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THE IMPACT OF TRADE LIBERALIZATION ON THE RETURN TO EDUCATION IN VIETNAM: WAGE VERSUS EMPLOYMENT EFFECT

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TRADE LIBERALIZATION AND THE RETURN TO EDUCATION IN VIETNAM: WAGE VERSUS EMPLOYMENT EFFECT

ABSTRACT

Several studies have identified the impact of trade liberalization in developing countries on the return to education within a Mincerian framework through a difference-in-difference estimator or with industry-level measures of trade openness. These studies have typically estimated the return to education in terms of changes in wages rather than employment, effectively ignoring the fact that trade liberalization affects not only wages but also employment opportunities. In this paper we use four large-scale representative household surveys from Vietnam for the period 1998-2006 to estimate the impact of trade liberalization on the return to education taking into account both changes in wages and employment. The results show that the impact was large in Vietnam but is severely underestimated if changes in employment opportunities are ignored.

Keywords: trade liberalization, return to education, employment, Vietnam

JEL: F16, J21, J31, O1

1. Introduction

The East Asian newly-industrialized economies (NICs) experienced a reduction in wage inequality after openness with a strong export-orientation was introduced in the 1960s and 1970s (Wood 1997). This finding corroborated standard trade theory which predicts that trade liberalization benefits the abundant factor, c.q. unskilled labor. More recent studies for countries that opened up to trade more recently showed a less beneficial outcome, with increases in wage inequality after trade liberalization (Robbins 1994, Robbins and Gindling 1999, Beyer *et al.* 1999, Hanson and Harrison 1999, Feliciano 2001, Cragg and Epelbaum 1996, Feenstra and Hanson 1997, Green *et al.* 2001). These studies have in common that they mainly (but not exclusively) relate to Latin American countries as these countries entered the liberalization phase in the 1980s and early 1990s.

The most common explanations for the different experiences between the East Asian and Latin American experiences have been the entry of large low-income exporters (especially China) into the world market and that trade and technology have increasingly become intertwined (Wood 1997, Green *et al*. 2001). Nowadays it is believed that trade liberalization unleashes a period of intensified competition and technical innovation that is complementary to high skilled labor. Also an additional factor may have been that low skill labor enjoyed sizeable rents in a number of these Latin American countries through institutionalized bargaining (union power) which were eroded with trade liberalization.

It is therefore interesting to analyze the experience of one of the most recent successful entrants in the world market, namely Vietnam. The question is of course whether Vietnam has experienced the same changes in the wage structure as the

liberalizing Latin American countries in the 1980s and 1990s, or whether its experience matches the earlier experience of the East Asian NICS in the 1960s and 1970s.

Apart from bringing new evidence on a recent entrant to the world market, this paper also addresses an important limitation in the literature on the impact of trade liberalization on the return to education. Existing studies typically estimate the return to education in terms of changes in wages rather than changes in employment, effectively ignoring the fact that trade liberalization may not only change wages but also employment opportunities across industries. Yet various studies have documented that the employment effect of trade reform in Vietnam can be of significant magnitude. For example, Niimi *et al.* (2002) argue that employment growth in the top ten export commodity sectors (including seafood, food processing, textiles and shoes) is a direct result of trade reform. They estimate that these export commodities generated 4.5 percent more jobs for the economy between 1993 and 1998. Jenkins (2003) enhances this finding and reveals a number of around 100,000 new jobs per annum created as the net employment effect of trade liberalization. Manning (2010) showed that the employment elasticities for manufacturing industries for the post-2000 period are much higher than those estimated by Jenkins for the earlier decade.

In this paper we estimate the impact of trade liberalization on the return to education taking into account changes in industry employment using four large-scale representative household surveys from Vietnam for the period 1998-2006. Previous studies on the return to education in Vietnam have reported a rise in skill premium over time (Gallup 2002, Pham and Barry 2007, Liu 2005 and Liu 2006) but it is unclear to which extent this is the result of trade liberalization.

The main finding of the paper is that trade liberalization did reduce the return to education in Vietnam and that most of its impact is through changes in industry employment. Therefore estimates based on changes in Mincerian returns provide an underestimate of the true impact of trade liberalization on the return to education.

The paper is structured as follows. In the next section we discuss the theory and previous evidence on the impact of trade liberalization on the returns to education succinctly. In section 3 the methodology is introduced for measuring the returns to education taking into account both the wage and employment effect (the 'unconditional' returns to education). In section 4 the data is introduced and the estimated Mincerian and unconditional returns to education are presented. In section 5 we estimate the impact of trade liberalization on the Mincerian and unconditional return. Section 6 concludes the paper.

2. Theory and previous evidence

Several theories suggest a link between trade liberalization and wages, particularly the skill premium or wage difference between low and high skilled workers. The common starting point is the Heckscher-Ohlin model suggesting that the relatively abundant factors would benefit from trade liberalization. Given that low skilled labor is the relatively abundant factor in developing countries, the theory makes the well-known prediction that the return to low skilled labor should increase relative to the return of high skilled labor and therefore the skill premium should decrease.

Although the experience of the East-Asian NICs confirmed the Heckscher-Ohlin prediction with a reduction in wage inequality with increasing openness in the 1960s and

1970s, the experience of the more recent liberalizers has been different with increasing return to education following trade liberalization (for an overview of the literature see Wood 1997, Arbache *et al*. 2004).

Consequently, trade and labor economists have been looking for other theories as well which can be broadly grouped as 'institutional', 'technological', and 'modified Heckscher-Ohlin'. An institutional theory is that trade liberalization leads to greater domestic competition and therefore lower prices and producer rents. If workers share in these rents through some type of rent-sharing mechanism, then wage inequality may be increased if it benefits the low skilled workers in particular (Rama 2003). This explanation may also be relevant for Vietnam where the (still large) state–owned sector faces increasing domestic and international competition after the introduction of the economic liberalization program in 1986.

A technological theory is that trade has an impact on technology by affecting the inflow of foreign technology as a result of both FDI and increased imports (Robbins 1996, Feenstra and Hanson 1995). Assuming skill complementarity, the inflow of technology increases the relative demand for skilled labor leading to an increase in the skill premium.

Davis (1996) and Wood (1999) have been arguing that the increase in the skill premium of the Latin American liberalizers can also be understood within a modified Heckscher-Ohlin framework. The entry of countries like China, India, Bangladesh, Pakistan and Indonesia in the world market for goods intensive in low skilled labor may have pressured middle-income countries such as those in Latin America to shift to the production of goods intensive in semi-skilled labor, increasing the skill premium in these

countries. Considering the case of Vietnam, we can hypothesize that the modified Heckscher-Ohlin framework may be less relevant as Vietnam is a very low income country and abundant in low skilled rather than semi-skilled labor.

It is important to note that in the presence of industry wage differentials (premiums) the return to education depends on the average within-industry skill premium as well as employment opportunities across industries. If the average within-industry skill premium is high but employment opportunities for high skill workers in industries with high (industry) wage premiums are low (for instance because of union activity or minimum wage legislation favoring low skill workers), then the average (within-industry) skill premium is an overestimate of the return to education. If industry wage differentials favor industries with relatively more skilled workers, then the average skill premium would be an underestimate of the overall return to education .[1]

With trade liberalization, changes in the return to education will therefore not only depend on changes in the average within-industry skill premium, but also on changes in industry employment patterns and industry wage differentials. We will show that under not implausible assumptions, that trade-induced changes in the skill premium will give an underestimate of the changes in the overall return to education, once we take into account that workers are not only affected by changing skill premiums within industries but also changing employment opportunities across industries. Only in the limiting case of perfect inter-industry mobility of workers (as in the standard Heckscher-Ohlin model), will the (change in) return to education be fully reflected in the (change in) skill premium.

Given that economic theory suggests that trade liberalization may increase or decrease the return to education, studies have typically approached this issue empirically

[1] This argument will be shown formally in section 3.

for specific countries and for specific episodes of trade liberalization. In this paper we will analyze empirically the impact of trade liberalization on the return to education in Vietnam. However, unlike previous studies, we will estimate the impact taking into account not only changes in wages but also changes in industry employment patterns. In the next section we will develop and discuss a formal methodology for this purpose and in section 4 the empirical results will be presented.

3. Trade liberalization and the return to education: wage versus employment effect

Studies estimating the impact of trade liberalization on the return to education typically start from the Mincerian earnings function where (log) wages are a function of education variables as well as other variables affecting labor productivity and therefore wages (Attanasio *et al*. 2004, Arbache *et al*. 2004, Beyer *et al*. 1999):

$$(1) \qquad logw_i = E_i\beta + X_i\gamma + \sum_{j=1}^{J} D_i^j \delta^j + \epsilon_i$$

where w_i is the hourly wage of individual i, E_i the years of education, X_i a vector of other individual determinants of wages (such as age, age squared and gender), D_i^j industry (or sector) dummies indicating whether the individual i is working in industry j (j=1,…,J), and ϵ_i an error term. The coefficients β measure the marginal impact of one additional year of education on the wage (in log terms) and can also be interpreted as the rate of return to education under certain assumptions (Heckman *et al.* 2003).

Although in the original specification of the Mincer earnings function no industry dummies are included (Becker 1964), many studies have shown that there are typically large and persistent industry wage differentials that cannot be explained by human capital

differences (Krueger and Summers 1987). Therefore without industry fixed effects the estimated return to education in equation (1) will be biased unless there is no correlation between the human capital variables and industry affiliation.[2]

In the literature one of two strategies is typically followed to estimate the impact of trade liberalization on the return to education. First, a difference-in-difference (DD) approach is used to compare the change in return to education before and after the onset of trade liberalization in the tradable sector with the corresponding change in return to education in the non-tradable sector (Arbache *et al*. 2004). Let β_t^{NT} and β_t^T indicate the return to education in the non-tradable (NT) and tradable (T) sector in period *t* respectively. Then the DD estimator of the impact of trade liberalization over the period *t* to $t+s$ is given by

$$\beta^{DD} = (\beta_{t+s}^T - \beta_t^T) - (\beta_{t+s}^{NT} - \beta_t^{NT}) \quad (2)$$

Under the assumption that all other factors affect the change in wages in the tradable and non-tradable sector similarly, the DD estimate isolates the impact of trade liberalization.

Although the DD estimate provides a simple and intuitive measure of the impact of trade liberalization, it has two important disadvantages. First, even if the reforms are concentrated in a period of a few years, i.e. *s* is small, one cannot be sure that the changes in the wage structure in the tradable sector are not due to other factors that had a differential impact on wages in the tradable versus non-tradable sector. Trade liberalization is often combined with other policy changes, such as privatization, labor

[2] We note that the literature has typically focused on another type of bias, namely the so-called 'ability bias' (Card 1999). However we note that the ability bias is more of a concern when the primary focus is on the *level* of return rather than the change in return due to trade liberalization (a difference-in-difference estimate) as in the latter case much of the ability bias will be differenced-out in the analysis.

market reforms, and financial liberalization, and these may have different impacts across the tradable and non-tradable sectors. Second, in practice trade reforms are not implemented as a 0-1 variable but sequentially and differentially with different industries affected at different points in time and at different degrees (Arbache *et al*. 2004).

The second strategy exploits these differences in timing and extent in trade liberalization across industries by assuming that the return to education in industry j (β^j) is a function of industry-level measures of trade openness (T^j):[3]

$$\beta^j = \beta + T^j\beta_T \tag{3}$$

The impact of trade on the return to education is then given by:

$$\frac{\partial\beta^j}{\partial T^k} = \begin{cases} \beta_T & if\ j = k \\ 0 & if\ j \neq k \end{cases} \tag{4}$$

Equation (4) shows that the return to education is affected by the degree of trade openness in the industry in which an individual is employed, but there is no cross-effect from changes in the degree of trade openness in other industries. This result no longer holds if one takes into account employment shifts across industries as we will do further below.

Although this approach addresses the two disadvantages of the difference-in-difference approach, it requires industry-level measures of trade openness which are known to be noisy. There are many possible proxies for trade openness but none is perfect given that trade liberalization has many dimensions (input tariffs, output tariffs,

[3] This is equivalent to adding interaction terms of E_i with $D_i^k T^k$ (k=1,..,J) in the Mincer equation (1).

weighted and unweighted tariffs, effective rates of protection, non-tariff barriers, etc.) which are typically measured with error (McCulloch *et al.* 2001). Because the difference-in-difference approach is less prone to measurement error, it is useful to use both strategies to study the impact of trade liberalization on the return to education.

It is important to note that both strategies can identify the impact of trade liberalization on the return to education provided that labor is not perfectly mobile across industries and sectors (Attanasio *et al*. 2004). With perfect labor mobility one will only observe economy-wide changes in the return to education after trade liberalization, and these changes may or may not be due to trade liberalization if there have been other changes in the economy as well.[4] In practice, however, labor mobility is less than perfect and reflected in large and persistent wage differentials across industries and sectors. We will find that this is also the case in this study for Vietnam (see section 4).

The above strategies have been used to study the impact of trade liberalization on the return to education in, for example, Colombia (Attanasio *et al* 2004), Brazil (Arbache *et al*. 2004), and Chile (Beyer *et al*. 1999). While some of these studies do not control for industry affiliation (most likely biasing the estimate of the returns to education), others do include controls for industry affiliation. However, even with controls for industry affiliation, previous studies still ignore the fact that industry affiliation is itself affected by education (and trade liberalization), and therefore should be taken into account when estimating the returns to education.[5] This issue is especially relevant when studying the

[4] In this case a CGE type of model will be needed to identify any impact of trade liberalization on the return to education.

[5] Attanasio *et al*. (2004) actually do analyze how the estimated skill premiums are affected by the inclusion of industry and/or occupation dummies and also how trade reform has impacted on industry wage differentials and the probability of informal sector employment. They do not, however, combine these results to estimate the full impact of trade reform on the return to education.

impact of trade liberalization, where theory and evidence suggest that it has not only an impact on wages but also on employment patterns, being effectively two sides of the same coin (Attanasio *et al*. 2004, Currie and Harrison 1997, Green *et al*. 2001, Revenga 1992, 1997).

Let $p_i^j = p^j(E_i, T, X_i)$ denote the probability of employment of individual *i* in industry *j*=1,…,*J*. The probability is a function of education level E_i, a vector of industry-level measures of openness $T = (T^1, \ldots, T^J)$, and a vector of individual characteristics X_i. Taking into account equation (1) and writing $\log w_i^j$ for the (log) wage of individual *i* working in industry *j*,[6] the expected return to education *unconditional* on industry employment, $\tilde{\beta}_i$, is given by:

$$(5) \qquad \tilde{\beta}_i = \frac{\partial \sum_{j=1}^{J} p_i^j \log w_i^j}{\partial E_i} = \sum_{j=1}^{J} p_i^j \beta^j + \sum_{j=1}^{J} \log w_i^j \frac{\partial p_i^j}{\partial E_i}$$

Equation (5) decomposes the unconditional return to education into two parts, namely (1) the return to education holding employment patterns constant ($\sum_{j=1}^{J} p_i^j \beta^j$), and (2) the return to education due to different industry employment patterns across education levels ($\sum_{j=1}^{J} \log w_i^j \frac{\partial p_i^j}{\partial E_i}$). Only in the unlikely event that employment patterns are unaffected by education ($\frac{\partial p_i^j}{\partial E_i} = 0$) or industry-wage differentials are uniformly zero ($\log w_i^j = \log w_i^{j'}$, $\forall j, j'$ =1,..,*J*) will the unconditional rate of return to education be equal to the expected Mincerian return ($\tilde{\beta}_i = \sum_{j=1}^{J} p_i^j \beta^j$).[7]

[6] $log w_i^j = E_i\beta + X_i\gamma + \delta^j + \epsilon_{ij}$

[7] The latter follows from the fact that $\sum_{j=1}^{J} \frac{\partial p_i^j}{\partial E_i} = 0$.

In fact, if industry wage differentials (δ^j) tend to be higher (lower) in industries with relatively more low skill workers, then the expected Mincerian return is an overestimate (underestimate) of the unconditional rate of return to education.[8]

Taking the return to education in the non-tradable sector as benchmark, the difference-in-difference (DD) estimator of the impact of trade liberalization on the return to education taking into account employment shifts is given by:

$$(6) \qquad \tilde{\beta}_i^{DD} = [(\tilde{\beta}_{i,t+s} - \tilde{\beta}_{i,t}) - (\beta_{t+s}^{NT} - \beta_t^{NT})]$$

It is useful to decompose the DD estimator into a wage and employment effect as follows:[9]

$$(7) \qquad \tilde{\beta}_i^{DD} = \left[\sum_{j=1}^{J} p_{i,t}^j \beta^{DD,j}\right] + \left[\sum_{j=1}^{J} \beta_{t+s}^j \Delta p_{i,t}^j + \sum_{j=1}^{J} \Delta(\log w_i^j \frac{\partial p_{i,t}^j}{\partial E_i})\right]$$

$$= \text{[wage effect]} + \text{[employment effect]}$$

where $\beta^{DD,j} = (\beta_{t+s}^j - \beta_t^j) - (\beta_{t+s}^{NT} - \beta_t^{NT})$ and $\Delta x_t = x_{t+s} - x_t$.

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[8] Note that $\sum_{j=1}^{J} \log w_i^j \frac{\partial p_i^j}{\partial E_i} = \sum_{j=1}^{J} \log w_i^j (\frac{\partial p_i^j}{\partial E_i} - \frac{1}{J}\sum_J \frac{\partial p_i^j}{\partial E_i}) = \sum_{j=1}^{J} (\log w_i^j - \frac{1}{J}\sum_J \log w_i^j)(\frac{\partial p_i^j}{\partial E_i} - \frac{1}{J}\sum_J \frac{\partial p_i^j}{\partial E_i}) = \sum_{j=1}^{J} (\delta^j - \frac{1}{J}\sum_J \delta^j)(\frac{\partial p_i^j}{\partial E_i} - \frac{1}{J}\sum_J \frac{\partial p_i^j}{\partial E_i}) + \sum_{j=1}^{J} (\varepsilon_{ij} - \frac{1}{J}\sum_J \varepsilon_{ij})(\frac{\partial p_i^j}{\partial E_i} - \frac{1}{J}\sum_J \frac{\partial p_i^j}{\partial E_i}) \rightarrow \text{cov}\left(\delta^j, \frac{\partial p_i^j}{\partial E_i}\right)$ because ε_{ij} is assumed to be noise and therefore $E\left\{\sum_{j=1}^{J} (\varepsilon_{ij} - \frac{1}{J}\sum_J \varepsilon_{ij})(\frac{\partial p_i^j}{\partial E_i} - \frac{1}{J}\sum_J \frac{\partial p_i^j}{\partial E_i})\right\} = 0$. If industry wage differentials tend to be higher in industries with relatively more low skilled workers, then $\frac{\partial p_i^j}{\partial E_i}$ will tend to be negative (positive) for industries where δ^j is larger (smaller), and $\text{cov}\left(\delta^j, \frac{\partial p_i^j}{\partial E_i}\right)$ will be negative. Hence, the expected Mincerian return will be an overestimate of the unconditional return.

[9] Here we use the employment shares in period t, $p_{i,t}^j$, as weights for $\beta^{DD,j}$. It is also possible to use $p_{i,t+1}^j$ or any linear combination of $p_{i,t}^j$ and $p_{i,t+1}^j$ as weights but this does not affect the empirical results in any notable way.

Also if we use industry-level measures of trade openness we can analyze the impact of trade on the return to education taking into account industry employment shifts. Combining (3) and (5), the impact of trade on the return to education unconditional on industry employment is given by:

$$(8) \qquad \frac{\partial \widetilde{\beta}_i}{\partial T^k} = \frac{\partial^2 \sum_{j=1}^{J} p_i^j \log w_i^j}{\partial E_i \partial T^k} = \frac{\partial}{\partial T^k}\left[\sum_{j=1}^{J} p_i^j \beta^j + \sum_{j=1}^{J} log w_i^j \frac{\partial p_i^j}{\partial E_i}\right]$$

$$= \left[p_i^k \beta_T\right] + \left[\sum_{j=1}^{J} \beta^j \frac{\partial p_i^j}{\partial T^k} + \frac{\partial}{\partial T^k}\sum_{j=1}^{J} log w_i^j \frac{\partial p_i^j}{\partial E_i}\right]$$

= [wage effect] + [employment effect]

Similarly to the difference-in-difference estimator (7), the first bracket of equation (8) describes the wage effect while the second bracket measures the employment effect. Only in the limiting case where there are no industry-specific wage differentials ($\delta^j = \delta^{j'} \ \forall j, j'$) and skill premiums ($\beta^j = \beta^{j'} \ \forall j, j'$) (as in the standard Heckscher-Ohlin model because of perfect inter-industry mobility of workers), the change in unconditional return to education following trade reform will be fully captured by the wage effect.

Assume that a country is labor abundant such as Vietnam. In that case standard trade theory suggests that trade reform will reduce the average within-industry return to education (β^j), implying a negative wage effect. If industry wage premiums (δ^j) tend to increase relatively more (or decrease relatively less) in expanding industries (c.q. increase relatively more in low skill compared to high skill labor intensive industries), then this will tend to make the employment effect negative.[10] If also the return to education tends

[10] Because $\text{cov}\left(\delta^j, \frac{\partial p_i^j}{\partial E_i}\right)$ will tend to fall for given values of $\frac{\partial p_i^j}{\partial E_i}$ (see footnote 8).

to be lower in low skill industries, then the employment effect will become more negative due to expanding employment in low skill industries.[11]

This suggests that the wage and employment effects tend to reinforce each other and that the wage effect (or change in expected Mincerian return) would be an underestimate of the change in the unconditional returns to education, although the argument depends on (not implausible) assumptions regarding the initial distribution of the within-industry returns to education as well as the predicted changes in wage premiums and employment shifts across industries.

Equation (8) also shows that there will be cross-effects across industries ($\frac{\partial \tilde{\beta}_i}{\partial T^k} \neq 0$ if $D_i^k = 0$) as long as trade affects the employment shares ($\frac{\partial p_i^j}{\partial T^k} \neq 0$), wages ($\frac{\partial log w_i^j}{\partial T^k} \neq 0$) and/or responsiveness of employment shares to education ($\frac{\partial^2 p_i^j}{\partial E_i \partial T^k} \neq 0$). No such cross-effects are present in the analysis on the conditional (Mincerian) return to education ($\frac{\partial \beta^j}{\partial T^k} = 0$ if $j \neq k$) as industry employment shifts are ignored.

4. Trade liberalization and the return to education in Vietnam

Trade policy reforms have been a very important part of the Vietnamese renovation process launched in 1986. Important liberalization measures were adopted since the 1990s that included export promotion, the replacement of quotas by tariffs and the reduction of trade barriers. Export processing zones (EPZs) were established in 1990-91 and export incentives in the form of duty drawback schemes were extended between 1990 and 1994. There was a move away from quantitative barriers towards a tariff-based

[11] I.e. $\sum_{j=1}^{J} p_i^j \beta^j$ will tend to decline.

system in the 1990s. In 1995 export quotas were eliminated for all commodities except rice. By 1998 the management of imports of most consumer goods had shifted to tariffs rather than quotas or licensing although 9 categories of goods remained under quantitative restrictions. In 1995 Vietnam joined the ASEAN and became a member of the WTO in 2007.

After a reform hiatus in the late 1990s largely because of the Asian crisis, reforms revived in the first few years of the new millennium when barriers to imports and to private trading and investing came down further, giving manufactured exports a further boost. The period 2000-2002 have seen further liberalization with the removal of a number of quantitative restrictions (World Bank, 2002, Table 3.1). The conclusion of Vietnam-US bilateral trade agreement (BTA) in July 2000 marked an important milestone in further deepening Vietnam's integration into the world economy.

Vietnam's exports responded strongly to the reforms aiming at opening the economy. Between 1991 and 2002 the dollar value of non-oil exports from Vietnam grew at an average annual rate of nearly 19 percent, double the average for developing countries as a group. The dollar value index for Vietnam's non-oil exports rose six fold, twice as much as any other East Asian countries (World Bank 2003). The export recorded even stronger performance during period 2002-2006, grew on average more than 21.7 per cent per annum. As a result, the value of non-oil export almost doubled in merely four years between 2003 and2006.

Rapid export growth was accompanied by a swift change in the export composition. Manufactured exports increased their share in non-oil exports from 13 to 67 percent over the same period, a rate similar to other East Asian exporters that came before it. Within

manufactured exports, the share of resource-based products fell from three-quarters to less than a fifth, and this was taken up by a rising share of labor-intensive low technology exports. Seventy percent of manufactures are accounted for by footwear and textile clothing alone, while furniture, clothing accessories, and travel goods and handbags contribute nearly 20 percent. The increase in labor-intensive exports has contributed significantly to employment and poverty-reduction, especially in urban and semi-urban areas. Medium-technology exports, mainly labor-intensive component-production for assembly elsewhere, are of recent origin, reaching a 5 percent share in 2002.

In this paper we use evidence from four nationally representative cross-section household surveys over the period 1998-2006, namely the Vietnam Living Standards Survey of 1998 (VLSS98) and the Vietnam Household Living Standards Survey 2002, 2004 and 2006 (VHLSS02, VHLSS04, VHLSS06). The same core modules including those on labor and employment have been repeated for all VHLSSs and hence enable comparability among all surveys. A total of 6,000 and 75,000 households were included in the VLSS98 and VHLSS02, while about 46,000 households were included in each of VHLSS04 and VHLSS06.

We have restricted the analysis to employed individuals with wage employment as their main activity, between ages 18 and 65 inclusive. The hourly wage was estimated for each employed individual by using the information on the total wage as well as the number of hours worked. Although the quality of the data is high, the bottom and top 1% of the wage distributions for each education level, year and sector (non-tradable, import substituting and export-oriented - see below) have been removed to eliminate outliers that

might be due to measurement error. Hourly wages have been adjusted for inflation and regional price differences and are in 1998 VND.

Descriptive statistics

Table 1 presents the descriptive statistics for mean wages and employment composition by sector. Two sectors are distinguished here, namely traded (defined as agriculture, mining and manufacturing) and non-traded sectors (the other sectors).[12] The traded sector is further decomposed into the import substituting sector and the export oriented sector. An industry has been defined as export-oriented if its exports are larger than its imports and exports are more than 10% of industry gross output, import-substituting if its imports are larger than its exports and imports are more than 10% of industry gross output.[13]

On average hourly wages are about 20-40% higher in non-traded sector than in traded sector, and higher in the import-substituting than export-oriented sector. Wage growth differed across the sectors and was the lowest in the export-oriented sectors. More individuals work in the non-traded than in the traded sector and the share of employment in the traded sector has been decreasing over 1998-2006. However, within the traded sector there has been a strong employment shift from the import-substituting to the

[12] Appendix A provides a detailed list of the included industries in each sector.
[13] Exports and imports have been calculated by their annual means for the period 1998-2006 and therefore the industry classification is constant for the entire period. A few industries in the traded sector could not be classified as import substituting or export oriented either because import and export data were lacking (two industries) or because less than 10% of gross industry output was imported and exported (two industries).

Table 1. Mean and change of real wages and employment composition by sector, 1998, 2002, 2004, and 2006

	1998	2002	2004	2006	Change 1998-2006 (%)
(a) Mean hourly wages					
Non-traded	4.14	4.75	5.03	5.80	40.1
Traded	3.47	3.63	3.95	4.66	34.3
Import substituting sector	3.75	4.36	4.56	5.27	40.5
Export oriented sector	3.21	3.27	3.59	4.20	30.8
(b) Composition of employment (%)					
Non-traded	55.9	55.8	58.7	58.1	3.9
Traded	44.1	44.2	41.3	41.9	-5.0
Of which (%)					
Import substituting sector	41.4	30.4	31.1	30.7	-25.8
Export oriented sector	58.6	69.6	68.9	69.3	18.3

Notes: real wages in 1998 VND; wages and employment are weighted with sampling weights; employment is also weighted for hours of work.

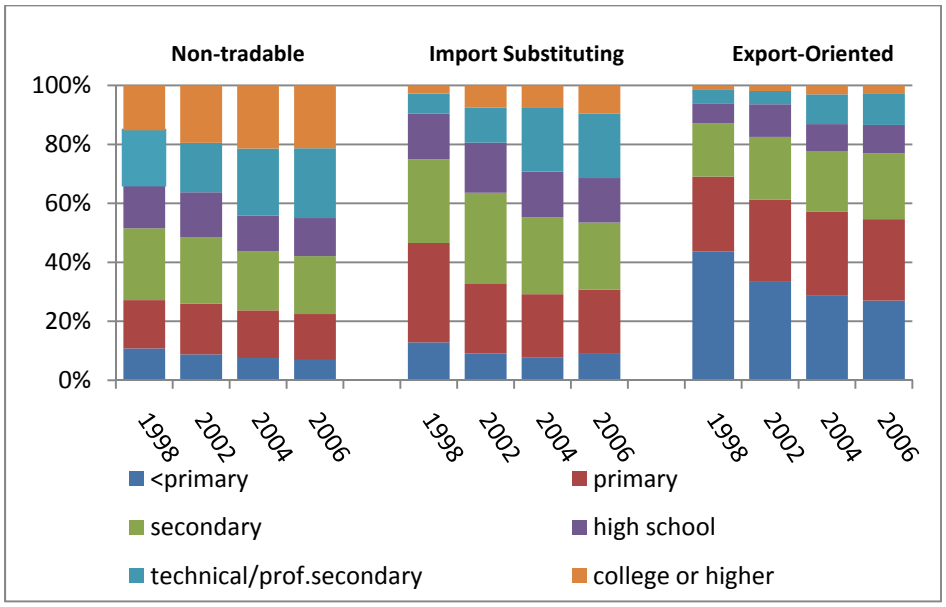
export-oriented sector. In so far as the return to education might differ across sectors and/or there are industry wage differentials, these employment shifts will have a strong impact on the unconditional return to education (see below).[14]

The following figure shows that the higher average wages in the non-traded and import substituting sector can be explained by the relatively high education of the workers in these sectors. Less than 10% of the workers in the non-traded and import substituting sector had less than primary education in 2006, against 27% in the export sector. The non-tradable sector has also a relatively large share of workers with college or higher education – namely 21% in 2006 against 10% and 3% in the import substituting and export-oriented sectors respectively. The difference in skills between workers in the

[14] Different return to education implies that $\beta^j \neq \beta^{j'} \ \exists j, j'$ and industry wage differentials imply that $\log w_i^j \neq \log w_i^{j'} \ \exists j, j'$ (see equation 5).

import substituting and the export oriented sectors follows the basic Heckscher-Ohlin prediction – Vietnam has a comparative advantage in low-skill exports.

Figure 1. Employment distribution by education and sector, 1998, 2002, 2004 and 2006



Note: employment is weighted with sampling weights.

Also noticeable is the process of skill upgrading in each of the sectors – the share of workers with education less than or equal to any given level of education is falling over time in each of the sectors. For instance, the share of workers with primary or less education has fallen from 27 to 22%, 47 to 31% and 69 to 55% in the non-tradable, import substituting and exported-oriented sector between 1998 and 2006 respectively. This shift may reflect both the inflow of the younger age groups with relatively high education into the labor force (supply shift) as well as skill-biased technical change (demand shift).

Table 2 reports the mean real hourly wages by sector and education level over the period 1998-2006.[15] We still find that wages differ across sectors and wages tend to be higher in the non-trade sector for low skill workers and higher in the traded sector for high skill (post-secondary education) workers. Also, as expected, wages increase in the

Table 2: Mean real hourly wages by sector and education level, 1998 and 2006

	Non-tradable		Tradable			
			Import substituting		Export-Oriented	
	1998	2006	1998	2006	1998	2006
Less than primary	3.61	3.70	3.24	4.14	2.47	3.39
Primary	3.34	3.97	3.34	4.02	3.52	3.86
Secondary	3.54	4.29	3.39	3.95	3.36	3.87
High school	4.75	5.33	4.40	4.41	4.06	4.69
Technical/ Professional Sec.	3.87	6.02	4.85	6.12	4.59	5.78
College or higher	6.06	9.25	8.18	11.58	10.25	10.61
Average	4.14	5.80	3.75	5.27	3.21	4.20

Notes: real wages in 1998 VND; wages are weighted with sampling weights

Mincerian return to education

level of education. Also workers at the higher levels of education have particularly benefited from higher wages between 1998 and 2006, suggesting that the rate of return to education has increased in Vietnam.

It is also notable that the education-wage profile is steeper in traded sector than in the non-traded sector, suggesting that openness increases the return to education in Vietnam. However in the next section we will check whether the return to education is also higher in the more open industries after we control for other factors in a regression analysis.

[15] We do not report wages for the intermediate years 2002 and 2004 in the table for clarity, but they fit the overall time pattern.

The above descriptive statistics suggest that in the period 1998-2006 the rate of return to education has increased in Vietnam. Also the return to education and wage levels appear to differ across the different sectors and therefore an analysis of the impact of trade liberalization on the return to education should take into account wage shifts as well as employment shifts. First we pool the four household surveys and run the Mincer earnings equation to identify the overall rates of return to education in Vietnam for the period 1998-2008. Education is measured by the years of education that is required for attaining the highest level of education completed.

We modify the basic Mincer equation (1) in two respects. First, there is increasing evidence from other countries that the return can be non-linear in education and therefore we also include a quadratic term for the education variable. Second, the return to education has often been found to differ across experience levels and therefore we estimate the include dummies for the age group (a proxy for experience) interacted with the years of education (Heckman *et al.* 2003):

$$(9) \qquad logw_{it} = \sum_{k=1}^{K} C_{it}^{k} E_{it} \beta_1^k + \sum_{k=1}^{K} C_{it}^{k} E_{it}^2 \beta_2^k + X_{it}\gamma + \sum_{k=1}^{K} C_{it}^{k} \chi^k + \sum_{j=1}^{J} D_i^j \delta^j + \tau^t + \epsilon_{it}$$

where C_{it}^{k} is an age group dummy equal to one if individual *i* belongs to age group *k*=1,2,…,*K* at time *t*. We distinguish among the age groups 18-24 years, 25-34 years, 35-44 years and 45-65 years.[16] The vector X_{it} includes controls for age, age squared, gender, region, and urban area.[17] Time fixed effects τ^t capture aggregate changes in wages. We

[16] The age groups are approximately equal-sized.
[17] Dummies for the following regions are included: North East, North West, North Central Coast, South Central Coast, Central Highlands, Southeastern, Mekong River Delta, and Red River Delta.

introduce further flexibility by estimating the Mincer equation (9) sector by sector to allow for a sector-specific return to education (j=1,2,…J):

$$(10) \quad logw_{it}^{j} = \sum_{k=1}^{K} C_{it}^{k} E_{it} \beta_{1}^{jk} + \sum_{k=1}^{K} C_{it}^{k} E_{it}^{2} \beta_{2}^{jk} + X_{it} \gamma^{j} + \sum_{k=1}^{K} C_{it}^{k} \chi^{jk} + \delta^{j} + \tau^{jt} + \epsilon_{ijt}$$

We distinguish as before among the non-tradable, import substituting and export-oriented sectors.[18]

We note that the choice of sector is endogenous and therefore estimation of equation (10) with OLS will give biased estimates of the parameters. Below we will model the choice of employment across sectors as the outcome of a multinomial logit model . The covariance matrix between ϵ_{ijt} in equation (10) and the error terms of the multinomial logit model will determine the correct sample selectivity terms for (10), following Dubin and McFadden (1984). However, we use a modification of the Dubin and McFadden method proposed by Bourguignon *et al*. (2007).[19] This method is more general and also provides a fairly good correction even if the implicit assumption of Independence of Irrelevant Alternatives would not hold as assumed in the multinomial logit model.

Table 3 reports the results and we note the following. First, the F-test (H_0: no age group effects for education) indicates that the return to education differs significantly across age groups. Second, the rate of return is nonlinear and increasing in education as the squared years of education variable is uniformly positive and significant. Third, females earn 12-21% lower (hourly) wages than males after controlling for education and

[18] The few tradable industries that could not be classified as either import substituting or export-oriented are classified as non-tradable (see footnote 13). Also because the relatively small number of observations, we combined the age groups 35-44 year and 45-65 year for workers in the import substituting sector.
[19] Bourguignon *et al.* (2007) propose two modifications and we apply the most robust variant (DMF1).

Table 3. Pooled OLS estimates of Mincer equation, 1998, 2002, 2004 and 2006.

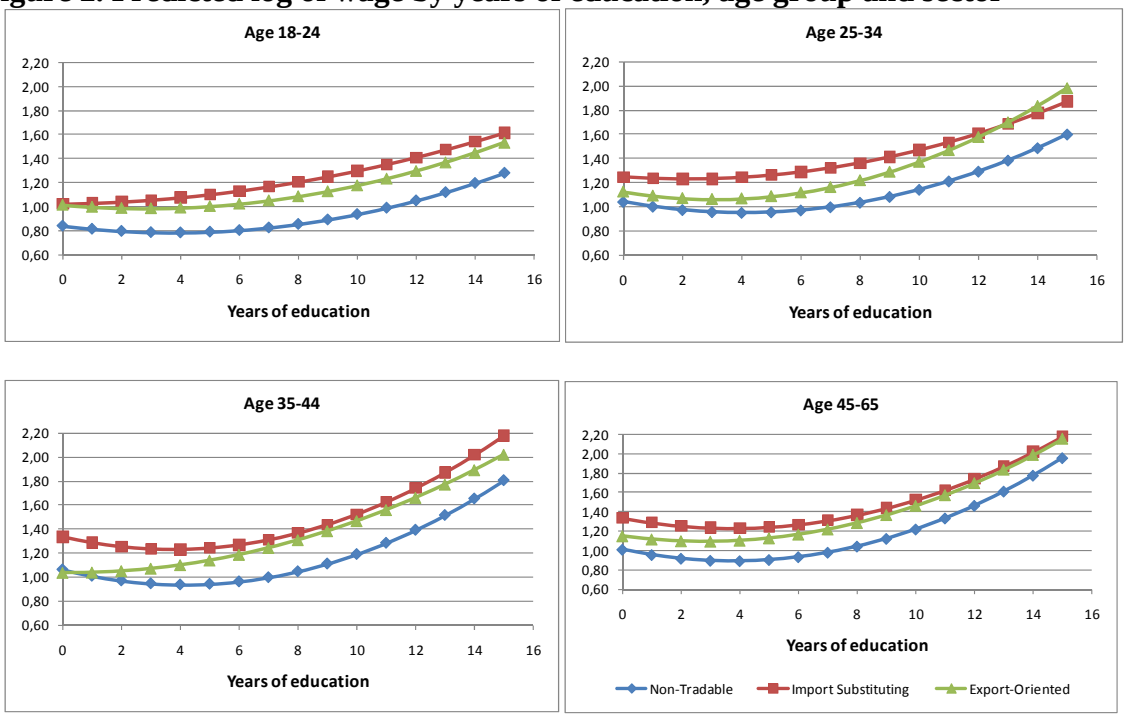
	Non-Traded	Traded	
		Import Substituting	Export-Oriented
	(1)	(2)	(3)
Age group 25-34	0.02	-0.03	-0.01
	(0.55)	(0.32)	(0.20)
Age group 35-44	-0.06	-0.09	-0.15
	(1.07)	(1.02)	(2.66)
Age group 45-65	-0.10	-0.09	-0.03
	(1.63)	(1.02)	(0.43)
Education (10^{-3})			
Age group 18-24	-29.7	3.86	-20.6
	(3.28)	(0.20)	(2.34)
Age group 25-34	-44.4	-16.6	-40.2
	(5.60)	(0.85)	(4.72)
Age group 35-44	-60.7	-56.5	-1.95
	(7.29)	(4.05)	(0.16)
Age group 45-65	-63.4	-56.5	-39.8
	(6.84)	(4.05)	(3.21)
Education squared (10^{-3})			
Age group 18-24	3.94	2.35	3.69
	(7.31)	(1.91)	(5.66)
Age group 25-34	5.45	3.85	6.51
	(12.1)	(3.42)	(10.1)
Age group 35-44	7.35	7.49	4.50
	(15.1)	(8.60)	(4.83)
Age group 45-65	8.43	7.49	7.11
	(17.2)	(8.60)	(6.95)
Age	0.05	0.07	0.03
	(9.78)	(7.62)	(4.21)
Age squared	-0.57	-0.78	-0.35
	(9.26)	(6.87)	(4.08)
Female	-0.13	-0.24	-0.23
	(14.2)	(11.4)	(19.9)
Year 2002	0.12	0.16	0.03
	(7.68)	(4.80)	(1.91)
Year 2004	0.20	0.23	0.15
	(10.8)	(5.99)	(7.16)
Year 2006	0.37	0.39	0.32
	(21.6)	(11.2)	(14.8)
λ_1	-0.18	-0.01	0.28
	(5.90)	(0.05)	(3.75)
λ_2	-0.35	-0.05	-0.63
	(5.38)	(2.32)	(9.20)
λ_3	-0.34	0.11	-0.05
	(4.63)	(0.85)	(1.69)
Constant	-0.22	-0.38	0.25
	(2.12)	(1.93)	(2.22)
F-test (p-value)	351.53 (0.00)	42.62 (0.00)	91.99 (0.00)
N	20089	3882	10154

Notes: Dependent variable: real wages in 1998 VND. Region and urban dummies are included. t-Values in parentheses. Bootstrapped estimator of variance based on 100 replications is used. F-test is for H_0: no age group effects for education.

age (cf. Liu 2004), and the gender wage gap is higher in the tradable than non-tradable sector.[20] Fourth, (real) hourly wages have been increasing steadily and increased by 38-48% between 1998 and 2006.[21] Fifth, the sample selectivity terms $\lambda_1, \lambda_2, \lambda_3$ are statistically significant different from zero suggesting the presence of sample selection bias in the Mincer regression equations.

Because of the nonlinear return to education we graph the predicted log of hourly wage by years of education for different sectors and age groups in Figure 2 for the average worker within each age group. Wages are generally higher in the import substituting sector than in the export-oriented sector and lowest in the non-tradable sector even after controlling for human capital differences.[22] Within the tradable sector, therefore,

Figure 2. Predicted log of wage by years of education, age group and sector



[20] Exp(-0.13)-1=-0.12, exp(-0.24)-1=-0.21.
[21] Exp(0.32)-1=0.38, exp(0.39)-1=0.48.
[22] These results still holds even if one controls for the ownership of the firm (CHECK), and hence cannot be explained by differences in pay-setting across foreign-owned, state-owned and privately owned firms (regressions not reported).

wage-setting is more competitive in the economic sectors in which Vietnam holds a comparative advantage, and less competitive in the more protected import-substituting sector.

The Mincerian return to education is given by the slope of the curves in Figure 2 and is reported in the first column of Table 4. The return is 3-5% at 6 years of education, increasing to 6-12% at 12 years of education, and 7-17% at 15 years of education. Given that Figure 2 shows wage profiles with roughly similar slopes across sector, one may conclude that sector differences are irrelevant for the returns to education. However, the figure also indicates large inter-sector wage differentials implying that the Mincerian return to education may be a poor measure of the return to education once the relationship between education and (sectoral) employment opportunities are taken into account. We therefore now proceed to estimate the unconditional return to education.

Table 4. Mincerian return to education by age group, education and sector

	6 years education			12 years education			15 years education		
Age	No Trade	Import	Export	No Trade	Import	Export	No Trade	Import	Export
18-24	0.02	0.03	0.02	0.06	0.06	0.07	0.09	0.07	0.09
25-34	0.02	0.03	0.04	0.09	0.08	0.12	0.12	0.10	0.16
35-44	0.03	0.03	0.05	0.12	0.12	0.11	0.16	0.17	0.13
45-65	0.04	0.03	0.05	0.14	0.12	0.13	0.19	0.17	0.17

Unconditional return to education

The unconditional return to education depends on the responsiveness of sectoral employment with respect to education, $\frac{\partial p_i^j}{\partial E_i}$ (see equation (5)). A worker will compare the utility from working in each sector and choose the sector with the highest utility. The utility will depend on sector characteristics, such as (expected) wage, job security, job opportunities, demand for skills, entry barriers and costs, as well as worker

characteristics, such as preference for job security and occupational preference.[23] We model the choice of a worker *i* with a multinomial logit (MNL) model where the utility from working in sector *j* at time *t* is given by[24]

$$(11) \quad U_{it}^{j} = \sum_{k=1}^{K} C_{it}^{k} E_{it} \theta_1^{jk} + \sum_{k=1}^{K} C_{it}^{k} E_{it}^{2} \theta_2^{jk} + Z_{it} \phi^{j} + \sum_{k=1}^{K} C_{it}^{k} \chi^{jk} + \delta^{j} + \tau^{jt} + \nu_{ijt}$$

Equation (11) should be interpreted as a reduced form equation where worker and sector characteristics are captured by education (E_{it}) and a vector Z_{it} which includes individual characteristics (age, age squared, gender, region, urban area, household composition, marital status, household size), sector characteristics (proportion of workers employed in the import substituting and the export-oriented sector within each province-urban pair as a proxy for local job opportunities), and year dummies. Also a sector fixed effect (δ^{j}) captures unobserved differences between sectors, a time fixed effect (τ^{jt}) captures aggregate changes over time and age group-effects are included for additional flexibility.

We estimate the model for three sectors, namely wage employment in the non-tradable, import substituting, and export-oriented sector. Self-employment is not considered because the measurement of return from self-employment is far from straightforward.[25] The next table reports the regression coefficients and t-values for the multinomial logit model of employment sector choice for the pooled sample of the 1998-2006 surveys. The non-tradable sector is used as the reference choice. Hence, the

[23] Occupational preferences will affect the choice of sector because sectors differ in their occupational distribution.

[24] A common concern with the MNL model is the assumption of the independence of irrelevant alternatives that is implicit in the model. We have compared the MNL estimates with logit estimates after excluding one of the employment sectors, and the coefficients were highly similar, suggesting that the outcome categories are plausibly distinct as required in a MNL model (Cheng and Long 2007). Also the Hausman test for the IIA did not reject the IIA (negative because of small sample).

[25] The return from self-employment depends on the marginal labor productivity in farm and non-farm production which is not observed directly.

estimated MNL coefficients reflect the effect of the independent variables on the likelihood of employment in the import-substituting and export-oriented sector relative to the non-tradable sector. In general the model fits the data reasonably well.[26]

The probability of employment in the import-substituting and export-oriented sectors falls with age (the quadratic term for age is not significantly different from zero) suggesting that younger people are more likely to employed in the tradable sectors. Also females are more likely to be employed in the tradable sectors, especially in the export-oriented sector, which is in line with Wood's finding that the export-oriented sector is often 'female-led' in developing countries (1991). The regional dummies suggest that employment in the tradable sectors is highest in the Red River Delta (the omitted category) as well as in urban areas, reflecting the regional distribution of economic activity in Vietnam. Similarly local sector job opportunities affect the probability of employment strongly as reflected by the relatively large coefficients for the proportion of workers employed in the import substituting and the export-oriented sector within each province-urban pair.

Employment across sectors also varies systematically and nonlinearly with education and across age groups.[27] Table 6 reports the predicted probability of employment in the import-substituting and export-oriented sector at different levels of education and for different age groups, evaluated at the mean value of all other variables.

[26] Goodness-of-fit is measured by the relative correspondence between the actual employment sector of workers and their predicted sector. If we take the sector with the highest estimated probability as the predicted sector of employment for each worker, then the model's predictive accuracy is 70.5% for workers in the non-tradable sector (58.8% of total workers), 45.7% for workers in import-substituting sector (11.4% of total workers), and 64.2% for workers in the export-oriented sector (29.7% of total workers).

[27] The age group effects are significantly different from zero (χ^2-test).

Table 5. Multinomial Logit Estimates of Employment Sector in Vietnam, 1998-2006

	Import-Substituting		Export Oriented	
	coefficient	t-value	coefficient	t-value
Age group 25-34	0.74	3.35	0.54	3.92
Age group 35-44	0.90	3.34	1.06	6.21
Age group 45-65	1.16	3.60	1.56	7.53
Education				
Age group 18-24	0.28	6.61	0.17	5.95
Age group 25-34	0.13	3.69	0.06	2.51
Age group 35-44	0.16	3.60	-0.04	-1.40
Age group 45-65	0.05	1.02	-0.13	-3.82
Education squared				
Age group 18-24	-0.02	-7.77	-0.02	-9.48
Age group 25-34	-0.01	-6.62	-0.01	-9.39
Age group 35-44	-0.02	-6.21	-0.01	-5.49
Age group 45-65	-0.01	-2.61	-0.01	-2.39
Age	-0.06	-2.55	-0.05	-2.60
Age squared	0.25	0.88	0.22	1.03
Female	0.28	7.20	0.79	26.51
Year 2002	0.37	5.18	0.29	5.00
Year 2004	0.27	3.42	0.23	3.58
Year 2006	0.31	3.94	0.31	4.89
North East	-0.05	-0.77	-0.03	-0.53
North West	-0.10	-0.60	-0.26	-1.79
North Central Coast	-0.03	-0.45	-0.19	-2.73
South Central Coast	-0.14	-2.12	-0.21	-3.77
Central Highlands	-0.34	-2.57	-0.34	-3.98
Southeastern	-0.22	-3.29	-0.40	-7.08
Mekong River Delta	-0.53	-6.24	-0.62	-9.97
Urban area	0.29	5.92	0.41	10.00
Share of household age <=15	-0.12	-0.81	0.41	3.45
Share of household 15<age <=25	-0.10	-0.58	0.12	0.89
Share of household 25<age <=35	0.10	0.54	0.17	1.16
Share of household 35<age <=45	0.17	0.99	-0.04	-0.26
Share of household 45<age <=55	0.07	0.42	-0.29	-2.32
Married	0.06	1.02	0.08	1.86
Household size	0.02	2.03	0.00	0.31
Share employment in import-substituting sector	8.81	28.11	2.24	8.34
Share employment in export oriented sector	1.78	9.50	5.21	39.08
Constant	-2.82	-6.45	-1.93	-6.05
N	34125			

It is clear that sectoral employment is strongly affected by the level of education. First, the probability of employment in the non-tradable sector increases sharply if education is increased from 6 to 15 years. Second, the probability of employment in the tradable sector decreases sharply with education, but especially so for the export-oriented sector. Employment probabilities also vary across age groups but the differences are relatively small.

Table 6. Predicted probability of employment by age group, education and sector

	6 years education			12 years education			15 years education		
Age	No Trade	Import	Export	No Trade	Import	Export	No Trade	Import	Export
18-24	0.53	0.11	0.35	0.71	0.09	0.20	0.85	0.05	0.10
25-34	0.53	0.12	0.35	0.77	0.08	0.15	0.89	0.05	0.06
35-44	0.50	0.14	0.36	0.75	0.10	0.15	0.88	0.05	0.07
45-65	0.48	0.13	0.39	0.73	0.12	0.15	0.84	0.09	0.08

Note: evaluated at the mean value of variables.

Given that the probability of employment across sectors is strongly dependent on the level of education, we expect the Mincerian return to education to differ from the unconditional return as well. The next table reports the unconditional return based on equation (5). The first column reports the weighted average of the Mincerian return ($\sum_{j=1}^{J} p^j \beta^j$) as reported in Table 4. The second column reports the employment effect on the return to education ($\sum_{j=1}^{J} logw^j \frac{\partial p^j}{\partial E}$). The employment effect is generally negative but small, reducing the return to education by up to 1.5% point. The negative effect can be explained by Table 6 and Figure 2 – increasing education increases the probability of employment in the non-tradable sector where wages tend to be lower. As a result, the

unconditional return (last three columns of Table 7) is slightly lower than the Mincerian return (first three columns).

Table 7. Unconditional return to education by age group and education

	Wage effect $(\sum_{j=1}^{J} p^j \beta^j)$			Employment effect $(\sum_{j=1}^{J} logw^j \frac{\partial p^j}{\partial E})$			Total effect $(\tilde{\beta})$		
	years of education								
Age	**6**	**12**	**15**	**6**	**12**	**15**	**6**	**12**	**15**
18-24	0.022	0.065	0.088	0.000	-0.015	-0.014	0.022	0.050	0.074
25-34	0.029	0.091	0.121	-0.002	-0.013	-0.011	0.027	0.078	0.110
35-44	0.037	0.115	0.159	-0.005	-0.011	-0.006	0.032	0.104	0.152
45-65	0.039	0.137	0.188	-0.005	-0.004	-0.003	0.035	0.133	0.185

Note: evaluated at the mean value of variables.

5. Trade liberalization and the return to education

The above analysis suggests that there are differences between the Mincerian and unconditional return to education, albeit small. Moreover, the analysis has shown that there has been a large employment shift from the import-substituting sector to the non-tradable and, especially, export-oriented sectors between 1998 and 2006 (Table 1). Also there are significant wage differentials across sectors (Figure 2). This suggests that changes in the Mincerian return may be a poor indicator of the impact of trade liberalization on the return to education because it ignores employment shifts. We therefore now analyze the impact of trade liberalization on both the Mincerian and unconditional return, starting with the difference-in-difference estimator.

Difference-in-difference

The difference-in-difference estimators β^{DD} and $\tilde{\beta}_i^{DD}$ involve time-variant estimates of

β^j, p_i^j and $\frac{\partial p_i^j}{\partial E_i}$. We therefore estimate Mincer regressions for 1998 and 2006 separately to estimate β_t^j for *t*=1998, 2006.[28] We also estimate a multinomial logit model of employment sector for 1998 and 2006 to estimate $p_{i,t}^j$ and $\frac{\partial p_{i,t}^j}{\partial E_i}$ for *t*=1998, 2006.[29] Because the Mincer regressions and multinomial logit models are now estimated for 1998 and 2006 separately, age group-specific educational effects are omitted to save degrees of freedom. This implies that the educational coefficients measure the impact of education for the average age group. Age group-specific intercepts are retained to allow for age group-specific wage differentials. Tables B.1 and B.2 in the Appendix report the regression results.

In Table 8 we report the difference-in-difference estimators for the Mincerian and unconditional return to education based on the regression results. The first two columns report the Mincerian difference-in-difference estimator for the import-substituting and the export-oriented sector.[30] The negative signs are consistent with the implications from the Heckscher-Ohlin model. With trade liberalization the export-oriented sector will expand, creating a strong demand for low-skilled workers and reducing the skill premium (and therefore the return to education). At the same time, the import-substituting sector will contract, putting pressure especially on the wages of high-skilled workers as they will have fewer alternative employment opportunities in the expanding, but low-skill intensive, export-oriented sector.

[28] Although we have survey data for four years, we estimate the difference-in-difference estimators based on the data for 1998 and 2006 to maximize the time period in the 'before' and 'after' comparison.
[29] The multinomial logit models are also used to estimate the modified Dubin and McFadden sample selectivity terms for the Mincer regressions (Bourguignon *et al*. 2007).
[30] For instance, the difference-in-difference estimator for the import-substituting sector is given by $\beta^{DD} = (\beta t{+}sImport{-}\beta tImp\square\square rt){-}\beta t{+}sNT{-}\beta tNT = \Delta(\beta tImport{-}\beta tNT)$.

Table 8. Double-difference estimates of Mincerian and unconditional return to education

	Mincerian (β^{DD})		Unconditional ($\tilde{\beta}_i^{DD}$)		
Education	Import $(\Delta(\beta_t^{Import} - \beta_t^{NT}))$	Export $(\Delta(\beta_t^{Export} - \beta_t^{NT}))$	Wage effect $(\sum_{j=1}^{J} p_{i,t}^{j} \beta^{DD,j})$	Employment effect $(\sum_{j=1}^{J} \beta_{t+s}^{j} \Delta p_{i,t}^{j} + \sum_{j=1}^{J} \Delta(\log w_i^j \frac{\partial p_{i,t}^{j}}{\partial E_i}))$	Total Effect $(\tilde{\beta}_i^{DD})$
6	-0.018	-0.025	-0.010	-0.026	-0.036
12	-0.010	-0.033	-0.005	-0.021	-0.026
15	-0.006	-0.037	-0.003	-0.010	-0.012

Note: evaluated at the mean value of variables.

While we can observe negative impacts on the rates of return for workers in both tradable sectors, the impact is the strongest in the export-oriented sector. A plausible explanation for this is that redundant high-skill workers from the import substituting sector can find alternative employment in the non-tradable sector (which is high-skill intensive, Figure 1) and also expanding (albeit not at the rate of the export-oriented sector, Table 1).

The estimated difference-in-difference of Mincerian returns measures the impact of trade liberalization on the rates of return for fixed employment patterns. However, we have noted that there are large employment shifts in the period 1998-2006 in Vietnam and therefore the unconditional return is a better measure of the overall impact of trade liberalization on the return to education. The last three columns in Table 8 report the unconditional return including the wage and employment effect (equation (7)).

The impact is estimated to be negative for both the wage and employment effect and therefore the wage and employment effect reinforce each other. However, the employment effect is dominant, and most of the estimated impact of trade liberalization is due to employment shifts rather than wage changes. Looking across levels of education,

the negative impact of trade liberalization on the return to education is the largest for workers with 6 years of education (-0.04%) and the smallest for workers with 15 years of education (-0.01%). We will return to this point in the final section.

Industry-level measures

The double difference estimator suggests that trade liberalization did reduce the return to education significantly in Vietnam. However, the period of trade liberalization was characterized by multiple changes in trade policy, including export promotion, replacement of quotas by tariffs and a reduction in tariff rates. Given that the double difference estimator provides an estimate of the joint impact of these policy changes, it is also interesting to identify the impact of any of these separate policy measures on the conditional and unconditional return to education.

In this section we focus on one measure of trade policy in particular, namely the effective rate of protection at the 2-digit ISIC level for the period 1998-2006. Following Arbache *et al*. (2004), we define a measure of openness for industry *j* at time *t* as: $open_{jt}=exp(-ERP_{jt})$, where *ERP* denotes the effective rate of protection. Higher values of the variable *open* correspond to lower rates of effective protection and reflect a more open trading environment.[31]

Table B.3 reports the measure of openness by industry and year. A level of openness equal to one corresponds to an effective rate of protection of zero. In all but six

[31] The effective rates of protection are defined as $ERP_j = \frac{V_j^d - V_j^f}{V_j^f}$, where V_j^d is the value added of industry *j* at domestic price (value added with tariff) and V_j^f the value added of industry j at border price (value added with free trade). For the computation, first the *ERP*s for industries identified in the IO tables were calculated for 1998, 2002, 2004 and 2006. Available IO tables were used (for 1996, 2000, and 2005), as well as tariff schedules from the MOF website and trade data from GSO for 1998, 2002, 2004 and 2006. Next the *ERP*s were computed at the 2-digit ISIC level as the output-weighted average of the *ERP*s across the IO industries.

industries the level of openness did increase between 1998 and 2006 as expected. For five of the six industries for which the level of openness did not increase between 1998 and 2006, the level of openness declined between 1998 and 2002, but increased between 2002 and 2006. The decline in openness between 1998 and 2002 coincided with a major tariff restructuring in 1999, with the issuance of MOF Decision 1983. This decision followed the accession to AFTA and can be seen as a strategic move to create bargaining space for future tariff reductions in anticipation of the negotiations for accession to the WTO in 2007.

In order to estimate the impact of the change in the effective rate of protection between 1998 and 2006 on the return to education in Vietnam, we re-estimated model (11) but now with our measure for openness:[32]

$$(12)\quad U_{it}^{j} = E_{it}\theta_1^{j} + E_{it}^2\theta_2^{j} + open_{jt}\theta_3 + E_{it}open_{jt}\theta_4 + E_{it}^2open_{jt}\theta_5 + Z_{it}\phi^{\check{\jmath}} + \sum_{k=1}^{K} C_{it}^{k}\chi^{\check{\jmath}k} + \delta^{j} + \tau^{\check{\jmath}t} + \nu_{ijt}$$

This model is similar to equation (11) except that we include our measure of openness in the equation (interacted with education and education squared). Also instead of estimating the model for three sectors, we distinguish between 18 different sectors (j=1,…,18).[33] However, in order to save degrees of freedom, the coefficients for the variables involving the individual characteristics $\phi^{\check{\jmath}}$, age groups $\chi^{\check{\jmath}k}$and time effects $\tau^{\check{\jmath}t}$ vary only across the non-tradable, import substituting, and export-oriented sectors ($\check{\jmath}$=1,2,3). For the same reason no interaction terms of the education

[32] Formally this is a conditional logit model because the effective rate of protection varies across choices (Greene 2000, chapter 19).

[33] A number of sectors reported in Table B.3 were combined (and their openness measures averaged) because they contained a small number of observations. The non-tradable sector was included and its openness measure was set equal to one.

variables with the age group-effects are included ($\theta_i^{jk} = \theta_i^{jk'} \ \forall k, k', \ i = 1,2$). The specification of the vector Z_{it} is the same as in model (11). Table B.4 in the appendix gives the regression results. Although there are many coefficients, we note in particular that the coefficients involving the openness measure are statistically different from zero (the p-value of the F-test for the null hypothesis that the coefficients of openness variable and its interactions with education variables are jointly zero is equal to 0.005). This suggests that the employment distribution has been affected by trade liberalization, measured in terms of changes in effective rate of protection, and therefore the Mincerian and unconditional return to education should differ as well.

In order to estimate the impact of the change in the effective rate of protection on the Mincerian and unconditional return to education, we also estimate the following wage model with the openness measure as an independent variable:

$$(13) \quad logw_{it}^{j} = E_{it}\beta_1 + E_{it}^2\beta_2 + open_{jt}\beta_3 + E_{it}open_{jt}\beta_4 + E_{it}^2open_{jt}\beta_5 + X_{it}\gamma + \sum_{k=1}^{K} C_{it}^{k}\chi^{k} + \delta^{j} + \tau^{t} + \epsilon_{ijt}$$

Table B.5 gives the results. The coefficients for the interaction terms between education and openness are significantly different from zero. Moreover, they imply that the Mincerian return to education rises (falls) with increasing openness for workers with at least (most) 6.6 years of education. This contradicts the prediction of the standard Heckscher-Ohlin model because it implies that the highly educated workers benefit most from increasing openness.[34]

However we are not interested in the theoretical impact of trade liberalization on the Mincerian return. Instead we will simulate the change in Mincerian and unconditional

[34] $\frac{\partial^2 lwage}{\partial E \partial open} = (-80.8 + 12.2E)10^{-3} > 0 \ \Leftrightarrow \ E > 6.6$

return (equation 8) to education that follows from the historical change in openness as reported in Table B.3. Table 9 gives the results.

Table 9. Impact of trade liberalization on Mincerian and unconditional return to education based on actual change in industry-level measures of openness, 1998-2006

	Mincerian ($\sum_{k=1}^{J} p^k \frac{\partial \beta^j}{\partial T^k} \Delta T^k$)		**Unconditional ($\sum_{k=1}^{J} \frac{\partial \widetilde{\beta}_i}{\partial T^k} \Delta T^k$)**		
Education	Import	Export	Wage Effect	Employment effect	Total effect
6	-0.0021	-0.0001	-0.0001	-0.0008	-0.0008
12	0.0246	0.0023	0.0012	-0.0002	0.0010
15	0.0610	0.0106	0.0012	-0.0006	0.0006

Note: evaluated at the mean value of variables.

In line with the regression results in Table B.5, we find that the Mincerian return to education (and therefore the wage effect of the unconditional return) was positively (negatively) affected by the trade liberalization for workers with more (less) than 6 years of education. Also in line with the difference-in-difference results of Table 8 we find that the employment effect is negative, and the Mincerian return to education is an overestimate of the unconditional return to education.

However, we note that the estimated effects are very small based on the actual change in industry-level measures of openness. In fact, when we simulate the impact of a 50% increase in openness from the level observed in 1998, we still find a very small impact on the return to education. It has been noted in the literature that while the effective rate of protection takes into account the tariffs on inputs as well as outputs, it does not take into account any non-tariff barriers (Arbache et al. 2004). This is an especially important consideration within the Vietnamese context where non-tariff barriers have been an important trade policy tool historically. Like other former centrally-

planned economies, trade taxes were not important either as a revenue-raising instrument or as a tool of development policy in Vietnam. Trade taxes were introduced in 1988, but at the same time, Vietnam maintained several non-tariff barriers. By 1998, 9 categories of products fell under QRs (quota, banned goods, and those under specialized management of line ministries) accounting for approximately 40% of imports (CIE 1999) and over 45% of total manufacturing production (Athukorala 2002). In 1999 the number of products under quota restrictions was doubled mainly as a temporary measure to avert balance of payments pressure in the wake of the Asian Financial crisis. Vietnam also imposes tariff rate quotas (TRQs) on seven agricultural commodities by the Prime Ministerial Decision No 91/2003/QD issued on May 9, 2003. There are also de facto barriers to international trade for non-state businesses. Firms are still allowed to trade only in commodities registered in the business licenses, and it is difficult to move from one kind of business to another without approved modification of the licenses. In addition to the formal licensing procedures, administrative rigidities and delays in the Customs administration have continued to remain important non-tariff barriers (Athukorala 2006). From time to time import flows have also been regulated in line with government priorities through regulating the release of foreign exchange by banks for meeting import payments. All these non-tariff barriers may explain why the above estimates based on industry-level measures of openness are so much smaller than those reported in the difference-in-difference estimates. Also the estimates will most likely form an underestimate because of measurement error – due to aggregation bias in view of the large number of tariffs and because of deviations between actually applied and bounded tariff rates (with the measured effective rate of protection based on the latter).

6. Discussion

In this paper we have analyzed the impact of trade liberalization on the return to education using four large-scale representative household surveys from Vietnam. The results of the paper show that trade liberalization reduced the return to education by 1.2-3.6% (difference-in-difference estimate). The decline in Mincerian return, however, was only 0.3-1.0% and most of the change in return was due to changes in the industry distribution of employment. Therefore the paper shows that earlier studies on the impact of trade liberalization on the return to education may have underestimated the total impact as they have typically concentrated on the changes in Mincerian return (the wage effect).

The reduction in return to education following trade liberalization puts the Vietnamese experience in line with the earlier experience of the East-Asian NICs in the 1960s and 1970s and fits within the prediction of the standard Heckscher-Ohlin framework. However the finding that the decrease in return to education was the largest for workers with less education cannot easily be explained in a standard Heckscher-Ohlin model as one would expect that the return would be most negatively affected at higher levels of education. However if we consider the presence of a non-tradable sector next to the import-substituting and export-oriented sectors, and the fact that this sector is both relatively skill-intensive and expanding within the Vietnamese context, then it is clear that redundant workers with relatively high skills have better employment opportunities outside the tradable sector. This is confirmed by the fact that the negative employment effect is much smaller for highly educated workers, while the wage effect varies little across education levels (Table 8).

It should be noted that the study ignored another source of changes in the return to education, namely regional shifts in employment. While the empirical models in this paper control for regional variation by including regional dummies in the regression analyses, it does not estimate the 'migration effect' of trade liberalization on the return to education. There are not only wage differentials across industries but also across regions. In so far as trade liberalization and educational levels affect the regional distribution of labor (i.e. location of the worker), then the Mincerian return should not only be corrected with an 'employment effect' but also a 'migration effect'. In this paper we have ignored this issue but it would be an interesting extension of the analysis.

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Appendix A. **Industries included by 2-digit ISIC code**

Traded sector

1	Agriculture and relating services (including livestock raising)
2	Sylviculture and relating services
5	Catching and raising sea products, and relating services
10	Coal mining
11	Oil and gas drilling and related services except exploring/searching activities
12	Uranium and Thorium mining
13	Metal mining
14	Mining for rocks, stone, sand, salt, fertilizer...
15	Food and beverage production
16	Tobacco production
17	Textile
18	Fur processing and fur products (excluding garments)
19	Leather tanning and leather products including wallets, seats, suitcases
20	Wood, bamboo, rattan processing and production of wood, bamboo and rattan products
21	Paper and paper products
22	Printing and publishing (books, magazines, newspapers, and
23	Coke, crude oil, uranium processing
24	Chemicals and chemical products
25	Plastic and Rubber production and products
26	Other non-metal mineral products production
27	Metal production and processing
28	Metal products (except machines and equipment)
29	Other equipment and machinery not specified elsewhere
30	Office and computer equipment production
31	Other electronic, electric equipment not specified elsewhere
32	Radio, TV, broadcasting and other communication equipment
33	Medical and laboratory equipment, precision instruments, and meters (clocks)
34	Motor vehicles and spare parts
35	Other means of transportation (boats, railroad, airplane)
36	Furniture production and other productions not specified elsewhere
37	Recycling, reprocessing
40	Electricity, gas, water steam, hot water production and distribution

Non-traded sector

41	Water exploitation, purification, and distribution
45	Construction
50	Vehicle sales, maintenance and repair; retail sale of gas
51	Wholesale and agent sales (excluding motor vehicles and motorbikes)
52	Retail sales (excluding motor vehicles and motorbikes);repairs of family appliances
55	Hotel and restaurant (including big and small restaurants, cafe, beverage and drink stands,...)
60	Road, railroad and pipeline transport
61	Water transport
62	Airline transport

63 Services in transport; tourist services
64 Post and telecommunications
65 Financial intermediary (excluding insurance and social welfare)
66 Insurance and pensions (excluding social insurance)
67 Assistance in finance (including social insurance)
70 Science and technology activities
71 Activities relating real-estate
72 Rental of machines and equipment (excluding operators); rental of furnitures and household goods
73 Computer-related activities
74 Other business activities (accounting, tax and other consulting, architecture, advertising, protection, housecleaning, photography, packaging, etc
75 Government administration and national defense; promulgated social ensurance
80 Education and training
85 Health and social relief (hospitals, health centers, veterinary care, social relief,...)
90 Cultural and sport activities (broadcasting, television, cinema, recreation and entertainment, press, library, museum, sport,…)
91 Communist party, mass organizations, professional associations
92 Disposal collection, public sanitation improvement, and similar activities
93 Other service activities (laundry, hairdressing, funerals,…)
95 Housework services provided at client's home
99 Activities of foreign organizations

Appendix B. Supplementary regression results

Table B.1. OLS estimates of Mincer equation, 1998 and 2006.

	Non-Traded		Import-substituting		Export-oriented	
	(1)	(2)	(3)	(4)	(5)	(6)
	1998	2006	1998	2006	1998	2006
Age group 25-34	-0.03	0.08	0.00	0.04	-0.12	0.05
	(0.42)	(1.94)	(0.03)	(0.47)	(1.50)	(0.92)
Age group 35-44	0.00	0.09	0.06	-0.13	-0.15	0.05
	(0.04)	(1.35)	(0.31)	(0.99)	(1.03)	(0.56)
Age group 45-65	0.17	0.24	0.17	-0.06	-0.18	0.12
	(1.18)	(2.73)	(0.59)	(0.33)	(0.83)	(0.90)
Education (10^{-3})	-64.1	-43.9	-40.2	-46.5	-6.59	-4.97
	(4.43)	(4.38)	(1.07)	(2.03)	(0.29)	(0.40)
Education squared (10^{-3})	5.98	6.89	5.05	6.67	4.25	4.57
	(6.81)	(11.5)	(2.01)	(4.01)	(2.27)	(5.00)
Age	0.03	0.06	0.06	0.06	0.03	0.05
	(1.40)	(6.49)	(1.62)	(2.35)	(1.83)	(2.76)
Age squared	-0.40	-0.83	-0.81	-0.64	-0.40	-0.63
	(1.81)	(6.89)	(1.57)	(1.86)	(1.52)	(2.75)
Female	-0.14	-0.21	-0.32	-0.30	-0.25	-0.29
	(4.05)	(7.63)	(5.99)	(5.26)	(6.16)	(8.70)
λ_1	-0.03	-0.10	0.15	0.00	-0.05	0.90
	(0.33)	(1.36)	(0.47)	(0.01)	(0.28)	(5.03)
λ_2	-0.28	-0.10	-0.10	0.00	-0.95	-0.48
	(1.61)	(0.68)	(1.53)	(0.02)	(4.91)	(2.32)
λ_3	0.13	-0.46	0.04	-0.23	-0.09	0.03
	(0.53)	(2.50)	(0.15)	(0.68)	(1.44)	(0.67)
Constant	0.70	-0.22	0.42	0.06	-0.30	0.52
	(2.12)	(1.09)	(0.73)	(0.13)	(1.03)	(1.89)
N	1739	3963	501	702	768	1883

Notes: Dependent variable: real wages in 1998 VND. Region and urban dummies are included. t-Values in parentheses. Bootstrapped estimator of variance based on 100 replications is used.

Table B.2. Multinomial Logit Estimates of Employment Sector in Vietnam, 1998 and 2006

	1998				2006			
	Import-Substituting		Export Oriented		Import-Substituting		Export Oriented	
	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
Age group 25-34	0.36	1.31	-0.05	0.19	0.00	-0.01	-0.30	1.75
Age group 35-44	0.49	1.07	-0.26	0.59	0.23	0.63	-0.25	0.92
Age group 45-65	0.55	0.89	0.05	0.09	0.64	1.39	-0.05	0.13
Education (10^{-3})	159.2	2.34	-48.6	0.89	63.6	1.29	44.9	1.33
Education squared (10^{-3})	-16.6	3.97	-7.79	2.15	-9.31	3.24	-14.24	6.69
Age	-0.10	1.41	0.04	0.65	-0.08	1.59	-0.08	1.94
Age squared	0.59	0.68	-0.74	1.02	0.38	0.60	0.66	1.43
Female	0.64	5.56	0.42	3.82	0.07	0.72	0.99	14.7
Share of household age <=15	0.23	0.46	0.99	2.23	-0.66	1.84	0.34	1.27
Share of household 15<age <=25	1.29	2.36	0.69	1.34	-0.53	1.43	0.04	0.15
Share of household 25<age <=35	1.29	2.18	0.66	1.17	-0.33	0.78	-0.46	1.41
Share of household 35<age <=45	1.75	3.14	0.86	1.59	-0.41	1.02	-0.63	2.11
Share of household 45<age <=55	0.81	1.55	-0.34	0.66	-0.30	0.93	-0.89	3.45
Married	-0.26	1.65	-0.46	3.07	0.21	1.65	0.29	3.08
Household size	0.02	0.59	-0.03	1.16	0.06	2.18	-0.03	1.40
Share employment in import-substituting sector	7.15	11.0	2.10	3.44	7.83	9.76	2.99	4.36
Share employment in export oriented sector	2.14	4.79	5.38	14.7	1.75	3.84	4.57	14.0
Constant	-1.91	1.60	-2.44	2.24	-0.56	0.61	-0.06	0.08
N	3008				6548			

Region and urban dummies are included

Table B.3. Openness by industry in Vietnam, 1998-2006

Industry	1998	2002	2004	2006
Agriculture and relating services (including livestock raising)	0.98	0.94	0.98	0.91
Sylviculture and relating services	0.98	0.93	0.95	0.97
Catching and raising sea products, and relating services	0.95	0.77	0.79	0.80
Coal mining	0.94	0.99	0.98	1.00
Oil and gas drilling and related services except exploring/searching activities	1.00	0.87	0.96	0.97
Metal mining	0.97	1.04	1.01	1.01
Mining for rocks, stone, sand, salt, fertilizer...	0.72	1.06	1.00	1.01
Food and beverage production	0.70	0.63	0.69	0.97
Tobacco production	0.82	0.55	0.68	0.65
Textile	0.63	0.62	0.66	0.66
Fur processing and fur products (excluding garments)	0.52	0.59	0.66	0.64
Leather tanning and leather products including wallets, seats, suitcases	0.84	0.56	0.68	0.77
Wood, bamboo, rattan processing and production of wood, bamboo and rattan products	0.64	0.68	0.79	0.79
Paper and paper products	0.64	0.80	0.78	0.81
Printing and publishing (books, magazines, newspapers)	0.88	1.42	1.45	1.28
Chemicals and chemical products	0.86	0.88	0.88	0.91
Plastic and Rubber production and products	0.56	0.77	0.77	0.80
Other non-metal mineral products production	0.77	0.66	0.74	0.85
Metal production and processing	0.87	1.20	1.26	1.09
Metal products (except machines and equipment)	0.82	1.13	1.14	1.08
Other equipment and machinery not specified elsewhere	0.83	1.07	1.08	1.04
Other electronic, electric equipment not specified elsewhere	0.83	0.86	0.88	0.88
Radio, TV, broadcasting and other communication equipment	0.70	0.89	0.93	0.94
Medical and laboratory equipment, precision instruments, and meters (clocks)	0.94	1.05	1.04	1.03
Motor vehicles and spare parts	0.40	0.61	0.61	0.67
Other means of transportation (boats, railroad, airplane)	0.56	1.09	1.06	1.01
Electricity, gas, water steam, hot water production and distribution	0.93	0.80	0.97	0.97

Table B.4. Conditional Logit Estimates of Employment Sector in Vietnam, 1998-2006

	coefficient	t-value
Education		
Industry 2	0.093	1.13
Industry 5	0.164	3.87
Industry 10,11,13,14	0.671	13.2
Industry 15,16	0.254	4.54
Industry 17	0.585	7.68
Industry 18	1.009	13.3
Industry 19	0.960	12.3
Industry 20	0.624	10.2
Industry 21	0.615	5.33
Industry 22	0.389	2.72
Industry 24	0.511	4.25
Industry 25	0.399	4.42
Industry 26	0.333	5.92
Industry 27,28	0.448	7.55
Industry 29,31,32,33,34,35	0.516	6.79
Industry 40	0.929	7.14
Industry >40	0.215	10.2
Education squared		
Industry 2	0.007	1.38
Industry 5	-0.012	3.93
Industry 10,11,13,14	-0.022	7.24
Industry 15,16	-0.006	1.73
Industry 17	-0.023	4.93
Industry 18	-0.041	8.97
Industry 19	-0.042	8.70
Industry 20	-0.029	7.18
Industry 21	-0.021	3.11
Industry 22	0.002	0.22
Industry 24	-0.005	0.78
Industry 25	-0.013	2.28
Industry 26	-0.012	3.34
Industry 27,28	-0.014	3.92
Industry 29,31,32,33,34,35	-0.008	1.94
Industry 40	-0.023	3.69
Industry >40	0.006	4.10
Open	-0.0001	0.23
Education x open	0.178	1.07
Education squared x open	-0.009	0.93
F-test (p-value)	0.005	
N	600102	

Notes: The regression includes 18 industry dummies. Also dummies for age group, year, region, urban, gender as well as variables measuring age and age squared are included, with coefficients varying across 3 sectors (see equation 13). For industry codes see Appendix A. The F-test has as H_0: coefficients of openness variable and its interactions with education variables are jointly zero.

Table B.5. Pooled OLS estimates of Mincer equation, 1998, 2002, 2004 and 2006.

	coefficient	t-value
Age group 25-34	0.02	1.66
Age group 35-44	0.01	0.56
Age group 45-65	0.09	2.99
Education (10^{-3})	42.4	1.82
Education squared (10^{-3})	-0.53	0.37
Open	0.10	0.94
Education x open (10^{-3})	-80.8	3.27
Education squared x open x (10^{-3})	6.08	4.05
Age	0.04	11.7
Age squared	-0.48	12.1
Female	-0.15	24.9
Year 2002	0.09	9.03
Year 2004	0.17	14.7
Year 2006	0.33	28.7
Constant	0.38	2.41
F-test (p-value)	0.000	
N	33339	

Notes: Dependent variable: real wages in 1998 VND. Region, urban and industry dummies are included.