gravity model:

$$x_{ijt} = \frac{y_{it} y_{jt}}{y_{wt}} \left(\frac{\tau_{ijt}}{P_{it} P_{jt}} \right)^{1-\sigma}, \tag{9}$$

where x_{ijt} are exports from country i to country j in year t.[24] y_{it} , y_{jt} , y_{wt} are real GDP in country i, country j, and in the world. τ_{ijt} is the bilateral resistance term and P_{it} and P_{jt} are the multilateral resistance terms in country i and j. Finally, $\sigma > 1$ is the elasticity of substitution between goods. Taking logs of equation (10) generates:

$$ln(x_{ijt}) = ln(y_{it}) + ln(y_{jt}) - ln(y_{wt}) + (1 - \sigma)(ln(\tau_{ijt}) - ln(P_{it}) - ln(P_{jt})). \tag{10}$$

Thus, bilateral export flows are a function of log real GDP in the importing country,

[23] Unlike Frankel and Romer (1999) and Feyrer (2009), which focus exclusively on geographic factors, we also exploit variation due to economic shocks in the foreign importing country. We explore several alternative strategies of instrument construction in robustness checks.

[24] Focusing on uni-directional trade is more relevant for this analysis and also avoids the "silver medal mistake" discussed by Baldwin and Taglioni (2006).

$ln(y_{it})$. Real GDP in the exporting country, $ln(y_{jt})$, will not be included in the subsequent empirical specification, since it could be correlated with educational attainment. Again, the goal of this IV strategy is to identify the variation in bilateral trade that is unrelated to conditions in the exporting country. Year fixed effects, γ_t, will absorb changes in world GDP, $ln(y_{wt})$, and common trends in the bilateral and multilateral resistance terms. Finally, a full set of bilateral pair fixed effects, γ_{ij}, will control for all time-invariant resistance factors such as distance, language, and colonial relationships that are often found to be important determinants of bilateral trade.[25] Thus, we obtain the following equation:

$$ln(x_{ijt}) = \alpha ln(y_{it}) + \gamma_t + \gamma_{ij} + \epsilon. \tag{11}$$

To estimate (11), we use bilateral export flows between every country in the World Trade Flows data set over five year intervals from 1965-2005.

In the first two columns of Table 3, we confirm that our data and analysis can replicate the gravity results now common in the literature. Column 1 reports a gravity specification with year fixed effects, importer fixed effects, and exporter fixed effects. Consistent with the existing literature, we find that bilateral export flows are increasing with importer GDP and exporter GDP, but decreasing with distance. Column 2 then includes a (more rigorous) set of bilateral pair fixed effects, which subsume the distance variable. We see that but both importer GDP and exporter GDP still have a significant positive impact on exports, consistent with existing work.

Column 3 then reports the estimates from equation (11). These fitted values capture variation in bilateral trade that is driven by importer GDP, time effects, and bilateral pair effects for each pair of countries in each year. Again, these fitted values are not a function of conditions in the exporting country. We find it reassuring that the coefficient on importer GDP does not change from columns 2 to 3, which alleviates concerns that importer GDP could inadvertently be picking up variation in exporter GDP.

The fitted values from column 3 are at the bilateral-year level, while the unit of observation in our main empirical specification is at the country-year level. The last step in

[25] Baldwin and Taglioni (2006) argue that relative to country fixed effects, bilateral pair fixed effects are better at dealing with the "gold medal error."

constructing our instrument is then simply to aggregate the bilateral fitted values across all trading partners within a year, to generate total exports abroad for each country in each year. Following Frankel and Romer (1999) and Feyrer (2009), the (unlogged) bilateral fitted values are summed in the following manner to construct our instrument:

$$export\_IV_{it} = \sum_{j \neq i} e^{\widehat{\alpha} ln(y_{it}) + \widehat{\gamma}_t + \widehat{\gamma}_{ij}} \tag{12}$$

Analogous instruments are constructed for each of the export components using the same methodology. Specifically, agricultural exports, manufacturing exports, unskilled manufacturing exports, and skilled manufacturing exports are used in turn as the dependent variables in equation (11). The results from these estimations are reported in columns 4-7 of Table 3. The fitted values are then summed according to equation (12) to create the instruments for each export type.

Finally, we note that our empirical strategy offers several additional features that limit concerns about the exclusion restriction. To address the possibility that importer GDP could affect domestic educational attainment through a channel other than exports, we control for both imports and migration in all specifications. We also control for FDI in an extension and find the results little changed (though the sample is smaller because of limited data on FDI). Another potential concern is that importer GDP could be correlated with exporter GDP in some unobserved way (outside of the time fixed effects, which are already included), especially if the two countries are geographically proximate or are economically integrated. That said, the results in Columns 2 and 3 of Table 3 argue against this possibility to the extent that the coefficient on importer GDP does not change when exporter GDP is excluded. Nonetheless, in a robustness check, we use the importing-country's death rate, rather than importer GDP, to construct the instrument. This alternative is less consistent with a gravity model approach but could be better at identifying an exogenous shock in the importing country. In Section 6.6, we also use bilateral trade agreements to construct the instrument rather than importer GDP. Overall, we find that our baseline results are robust to these alternative IV specifications, which limits concerns about the exclusion restriction.[26]

5 Results

5.1 OLS

We report baseline results using Ordinary Least Squares (OLS) in Table 4. All regressions include the full set of controls, country fixed effects, year fixed effects, and have robust standard errors clustered at the country level in brackets. Column 1 shows the estimated relationship between agricultural and manufacturing exports and average years of schooling. As expected, exporting unskill-intensive agricultural goods is negatively correlated with average years of schooling. Specifically, doubling agricultural exports is associated with a decline in average schooling within a country of 0.3 years. The coefficient is significant at the one percent level and is smaller but similar in magnitude to the impact of GDP on average years of schooling. While the coefficient may seem small, it is important to remember that the educational decisions of only a subsample of the population are affected by agricultural exports. In this light, it is perhaps remarkable that a change in exports is large enough to show up in the overall average years of schooling of the entire population. This finding that trade exposure can have a substantial effect on aggregate labor market outcomes is consistent with existing work, including important early findings by Bernard and Jensen (1997) and more recent work by Hakobyan and McLaren (2010) and Autor, Dorn, and Hanson (2013).

In column 1, we find that the relationship between manufacturing exports and educational attainment is insignificant. At first glance, this result seems surprising, since the theory predicts that exporting relatively more skill-intensive goods should increase the relative wage of skilled workers, and thus provide an incentive to go to school. There is, however, marked heterogeneity among these manufacturing industries. For instance, textile yarn and fabric (SITC 65) and office and automatic data processing machines (SITC 75) are both classified as manufactured goods but, according to UNCTAD, the former is

[26] We also tried constructing an instrument using the distance weighted average tariff rates of a country's foreign trading partners. Unfortunately, TRAINS tariff data by country and industry are only available after 1988. Unsurprisingly, drastically limiting the number of years in the sample weakens the IV.

resource and unskill-labor intensive while the latter is technological and skill-intensive. To disentangle these effects, Column 2 reruns the empirical specification decomposing manufacturing exports into unskilled and skilled components using the classifications described earlier. Since the industries that comprise the agricultural sector are broadly of the same (low) skill intensity (at least in the developing world), we leave the definition of agricultural exports unchanged.

In this new specification in Column 2, the coefficient on agricultural exports is still negative and significant as before. In contrast, the two components of manufacturing exports demonstrate sharp and opposing relationships with schooling. Unskill-intensive manufacturing exports are negative and significantly related to average years of schooling, while the coefficient on skill-intensive manufacturing exports is positive and significant, consistent with the predictions generated by theory. These contrasting results explain why the estimated coefficient on aggregate manufacturing exports in column 1 was insignificant. Finally, the coefficients on the control variables are of the expected sign, with years of schooling increasing with GDP but decreasing with the death rate.

Overall, the results in Table 4 are consistent with the predictions of the theory, but we have not yet demonstrated causality. We turn to the instrumental variables results now.

5.2 IV

Despite lagging the independent variables and including a variety of controls and fixed effects, there are still potential endogeneity concerns. Thus, we implement an IV approach to test the causal predictions of the theory. As described earlier, our instrument is constructed using the variation in a country's export pattern that is driven by exogenous factors.

Table 5 reports the first stage IV results for two specifications. The first two columns report the first stage results when exports are divided into two categories: agriculture versus total manufactures. The last three columns re-run the first stage results when there are three categories of exports: agriculture, unskill-intensive manufactures, and skill-intensive manufactures. In every column of Table 5, the relevant instrument has a large, positive, and significant impact on the component of exports it was designed to predict. The F-stat on the excluded instruments is well above 10 in every specification, which indicates a relatively strong first stage. Again, to address the potential violation of the exclusion restriction whereby a foreign shock in the importing country affects the domestic economy through a channel other than trade, we specifically control for imports and migration throughout.[27] Finally, as an interesting aside, notice that agricultural exports are increasing with migrants while manufacturing exports are increasing with GDP and decreasing with the death rate. All of which we find plausible.

Table 6 reports the second stage IV results. The results are similar to our OLS findings, but now carry a causal interpretation consistent with theory. Agricultural exports depress average years of schooling while aggregate manufactured exports do not have a significant impact on educational attainment. When, in column 2, manufacturing is separated by skill intensity, we find evidence of a sharp causal relationship between manufacturing exports and educational attainment. Educational attainment is decreasing with unskill-intensive manufactured exports and increasing with skill-intensive manufactured exports. Both coefficients are significant at the one percent level.

Overall, the results in Table 6 provide compelling support for the predictions of the theory. Educational attainment is decreasing with unskill-intensive exports and increasing with skill-intensive exports. The magnitudes are small but plausible given that export-oriented jobs are often a relatively small component of the aggregate labor market. We find that a country's exports affects aggregate labor markets enough to change the individuals' incentives to go to school, and that these effects depend critically on the skill-intensity of the export sector. Next, we ask whether these effects are felt more acutely at different points along the educational ladder.

5.3 Heterogeneous Effects along the Educational Ladder

By focusing only on average years of schooling, our baseline specification could mask a heterogeneous impact of exports on different levels of schooling. The results so far indicate overall average years of schooling are affected by exports, but is this driven by changes in a primary, secondary, or college education? Both common sense and formal theory suggest

[27] And as noted earlier, we control for FDI in an extension in Section 6.4 and find the results to be robust despite the limited sample size.

that agricultural exports may be more likely to decrease primary education even as exports of skilled manufacturing products drive up achievement at the secondary or tertiary levels.

Table 7 explores this possibility, by examining how exports affect average years of primary, secondary and tertiary schooling. As expected, agricultural exports have a significant negative impact on primary schooling, but have little impact on secondary and tertiary education. This indicates that, as expected, students in grade school are more affected by growth in the agricultural sector than those pursing a college education.[28] In addition, unskilled manufactured exports also negatively affect primary schooling but have little impact on secondary and tertiary education. Conversely, skilled manufactured exports have a positive impact further up the skill distribution, particularly on secondary schooling.[29]

Table 8 pursues a similar type of analysis but uses slightly different dependent variables. Specifically, in Table 8 the dependent variable is the percent of the 15-29 year old population with no schooling, at least some primary schooling, at least completed primary schooling, at least some secondary schooling, at least completed secondary schooling, at least some tertiary schooling, and at least completed tertiary school. This specification provides greater insight into how exports affect schooling decisions at various points in the schooling distribution. The results are broadly consistent with those from Table 7. Agricultural and unskilled manufactured exports affect educational decisions negatively and toward the bottom end of the skill distribution while skilled manufacturing exports affect decisions positively, and higher up the skill distribution.

Not only are the results in Tables 7 and 8 consistent with the theory, they also serve as a sort of quasi-placebo test of our main results. We would be concerned, for instance, if agricultural exports significantly affected college level education decisions. The fact that the results are strongest in the most logical places is thus reassuring.

[28] Although we include country fixed effects, it is possible that the only variation in the primary education variable occurs in developing countries, which would subsequently drive our results. We address this point in an extension in which we look separately at developing and less developed countries.

[29] The lack of a discernable effect on tertiary education is perhaps not surprising given the extent of heterogeneity even in the skilled-manufacturing category: many sub-sectors in this category may hire workers out of high school, especially in the developing world.

6 Extensions

6.1 Age

The analysis so far has focused on the average years of schooling of 15-29 year olds. This younger cohort is in the process of making educational decisions and they have their entire working careers ahead of them to recoup investments in human capital. Thus, they should be more sensitive to relative wage changes driven by exports. As a placebo test, however, we can test how exports affect educational attainment of older cohorts within the same 5-year time horizon. Since older individuals have already made their educational decisions and chosen careers, they should be less responsive to changing economic conditions and thus to the pattern of exports.

Table 9 shows the results from this placebo test. Column 1 re-reports the baseline results using the average years of schooling of 15-29 year olds as the dependent variable, while column 2 examines the impact of exports on the average years of schooling of 30-49 year olds. As we have seen, exports have a strong significant impact on the educational decisions of the young. However, as expected, the average years of schooling of 30-49 year olds is unaffected in column 2. All three components of exports have an insignificant impact on the educational decisions of this older cohort of individuals. Comparing the results in columns 1 and 2 confirms our expectation that the results should hold for only younger individuals.

6.2 Gender

The Barro and Lee (2013) data also report educational attainment by gender. Although theory does not have strong predictions about how exports might differentially affect educational decisions of males and females, we nonetheless find it to be an interesting dimension to investigate. Perhaps exporting affects one gender more than another or perhaps the responsiveness of educational decisions to market forces differs across genders. In Table 10, we thus examine the impact of exports on the educational attainment of males and females. The results indicate that the educational decisions of both males and females respond to exports. However, comparing columns 1 and 2 we see that males are slightly more responsive to agricultural exports and unskilled manufactured exports, while skilled manufactured exports have a similar impact on males and females. These gender differences may reflect the types of industries males and females tend to be employed in.

6.3 Level of Development

This section examines whether there are differences in how exports affect years of schooling in developed versus less-developed countries. Time invariant differences across countries are captured by the country fixed effects in the baseline specification, but there could be, for instance, systematic differences in the skill intensity of agricultural and manufacturing exports across developed and less developed countries.

The results of this extension are reported in Table 11 where developed countries are defined as those designated as "High Income" or "Upper Middle Income" by the World Bank in year 2000 and less developed countries are those designated "Lower Middle Income" or "Low Income". While the IV specification is generally preferable, in this case splitting the sample in half leads to a sufficiently weak first stage that we report instead the OLS results.

Overall, we see that exports affect educational decisions in both developed and less developed countries. However, there are some interesting differences. Agricultural exports have a strong negative impact on years of schooling in less developed countries but an insignificant impact in developed countries. This is consistent with the idea that the agricultural sector is unskill-intensive in less developed countries but is more skill intensive (or indeed, attracts very little formal-sector labor) in many developed countries. Furthermore, this result indicates that the negative coefficient on agricultural exports in the baseline results is primarily driven by less developed countries. In additional cuts of the data by region or time period (not reported), we found that this negative relationship between agricultural exports and educational achievement is widespread, and not driven by a particular region or time period.

Not surprisingly, we find that manufactured exports have a stronger impact on educational attainment in developed countries. Overall, the results in Table 11 show that there is support for the predictions of the theory in both developed and less-developed countries, and that our results are again strongest where common sense would suggest.

6.4 Sensitivity Analysis

Table 12 reports a number of sensitivity checks that test the robustness of the baseline results. Specifically, column 1 lags the independent variables by 10 years, rather than the 5 year lags that are used in the baseline specification. This specification addresses the concern that the 5 year lags may be too short to capture the schooling responses of some of the youngest cohorts. The downside of using the longer lags is that we lose more than ten percent of our observations. Despite the smaller sample, the results in column 1 of Table 12 are of the expected sign, significant, and quite similar to the baseline results. Thus, we find no evidence that our results are sensitive to the lag structure used in the baseline specification.

Columns 2-6 include a variety of additional controls. In Column 2, we include a control for national educational expenses as a percent of gross national income using data from the World Bank's World Development Indicators. Unfortunately, this variable has limited coverage, which significantly reduces the sample. As expected, educational expenditures have a strong positive relationship with the average years of schooling. Because educational expenditures are likely endogenous to the demand for education, however, we are careful not to draw causal inference. The important point is, rather, that including educational expenditures as a control does not change the estimated coefficients of interest on the export variables, which remain of the expected sign and significant. This should not be surprising given our IV approach eliminates variation in exports that is driven by domestic conditions such as educational policies.

To address concerns that a shock in the importing country could affect domestic educational attainment through a channel other than exports, Column 3 controls for foreign direct investment. This measure of inward FDI was obtained from the World Development Indicators but it has relatively poor coverage and thus was not included in the baseline specification. Despite the fact that the sample is more than twenty percent smaller, the estimated coefficients on the export components remain similar in sign, magnitude, and significance level. At the same time, the coefficient on FDI is not statistically significant.

This provides yet more support for the exclusion restriction and thus our IV approach.

In column 4, we include total exports as an additional control variable. Given the log specification, this is equivalent to regressing education on the share of agricultural exports and the share of manufacturing exports. We find the results to be virtually unchanged relative to the baseline analysis. Presumably, this is because the country fixed effects control for time invariant differences across countries and the inclusion of GDP controls for the changing size of the economy within a country over time. Thus, including total exports as a control variable does not add much additional information to the empirical specification.

Finally, in column 5, we explore the thus-far omitted exports of natural resources (like oil). For some countries these exports represent a substantial share of total exports, even if the share of the labor market is more limited. Column 5 includes exports of coal, oil, and gas exports (SITC 3) as well as the baseline export components. The data indicate that natural resource exports have no discernible impact on average years of schooling, and importantly that their inclusion does not affect the agricultural or manufacturing export coefficients.

Finally, following the export definitions, the import control variable is decomposed into analogous agricultural and manufacturing components. As is evident in column 6, including these separate import controls does not change the export coefficients of interest. In addition, the import components have a minimal impact on educational attainment. Only unskilled manufactured imports have a significant impact on years of schooling, and not surprisingly it is opposite in sign from the analogous export component. Overall, column 6 shows that the baseline results are robust to the inclusion of these import components and that educational decisions are far more sensitive to exports than to imports.

6.5 Alternative Instruments

Our IV approach identifies variation in exports that is driven by foreign country shocks and exogenous geographic factors. Specifically, in the baseline analysis the instrument is constructed by regressing bilateral trade values on importer GDP, year fixed effects, and bilateral pair fixed effects. The fitted values from this regression are used to construct the instrument. Although this is a logical way of identifying an exogenous source of variation in exports and it is consistent with the insights from the gravity model, there are other ways to accomplish this goal. This section constructs the instrument in a few different ways to test the robustness of the results. In the process, our findings below offer more support for the validity of the exclusion restriction.

Similar to Table 3, Table 13 reports the gravity style regressions that are used to create the alternate instruments. Column 1 reports the baseline results again, while column 2 instead uses the death rate in the importing country. This captures various negative shocks in the importing country (such as natural disasters, epidemics, etc.) which are plausibly exogenous. In addition, this method alleviates concerns that importer and exporter GDP could be correlated. Not surprisingly, we see that an increase in the death rate in the foreign country reduces exports to that country. Column 3 instead includes indicator variables for whether the pair of countries are part of a free trade agreement. Not surprisingly, we see that exports are increasing with WTO, NAFTA, and EU membership. Finally, column 4 includes importer GDP, the importer death rate, and the trade agreement variables. Using the fitted values from these different specifications, the instruments are then constructed in the manner outlined in section 4.5.

Table 14 then reports the second stage IV results. Column 1 shows the baseline results while columns 2-4 report the results obtained using the alternate instruments. Although the construction of the instruments vary substantially, they all share the common goal of eliminating variation in exports that is driven by domestic factors which could be correlated with educational attainment. Furthermore, columns 2 and 3 specifically address the concern that importer and exporter GDP could be correlated in some unobserved way which would be problematic for our exclusion restriction. The results in Table 14 show that the impact of exports on average years of schooling is similar across these different IV approaches. Educational attainment is decreasing with unskill-intensive exports and increasing with skill-intensive exports regardless of which IV approach is used. Overall, these results demonstrate that our baseline results are robust to a variety of different IV approaches.

7 Conclusion

This paper investigates how investment in human capital responds to structural transformation within an economy. Specifically, we are interested in examining whether and how specialization changes internal labor market opportunities and thus educational attainment. We argue that exports are a useful way of identifying exogenously-driven structural change, and offer a unique opportunity to estimate skill intensity with globally consistent measures.

We construct a panel data set that spans 104 countries and 45 years and we use an IV approach that utilizes bilateral trade data to identify the variation in exports that is unrelated to domestic factors. Both our OLS and IV results support the predictions of the theory. The data indicate that educational attainment is decreasing with agricultural exports, decreasing with unskill-intensive manufacturing exports, and increasing with skill-intensive manufacturing exports. We find that these results are strongest where we most expect, and are robust to a variety of extensions and sensitivity checks.

Our findings carry important policy implications. First, while the benefits of international trade are often stressed, we examine the more complex question of what types of exports are most beneficial for human capital accumulation. Since most countries are already integrated into world markets, the relevant policy question is how best to engage in trade with the rest of the world; our results suggest that exporting skill-intensive goods has important long-run benefits via an empirically demonstrated increase in human capital.

Accordingly, we find empirical support for the concern voiced by Bajona and Kehoe (2010) and others that trade may exacerbate economic differences across countries through its impact on educational attainment. Our results provide evidence that less developed countries that export low skill-intensive goods will see a decline in average educational attainment. To the extent that human capital is a key driver of economic growth, as demonstrated yet again in compelling terms by Jones (2014), this mechanism may undermine the development process. The same logic suggests that developed countries that export skill-intensive goods may continue to experience an increase in educational attainment that would reinforce initial economic advantages. These implications are troubling and warrant additional research.

References

Anderson, James E. 2011. "The Gravity Model." Annual Review of Economics, 3: 133-160.

Anderson, James E. and Eric van Wincoop. 2005. "Gravity with Gravitas: A Solution to the Border Puzzle." The American Economic Review, 93(1): 170-192.

Atkin, David. 2012. "Endogenous Skill Acquisition and Export Manufacturing in Mexico." Working Paper.

Autor, David H., David Dorn, and Gordon H. Hanson. 2013. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." American Economic Review, 103(6): 2121-68.

Bajona, Claustre and Timothy J. Kehoe. 2010. "Trade, Growth, and Convergence in a Dynamic Heckscher-Ohlin Model." Review of Economic Dynamics, 13(3): 487-513.

Banerjee, Abhijit and Esther Duflo. 2005. "Growth Theory Through the Lens of Development Economics." in Philippe Aghion and Steve Durlauf (eds.) Handbook of Economic Growth, Vol. 1A: 473-552.

Baldwin, Richard and Daria Taglioni. 2006. "Gravity for Dummies and Dummies for Gravity Equations." NBER Working Paper #12516.

Barro, Robert and Jong-Wha Lee. 2010. "A New Data Set of Educational Attainment in the World, 1950-2010." Journal of Development Economics, 104: 184-198.

Basu, Sudip Ranjan. Forthcoming. "Retooling Trade Policy in Developing Countries: Does Technology Intensity of Exports Matter for GDP Per Capita?" Policy Issues in International Trade and Commodities, UNCTAD/ITCD/TAB/57. United Nations, New York and Geneva.

Bernard, Andrew B. and J. Bradford Jensen. 1997. "Exporters, Skill Upgrading, and the Wage Gap." Journal of International Economics, 42(1-2): 3-31.

Black, Dan A., Terra G. McKinnish, and Seth G. Sanders. 2005. "Tight Labor Markets and the Demand for Education: Evidence from the Coal Boom and Bust." Industrial and Labor Relations Review, 59(1): 3-16.

Blanchard, Emily and Gerald Willmann. 2013. "Trade, Education, and The Shrinking Middle Class." Working Paper.

Davidson, Carl and Nicholas Sly. 2013. "A Simple Model of Globalization, Schooling, and Skill Acquisition." Working Paper.

Edmonds, Eric V. 2006. "Child Labor and Schooling Responses to Anticipated Income in South Africa." Journal of Development Economics, 81(2): 386-414.

Edmonds, Eric V. and Nina Pavcnik. 2005. "The Effect of Trade Liberalization on Child Labor." Journal of International Economics, 65(2): 401-419.

Edmonds, Eric V. and Nina Pavcnik. 2006. "International Trade and Child Labor: Cross Country Evidence." Journal of International Economics, 68(1): 115-140.

Edmonds, Eric V., Nina Pavcnik, and Petia Topalova. 2009. "Child Labor and Schooling in a Globalizing World: Some Evidence from Urban India." Journal of European Economic Association, 7(2-3): 498-507.

Edmonds, Eric V., Nina Pavcnik, and Petia Topalova. 2010. "Trade Adjustment and Human Capital Investment: Evidence from Indian Tariff Reform." American Economic Journal: Applied Economics, 2(4): 42-75.

Feenstra, Robert C., Robert E. Lipsey, Haiyan Deng, Alyson C. Ma, and Hengyong Mo. 2005. "World Trade Flows: 1962-2000." NBER Working Paper #11040.

Feyrer, James. 2009. "Trade and Income – Exploiting Time Series in Geography." NBER Working Paper #14910.

Findlay, Ronald and Henryk Kierzkoski. 1983. "International Trade and Human Capital: A Simple General Equilibrium Model." Journal of Political Economy, 91(6): 957-978.

Foster, Andrew D. and Mark R. Rosenzweig. 1996. "Technical Change and Human-Capital Returns and Investments: Evidence from the Green Revolution." The American Economic Review, 86(4): 931-953.

Frankel, Jeffrey A. and David Romer. 1999. "Does Trade Cause Growth?" The American Economic Review, 89(3): 379-399.

Galor, Oded and Andrew Mountford. 2008. "Trading Population for Productivity: Theory and Evidence." The Review of Economic Studies, 75(4): 1143-1179.

Goldberg, Pinelopi Koujianou and Nina Pavcnik. 2007. "Distributional Effects of Globalization in Developing Countries." Journal of Economic Literature, 45: 39-82.

Hanson, Gordon H., Nelson Lind, and Marc-Andreas Muendler. 2013. "The Dynamics of Comparative Advantage: Hyperspecialization and Evanescence." Working Paper

Hakobyan, Shushanik and John McLaren. 2010. "Looking for Local Labor Market Effects of NAFTA," NBER Working Paper No. 16535.

Heath, Rachel and A. Mushfiq Mobarak. 2014. "Manufacturing Growth and the Lives of Bangladeshi Women." Yale School of Management Working Paper.

Hickman, Daniel C. and William W. Olney. 2011. "Globalization and Investment in Human Capital." Industrial and Labor Relations Review, 64(4): 652-670.

Jensen, Robert. 2012. "Do Labor Market Opportunities Affect Young Women's Work and Family Decisions? Experimental Evidence from India." Quarterly Journal of Economics, 127(2):753-792.

Jones, Benjamin F. 2014. "The Human Capital Stock: A Generalized Approach." American Economic Review, 104(11): 3752-3777.

Jung, Jae-won and Jean Mercenier. 2008. "A Simple Model of Offshore Outsourcing,Technology Upgrading and Welfare." THEMA Working Paper 2008-21.

Oster, Emily and Bryce Millett Steinberg. 2013. "Do IT Service Centers Promote School Enrollment? Evidence from India." Journal of Development Economics, 104:123-135.

Redding, Stephen and Peter K. Schott. 2003. "Distance, Skill Deepening and Development: Will Peripheral Countries Ever Get Rich?" Journal of Development Economics, 72(2): 515-541.

Shastry, Gauri Kartini. 2012. "Human Capital Response to Globalization: Education and Information Technology in India." Journal of Human Resources, 47(2): 287-330.

Ventura, Jaume. 1997. "Growth and Interdependence." Quarterly Journal of Economics, 112(1): 57-84.

Vogel, Jonathan. 2007. "Institutions and Moral Hazard in Open Economies." Journal of International Economics, 71(2): 495-514.

Wood, Adrian and Cristobal Ridao-Cano. 1999. "Skill, Trade, and International Inequality." Oxford Economic Papers, 51: 89-119.

TABLE 1
Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Average Years of Schooling	791	7.8	2.9	0.5	13.8
ln (Agr. Exports)$_{t-5}$	791	9.3	1.7	3.8	13.5
ln (Man. Exports)$_{t-5}$	791	9.3	2.8	0.6	15.2
ln (Unskilled Man. Exports)$_{t-5}$	791	8.6	2.6	0.0	14.2
ln (Skilled Man. Exports)$_{t-5}$	791	7.9	3.4	0.0	14.9
ln (Imports)$_{t-5}$	791	10.8	1.9	3.0	15.9
ln (GDP)$_{t-5}$	791	18.1	1.7	14.3	23.3
ln (Population)$_{t-5}$	791	9.5	1.4	6.6	14.1
ln (Death Rate)$_{t-5}$	791	2.2	0.4	0.4	3.5
ln (Migrant Share)$_{t-5}$	791	1.0	1.5	-4.6	4.4

TABLE 2

Average Years of Schooling and Average Exports by Country 1965-2010

Country	Years of Schooling	Total Exports	Agr Exp (%)	Man Exp (%)	Country	Years of Schooling	Total Exports	Agr Exp (%)	Man Exp (%)
Afghanistan	2.9	2	71	20	Lithuania	9.9	25	23	54
Albania	9.6	2	36	47	Malaysia	9.4	317	20	64
Algeria	6.4	108	3	1	Mali	1.5	2	63	9
Argentina	9.0	109	64	21	Mauritius	7.9	7	46	51
Armenia	10.2	2	21	73	Mexico	7.6	394	10	65
Australia	11.5	315	50	21	Moldova	9.7	5	49	49
Austria	8.3	244	10	77	Mongolia	7.6	1	61	21
Bangladesh	4.4	21	13	84	Morocco	4.0	36	51	36
Belgium-Lux	10.6	671	12	63	Myanmar	4.0	7	66	19
Benin	3.1	1	82	7	Nepal	3.0	2	25	70
Bolivia	8.7	7	48	17	Netherlands	10.3	901	22	44
Brazil	6.1	271	49	41	New Zealand	12.8	70	70	20
Bulgaria	9.3	22	23	54	Norway	10.3	232	11	30
Cameroon	5.5	14	52	8	Pakistan	4.0	38	26	70
Canada	11.2	975	22	54	Panama	8.7	14	35	49
Chile	9.3	77	51	42	Papua New Guinea	3.9	10	72	2
China	7.8	1081	8	84	Paraguay	7.0	6	83	8
Colombia	6.9	55	45	19	Peru	8.1	39	52	32
Costa Rica	7.6	20	51	44	Philippines	8.0	112	26	70
Cote Divoire	4.0	23	87	7	Poland	9.2	131	17	62
Croatia	8.3	27	17	61	Portugal	8.2	91	16	72
Czech Rep	11.2	220	8	81	Romania	10.0	53	14	65
D.R. Congo	3.3	19	19	60	Russian Fed	10.6	793	9	27
Denmark	9.6	218	32	48	Saudi Arabia	6.7	569	1	2
Dominican Rep.	6.8	18	35	58	Senegal	4.4	5	78	8
Ecuador	7.7	28	50	5	Singapore	9.0	322	6	69
Egypt	5.7	41	23	22	Slovakia	10.3	95	7	77
El Salvador	6.5	10	51	44	Slovenia	10.4	63	6	81
Estonia	10.1	26	17	59	South Africa	7.2	148	29	44
Finland	9.1	177	15	75	Spain	9.4	373	20	66
France	8.9	1252	17	66	Sri Lanka	10.4	17	43	52
Germany	7.9	2415	7	74	Sudan	2.9	9	57	2
Greece	10.3	55	35	49	Sweden	11.0	377	14	74
Haiti	4.2	3	28	66	Switzerland	9.8	397	5	64
Honduras	5.9	11	60	38	Syria	4.8	18	19	10
Hong Kong	11.3	288	3	91	Taiwan	10.8	375	7	86
Hungary	10.5	86	16	70	Tajikistan	9.4	3	36	62
India	4.5	176	25	60	Tanzania	4.8	6	77	13
Indonesia	5.5	241	23	33	Thailand	7.0	202	27	65
Iran	7.0	219	3	4	Trinidad & Tobagc	9.3	24	6	5
Ireland	11.0	205	20	43	Tunisia	6.3	25	17	53
Israel	10.7	92	11	70	Turkey	6.1	107	25	68
Italy	9.4	976	9	78	U Arab Emirates	6.9	237	2	13
Japan	11.4	1857	2	90	UK	9.4	1166	9	65
Jordan	8.2	7	38	33	USA	12.2	2831	17	66
Kazakhstan	8.7	77	13	22	Uganda	4.3	4	93	5
Kenya	6.0	10	69	13	Ukraine	10.4	99	21	61
Korea Rep.	11.3	483	4	86	Uruguay	8.4	12	54	34
Kuwait	5.7	123	1	3	Venezuela	6.5	161	5	7
Kyrgyzstan	8.1	2	41	26	Vietnam	6.3	35	26	48
Latvia	9.3	18	29	41	Yemen	2.3	10	6	2
Libya	6.8	108	0	0	Zambia	5.7	14	8	91

Average years of schooling of 15-29 year olds, average real exports (in millions of real US $), and the share of agricultural and manufactured exports over the sample (1965-2005). Schooling data is from Barro and Lee (2013) and the trade data is from the NBER-UN Trade Dataset.

TABLE 3

Construction of Instrument using Gravity Model

	ln (Exports)	ln (Exports)	ln (Exports)	ln (Agr. Exports)	ln (Man. Exports)	ln (Unskilled Man. Exports)	ln (Skilled Man. Exports)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (Importer GDP)	1.250***	1.358***	1.373***	1.272***	1.263***	1.198***	1.058***
	[0.039]	[0.034]	[0.034]	[0.037]	[0.039]	[0.041]	[0.044]
ln (Exporter GDP)	1.330***	1.386***					
	[0.037]	[0.033]					
ln (Distance)	-1.213***						
	[0.013]						
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE	Yes	No	No	No	No	No	No
Exporter FE	Yes	No	No	No	No	No	No
Bilateral Pair FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,718	51,718	53,433	45,983	46,426	42,232	40,601
R-squared	0.722	0.873	0.857	0.829	0.87	0.854	0.868

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 4
Impact of Exports on Average Years of Schooling (OLS)

	Average Years of Schooling	
	(1)	(2)
ln (Agr. Exports)$_{t-5}$	-0.306***	-0.333***
	[0.113]	[0.109]
ln (Man. Exports)$_{t-5}$	-0.023	
	[0.062]	
ln (Unskilled Man. Exports)$_{t-5}$		-0.161***
		[0.051]
ln (Skilled Man. Exports)$_{t-5}$		0.166***
		[0.056]
ln (Imports)$_{t-5}$	0.078	0.053
	[0.143]	[0.125]
ln (GDP)$_{t-5}$	0.803***	0.743***
	[0.267]	[0.236]
ln (Population)$_{t-5}$	0.499	0.45
	[0.473]	[0.468]
ln (Death Rate)$_{t-5}$	-1.411***	-1.473***
	[0.404]	[0.385]
ln (Migrant Share)$_{t-5}$	0.004	0.042
	[0.138]	[0.133]
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	791	791
R-squared	0.956	0.957

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the average years of schooling of 15-29 year olds.

TABLE 5
First Stage IV Results

	Agr. Exports	Man. Exports	Agr. Exports	Unskilled Man. Exports	Skilled Man. Exports
	(1)	(2)	(3)	(4)	(5)
ln (Agr. Exports IV)$_{t-5}$	0.788***	-0.594***	0.772***	-0.649***	-0.517**
	[0.129]	[0.220]	[0.125]	[0.244]	[0.235]
ln (Man. Exports IV)$_{t-5}$	0.000	1.204***			
	[0.088]	[0.163]			
ln (Unskilled Man. Exports IV)$_{t-5}$			0.017	0.978***	-0.146
			[0.103]	[0.147]	[0.162]
ln (Skilled Man. Exports IV)$_{t-5}$			0.020	0.304*	1.304***
			[0.087]	[0.162]	[0.119]
ln (Imports)$_{t-5}$	0.296***	0.495***	0.290***	0.427***	0.481***
	[0.066]	[0.106]	[0.070]	[0.107]	[0.126]
ln (GDP)$_{t-5}$	0.088	1.009***	0.086	0.755**	0.897***
	[0.169]	[0.252]	[0.168]	[0.294]	[0.219]
ln (Population)$_{t-5}$	-0.568**	-0.903**	-0.552**	-0.882**	-0.021
	[0.267]	[0.433]	[0.263]	[0.417]	[0.477]
ln (Death Rate)$_{t-5}$	-0.121	-0.970***	-0.109	-1.098***	-0.391
	[0.252]	[0.328]	[0.250]	[0.349]	[0.290]
ln (Migrant Share)$_{t-5}$	0.133**	-0.072	0.134**	-0.047	-0.178*
	[0.066]	[0.098]	[0.066]	[0.113]	[0.098]
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	791	791	787	787	787
R-squared	0.958	0.965	0.958	0.951	0.971
F-Stat, Instrument	19.7	27.3	13.6	20.4	52.4

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 6

Impact of Exports on Average Years of Schooling (IV)

	Average Years of Schooling	
	(1)	(2)
ln (Agr. Exports)$_{t-5}$	-0.637***	-0.666***
	[0.237]	[0.199]
ln (Man. Exports)$_{t-5}$	-0.182	
	[0.134]	
ln (Unskilled Man. Exports)$_{t-5}$		-0.300***
		[0.110]
ln (Skilled Man. Exports)$_{t-5}$		0.299***
		[0.105]
ln (Imports)$_{t-5}$	0.333	0.195
	[0.203]	[0.148]
ln (GDP)$_{t-5}$	0.993***	0.747***
	[0.239]	[0.216]
ln (Population)$_{t-5}$	0.241	0.275
	[0.443]	[0.456]
ln (Death Rate)$_{t-5}$	-1.615***	-1.603***
	[0.387]	[0.360]
ln (Migrant Share)$_{t-5}$	0.032	0.109
	[0.116]	[0.108]
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	791	787
R-squared	0.953	0.954

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the average years of schooling of 15-29 year olds.

TABLE 7

Impact of Exports on Average Years of Schooling by Education Level (IV)

	Primary	Secondary	Tertiary
	(1)	(2)	(3)
ln (Agr. Exports)$_{t-5}$	-0.608***	-0.108	0.05
	[0.142]	[0.186]	[0.044]
ln (Unskilled Man. Exports)$_{t-5}$	-0.226**	-0.06	-0.014
	[0.115]	[0.102]	[0.022]
ln (Skilled Man. Exports)$_{t-5}$	0.117	0.167*	0.014
	[0.089]	[0.095]	[0.018]
Controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	787	787	787
R-squared	0.911	0.915	0.84

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are average years of primary schooling, average years of secondary schooling, and average years of tertiary schooling of 15-29 year olds.

TABLE 8

Impact of Exports on Completion Rates (IV)

	% No Schooling	% Primary	% Compl. Primary	% Seconday	% Compl. Secondary	% Tertiary	% Compl. Tertiary
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (Agr. Exports)$_{t-5}$	3.357*	-3.343*	-7.446***	-10.975***	-3.819	1.862	0.614
	[1.813]	[1.815]	[1.992]	[2.928]	[2.428]	[1.480]	[0.753]
ln (Unskilled Man. Exports)$_{t-5}$	2.545**	-2.532**	-2.624*	-1.62	-0.375	-0.337	-0.387
	[1.159]	[1.158]	[1.376]	[1.485]	[1.449]	[0.756]	[0.386]
ln (Skilled Man. Exports)$_{t-5}$	-1.086	1.091	2.756**	3.477**	1.518	0.277	0.446
	[0.935]	[0.933]	[1.167]	[1.574]	[0.987]	[0.657]	[0.305]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	787	787	787	787	787	787	787
R-squared	0.941	0.941	0.938	0.915	0.914	0.827	0.838

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the percent of the 15-29 year old population with no schooling, at least some primary school, at least completed primary school, at least some secondary school, at least completed secondary school, at least some tertiary school, and at least completed tertiary school.

TABLE 9

Impact of Exports on Average Years of Schooling by Age (IV)

	Age 15-29	Age 30-49
	(1)	(2)
ln (Agr. Exports)$_{t-5}$	-0.666***	-0.453
	[0.199]	[0.282]
ln (Unskilled Man. Exports)$_{t-5}$	-0.300***	0.219
	[0.110]	[0.149]
ln (Skilled Man. Exports)$_{t-5}$	0.299***	-0.06
	[0.105]	[0.118]
Controls	Yes	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	787	787
R-squared	0.954	0.972

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the average years of schooling of 15-29 year olds and the average years of schooling of 30-49 year olds.

TABLE 10

Impact of Exports on Average Years of Schooling by Gender (IV)

	Male	Female
	(1)	(2)
ln (Agr. Exports)$_{t-5}$	-0.715***	-0.613***
	[0.205]	[0.231]
ln (Unskilled Man. Exports)$_{t-5}$	-0.427***	-0.165
	[0.118]	[0.127]
ln (Skilled Man. Exports)$_{t-5}$	0.307**	0.290***
	[0.124]	[0.107]
Controls	Yes	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	787	787
R-squared	0.934	0.961

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable in column 1 is average years of schooling of 15-29 year old males and in column 2 it is average years of schooling of 15-29 year old females.

TABLE 11

Impact of Exports on Average Years of Schooling by Level of Development (OLS)

	Developed	Less Developed
	(1)	(2)
ln (Agr. Exports)$_{t-5}$	0.051	-0.425***
	[0.165]	[0.123]
ln (Unskilled Man. Exports)$_{t-5}$	-0.201**	-0.150**
	[0.096]	[0.059]
ln (Skilled Man. Exports)$_{t-5}$	0.222*	0.148**
	[0.131]	[0.063]
Controls	Yes	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	384	407
R-squared	0.896	0.960

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. Developed countries are those designated High Income or Upper Middle Income by the World Bank in 2000. Less Developed countries are those designated Lower Middle Income or Low Income by the World Bank in 2000.

TABLE 12
Impact of Exports on Average Years of Schooling - Sensitivity Analysis (IV)

	10 Year Lags	Educ. Expenditures	FDI	Total Exports	NR Exports	Import Components
	(1)	(2)	(3)	(4)	(5)	(6)
ln (Agr. Exports)	-0.541***	-0.518**	-0.609**	-0.770**	-0.666***	-0.653***
	[0.204]	[0.222]	[0.264]	[0.300]	[0.203]	[0.195]
ln (Unskilled Man. Exports)	-0.363***	-0.389***	-0.327**	-0.360***	-0.300***	-0.302***
	[0.123]	[0.146]	[0.146]	[0.132]	[0.107]	[0.113]
ln (Skilled Man. Exports)	0.381***	0.307***	0.267**	0.293***	0.299***	0.275***
	[0.136]	[0.107]	[0.114]	[0.107]	[0.108]	[0.101]
ln (Educ. Expenditures)		0.491***				
		[0.139]				
ln (Inward FDI)			-0.029			
			[0.033]			
ln (Total Exports)				0.291		
				[0.308]		
ln (Coal, Oil, Gas Exports)					0.000	
					[0.031]	
ln (Agr. Imports)						-0.029
						[0.127]
ln (Unskilled Man. Imports)						0.329**
						[0.137]
ln (Skilled Man. Imports)						-0.154
						[0.177]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	686	660	591	787	787	787
R-squared	0.955	0.957	0.954	0.953	0.954	0.955

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the average years of schooling of 15-29 year olds. Column 1 lags the independent variables 10 years rather than 5 years (like the rest of the columns). Column 2 controls for educational expenditures, Column 3 controls for inward FDI, Column 4 controls for total exports, Column 5 controls for coal, oil, and gas exports (SITC 3), and finally Column 6 controls for the type of imports.

TABLE 13

Construction of Alternate Instruments using Gravity Model

	Baseline	Importer Death Rate	Trade Agreement	All
	(1)	(2)	(3)	(4)
ln (Importer GDP)	1.373***			1.302***
	[0.034]			[0.037]
ln (Importer Death Rate)		-0.694***		-0.365***
		[0.041]		[0.046]
Both in WTO Dummy			0.270***	0.136***
			[0.025]	[0.030]
Both in NAFTA Dummy			0.515***	0.452***
			[0.133]	[0.065]
Both in EU Dummy			0.287***	0.063*
			[0.027]	[0.034]
Year FE	Yes	Yes	Yes	Yes
Importer FE	No	No	No	No
Exporter FE	No	No	No	No
Bilateral Pair FE	Yes	Yes	Yes	Yes
Observations	53,433	54,949	55,491	52,891
R-squared	0.857	0.846	0.845	0.858

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the ln of exports. Column 1 reports the baseline specification and columns 2-4 report results from three alternate specifications.

TABLE 14

Impact of Exports on Average Years of Schooling using Alternate Instruments (IV)

	Baseline	Importer Death Rate	Trade Agreements	All
	(1)	(2)	(3)	(4)
ln (Agr. Exports)$_{t-5}$	-0.666***	-0.662***	-0.575***	-0.622***
	[0.199]	[0.169]	[0.157]	[0.214]
ln (Unskilled Man. Exports)$_{t-5}$	-0.300***	-0.267**	-0.259**	-0.256**
	[0.110]	[0.124]	[0.123]	[0.110]
ln (Skilled Man. Exports)$_{t-5}$	0.299***	0.254**	0.268***	0.281***
	[0.105]	[0.100]	[0.103]	[0.104]
Controls	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	787	787	787	787
R-squared	0.954	0.955	0.956	0.955

Robust standard errors clustered at the country level in brackets. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the average years of schooling of 15-29 year olds. Column 1 uses the baseline method to construct the instruments while columns 2-4 use alternate methods to construct the instruments.