Environmental Regulation and Labour Demand among Vietnamese SMEs

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Abstract: The effects of environmental regulation on labour demand has received significant attention, though research has almost entirely been conducted in developed countries. The aggressive development strategy pursued by Vietnam, through reforms such as the Doi Moi, has been associated with poor environmental performance. Since 1994, Vietnam has pursued detailed Environmental Plans aimed at reducing emissions and pollution by firms and has introduced numerous laws which have implications for all Vietnamese businesses. This dissertation examines changes in employment resulting from treatment of environmental factors as mandated by regulation among micro, small, and medium manufacturing enterprises in Vietnam, using unbalanced firm-level panel data from the 2011, 2013, and 2015 rounds of the UNU-Wider Vietnam SME survey. Ordinary Least Squares (OLS), two-stage-least squares (2SLS), fixed-effects, and fixed-effects-2SLS models are estimated to recover effects of treatment of environmental factors on labour demand. OLS and fixed-effect models show small positive effects. Once instrumental variables and fixed effects are used to control for endogeneity, results still indicate that there are no large negative effects on employment from treatment of environmental factors. These results are consistent with existing evidence from developed countries that environmental regulation does not lead to large reductions in employment by regulated firms.

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1. Introduction

Since the Doi Moi reforms of 1984 Vietnam has enjoyed a rapid pace of development through an effective development strategy, and is often hailed as an economic success story. However, such rapid growth has been accompanied by mounting concerns over the consequences for the environment. Poor water quality, as a result of significant production of wastewater, has been directly linked to adverse health and serious environmental consequences (World Bank and VMPI 2016; Wilbers et al. 2014). Furthermore, with rapid urbanization, the distance between polluting firms and residential areas has closed, making the effects of environmental degradation more salient to the populace (Nhat 2006). Direct consequences on health are only one side of the issue, as climate change threatens the continued reliance of the Vietnamese economy on lowland river deltas for agricultural production (World Bank and VMPI 2016). As a result, authorities have declared recognition that environmental protection is a necessity, and that moving towards sustainable growth is the only way to ensure that the economic success enjoyed by Vietnam in recent decades continues. With this goal in mind, since 1994, Vietnamese authorities have pursued ambitious environmental protection plans and promulgated various laws on environmental protection.

These ambitious environmental strategies incur costs, which may be distributed unevenly across economic actors. The manner in which these costs are distributed likely feeds back into how future environmental policy is formulated and enacted. Indeed, this has been the experience of the US in regard to environmental reform: concerns that the cost firms incur through pollution abatement would fall on workers, led to resistance to environmental reform from unions (Morgenstern et al. 2002). Similar concerns are relevant to developing contexts. Indeed, the goals of continued growth, and environmental protection as prescribed in the Sustainable Development goals agenda, involve trade-offs, the consequences of which have already been documented in Vietnam, where

although the large costs of neglecting environmental factors are apparent, an 'economy vs. environment' debate has quite recently led to poor enforcement and implementation of environmental policies (Sachs 2012) (Pulliat 2019). Determining the distributional consequences of environmental reform therefore has serious implications not only for the direct wellbeing of affected economic agents, but also for the political economy of reform.

This paper evaluates how firms' treatment of environmental factors specified in Vietnam's 1994 Environment Protection Act affects employment and wages of their workers. Vietnamese environmental regulation requires firms to treat environmental factors which have adverse consequences on the surrounding environment. An important step in exploring how this regulation affects labour demand is determination of how firms' treatment of these factors, as specified in Vietnamese environmental laws, will affect the outcomes of their workers. By doing so, this paper contributes to limited evidence on the relationship between environmental regulation and labour outcomes in a developing country. This paper is unique in that it explores effects on micro, small, and medium (SME) manufacturing firms in a developing country, whereas existing studies in developing countries (entirely limited to China) exclusively focus on large firms. The results of this paper have implications for a large portion of the Vietnamese workforce, as manufacturing firms account for about 13% of employment in Vietnam in 2013 (GSO 2014). Additionally, using detailed micro-data, this paper is able to explore whether the effects of treatment of environmental factors vary by the specific factor treated (air, noise, waste or water).

Existing empirical work provides little guidance as to how economic actors may be affected by environmental reforms in developing countries. The external validity of empirical work across contexts is low; effects of environmental regulation depend at least on the structure of affected firms, the methods of abatement available to firms, and the characteristics of product and factor markets, all of which vary greatly across time and geography (Deschenes 2018). Furthermore, empirical work to date is almost entirely limited to developed

countries (with rare exceptions using data from China). For this reason, empirical exploration of the effects of regulation on economic actors in developing countries requires extensive empirical work to highlight which concerns are relevant when implementing environmental reform.

Vietnam poses several unique challenges in terms of assessing the impact of environmental reform. Low compliance with regulation is endemic among Vietnamese firms, which makes endogeneity among firms who do treat environmental factors a serious issue. Furthermore, the labour market is characterized by significant imperfections in terms of both identification of skilled labour and labour mobility (Demombynes and Vu 2016). Decades of centrally planned migration, through policies such as the hộ khẩu registration system, has created major economic constraints for workers and families seeking to relocate across provinces (Demombynes and Vu 2016). Finally, the Vietnamese economy is primarily comprised of SMEs (firms with less than 300 employees).[2] As efforts to protect the environment increase in stringency and immediacy, serious effects may be expected for these small businesses and their employees, especially firms involved in manufacturing. Existing results are not sufficient to suggest the direction of these effects, as the set of optimal, feasible, and actually pursued methods of environmental abatement available to these Vietnamese firms likely differs significantly from those of the larger firms observed in other studies.

This paper seeks to identify the effect of treatment of environmental factors by using a fixed effects model with instrumental variables. This approach mitigates concerns of endogeneity from both time-variant and fixed confounders. This paper finds either small positive or insignificant effects of a firms' treatment of environmental variables on firms' employment. These findings are in line with previous research focused on developed countries, which does not find negative effects of environmental reform on labour outcomes.

[2] Over 98% of firms in Vietnam were recorded as SMEs in 2014 (GSO, 2014)

This remainder of this dissertation is divided as follows: in section 2, I discuss a literature review detailing results on the effects of environmental regulation on labour demand. Section 3 discusses Vietnamese environmental laws and labour markets. Section 4 outlines the conceptual framework used to motivate and interpret results from econometric specifications; section 5 describes the dataset used; section 6 details econometric details; and finally section 7 discusses results before concluding.

2. Literature Review

Most broadly, this paper contributes to literature on the effects of pollution control on labour demand. The papers most similar to mine are Liu et al. (2018), Martin et al. (2014), and Mishra and Smyth (2012), all of which use instrumental variables to detect effects of pollution abatement on the labour outcomes of abating firms. Liu et al. (2018), similar to this dissertation, examine effects in a developing context. The paper comprises one of the only three studies in the literature (all of which are limited to China) which use microdata in developing countries to recover effects of regulation or abatement on labour demand. The results from this literature consistently find negative effects on labour demand. In particular, Liu et al. (2018) find that compliance with pollution regulation leads to a modest 0.6% decrease in employment among Chinese manufacturing firms. Similarly, Liu et al. (2017), focusing on variation in enforcement across Jiangsu province, China, find evidence that stricter wastewater laws reduce employment by 7% among affected firms. Finally, Mishra and Smyth (2012) use cross-sectional data at the employee level among Chinese manufacturing firms and find that abating firms reduce wages by 13-19%. However, the regulatory environment and subjects of observation differ greatly between those papers and this one. The three papers above focus on larger, formally registered firms with annual income above 5 million CNY (about £570,000), whereas my sample includes firms with no lower bound on annual income. The average number of employees per firm in samples used in the above three papers is well above 100

employees, in contrast to the mean of about 16 employees in the sample used in this paper. The Vietnamese context also varies greatly from China in terms of regulation. China has made serious strides towards improving governance and creating effective environmental monitoring mechanisms; on the other hand, Vietnam lacks consistent monitoring of environmental performance while the decentralized political structure has made systematic enforcement of environmental reforms difficult (Mol 2009).

The remaining literature on the relationship between labour demand and pollution control is concentrated in developed countries, especially the US (Deschenes 2018). Unlike the papers above, this literature focuses on variation in regulatory stringency rather than pollution abatement. Walker (2013) uses a triple-difference approach that explores regional variation in environmental regulation to examine effects on wages and employment in polluting firms, finding that wages remain constant although regulation results in significant temporary unemployment. Less confident results are found by Gray et al. (2014), who use variation in the US's Enironmental Protection Authority 's enforcement methods to identify a difference-in-difference approach. The authors generally find that effects on wages and employment were insignificant and small. Other studies have found small positive or insignificant effects on employment, for example, Martin et al. (2014) and Berman and Bui (2001). These results have conflicted with the perception that environmental regulation has negative effects on labour demand. However, the limited external validity of such papers reduces their efficacy in extrapolation to other contexts (Deschenes 2018).

The empirical literature has been accompanied by efforts at providing a theoretical framework which can formalize the relationship between environmental abatement and labour demand, and provide more general conclusions. Morgenstern et al. (2002) use a structural model to analyze effects of regulation on labour markets, and find positive and significant effects on employment across American industries, although structural analysis requires strong assumptions on the structure of markets and firms. Yohe (1979) augments

trade theory to illustrate the effects of pollution control on national income in a two-sector two-factor general equilibrium model. Yohe (1979) shows that factor intensity determines long-run adjustments to pollution regulation, although short-term unemployment is likely regardless of whether the polluting sector is labour or capital intensive. This is consistent with views that environmental regulation would lead to unemployment and reduced wages for workers, a view often taken by opponents to environmental reform in developed nations (Morgenstern, et al. 2002). However, as shown above, subsequent empirical work has conflicted with this result.

A key assumption made by Yohe (1979, p. 188) is that pollution abatement is primarily conducted with capital, or pollution reducing machinery, and that elasticity of substitution between labour and pollution abatement is 'negligible'. In contrast, Berman & Bui (2001) provide a simple and flexible framework which relaxes this assumption, and allows for reconcilliation between the mixed results of extant empirical studies. The next section introduces this framework, which is used to interpret results from empirical specifications.

3. Vietnamese legal and labour market context

In order to understand how manufacturing SMEs may be affected by environmental regulation, it is important to characterize the legal environment faced by such firms. Since at least 2006, Vietnamese authorities have introduced many laws and decrees which require all firms, including SMEs, to treat environmental factors.

Based on size, Vietnamese firms are required to comply with environmental regulation in different ways. Decree No. 80/2006/ND-CP states that larger businesses, specifically those classified as 'investment projects' (businesses with initial investment of over 15 billion Vietnamese Dong (VND)) are subject to submitting Environmental Impact Assessments, while smaller businesses, such as those in this sample, must have an approved 'environmental protection

commitment' (EPC) promising compliance with environmental standards as issued by The Ministry of Science and Technology of Vietnam. Firms are required to possess one of the above documents in order to operate. As of 2009, EPCs required submittal of details to authorities on how businesses' production affects environmental factors, and which methods are used to ensure such effects do not violate environmental standards. Decree No. 3733/2002/QD-BYT similarly describes environmental factors required for treatment under labour hygiene standards. There is overlap between the factors described in either environmental or labour hygiene law, though this paper focuses only on factors most strongly focused on in environmental regulation (air, noise, water, and waste).[3] Failure to comply with standards specified in environmental law results in fines, closure, or relocation according to Decree No. 81/2006/ND-CP. Thus, since 2006, laws are in place which illustrate, enforce, and penalize violations of environmental standards for firms of all sizes. Compliance is low; only about 19% of the firms in the sample used in this paper report treating at least one environmental factor specified in environmental laws. This issue is at least partly a result of firms' inability to treat factors: Nhat (2006), in an observational study on Vietnamese slaughterhouses, observes that that even when investments are made in equipment used to treat environmental factors, machinery is not necessarily used as its operation is prohibitively expensive. Despite weak compliance, enforcement is evident among firms, which is often facilitated by

[3] The 1994 Environment Protection Act (EPA) specifies air, noise, waste and water, though soil is indirectly referred to in the context of waste. The 2005 Law on Environmental Protection (LEP) specifies soil, water, light, air, noise, and waste. Decree No. 117/2009/ND-CP, specifies that violations of environmental factors of air, water, waste, soil, and noise are finable offenses. The intersection of these requirements includes air, noise, water, and waste. However, environmental regulation which applies to small firms does not typically specify soil: Circular 05/2008/TT-BTNMT lists environmental factors required for treatment in order to receive EPCs (the relevant certification for smaller firms) and specifies "emissions," "waste water," "solid waste," and "other waste." Although noise is not specified, Konstadakopulos, (2008) and Nhat (2006) both document that noise is a complaint often levelled by locals at manufacturing firms, including SMEs, in Vietnam. As factors which affect local residents must be treated according to the 2005 LEP, it appears that air, noise, waste, and water are the factors which are actually required for treatment by SMEs such as those within this sample.

local citizens, who may report on suspected violations of environmental law (Nhat 2006; Nguyen et al. 2015). The low enforcement of firms, as well as the role of locals in reporting reflects the common reliance of developing countries on external sources of motivation in driving pollution abatement (Blackman 2010).

As implied by the work of Yohe (1979) and follow-on work by Forster (1984), it is important to characterize the labour market when exploring effects of environmental regulation, as market imperfections determine the particular channels through which effects may occur. Workers in Vietnam have faced a non-transparent and difficult environment in terms of relocating between provinces, as a result of central planning of migration, though in recent years constraints on mobility created by laws have lessened (Demombynes and Vu 2016). Still, laws designed to limit migration continue to confound mobility, and social networks are relied upon to facilitate inter-provincial mobility (Demombynes and Vu 2016). Lack of worker mobility does not necessarily constrain firms from changing wages or reducing employment, though it may limit the spread of general equilibrium effects in labour markets and firms ability to find labour. Indeed, firms in this sample are often constrained in terms of finding skilled labour. In 2015, 17% of hiring firms in the sample stated that there was a lack of skilled labour. However, larger firms are more likely to provide training for workers, mitigating this issue; in 2015, 40% of small and medium firms provide worker training compared to only 13% of micro firms (Brandt, et al. 2016). In terms of treating environmental factors, this suggests the ability of firms to satisfy increased demand for skilled labour needed for environmental treatment methods may be stunted by a lack of skilled labour. The interpretation of results is conducted with respect to this feature of Vietnamese labour markets.

4. Conceptual Framework

I follow Berman and Bui (2001)'s model of labour demand to illustrate how pollution abatement may affect the labour demand of Vietnamese manufacturing SMEs. Berman and Bui (2001), following Brown and Christensen (1980), show pollution abatement investments or costs can be thought of as an input in a firm's production function that exogenously determined by environmental regulation:

$$\mathrm{Y} = f(\mathrm{X}, \mathrm{Z}, \mathrm{P}) \tag{1}$$

Where Y represents output, X represents variable inputs into production, Z represents pollution abatement, and P represent a vector of prices of variable inputs. According to duality theory, there is a cost minimization function dual to equation 1 (Brown and Christensen 1980):

$$\mathrm{C} = g(\mathrm{Y}, \mathrm{Z}, \mathrm{P}) \tag{2}$$

Where C represents variable costs. First-order conditions of a cost-minimization problem allow labour (L) to be written as a function of prices, output, and pollution abatement:

$$\mathrm{L} = h(\mathrm{Y}, \mathrm{Z}, \mathrm{P}) \tag{3}$$

Berman and Bui (2001) express the partial derivative of this function with respect to regulation as the authors rely on variation in regulation to motivate their identification strategy. In the data used in this paper, varation in whether a firm engages in pollution abatement is observed directly, so here the derivative is taken with respect to abatement. The following represents a departure to the Berman and Bui (2001) framework. Equation 4 shows the channels through which abatement affects labour demand:

$$\frac{\partial \mathrm{L}}{\partial \mathrm{Z}} = \frac{\partial h(\mathrm{Y}, \mathrm{Z}, \mathrm{P})}{\partial \mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{Z}} + \frac{\partial h(\mathrm{Y}, \mathrm{Z}, \mathrm{P})}{\partial \mathrm{Z}} + \frac{\partial h(\mathrm{Y}, \mathrm{Z}, \mathrm{P})}{\partial \mathrm{P}} \frac{\partial \mathrm{P}}{\partial \mathrm{Z}} \tag{4}$$

With significant capital and labour market imperfections, it is unlikely that abatement changes factor prices faced by abating firms. Therefore the final term, the response of factor prices to changes in abatement, is expected to be zero. The

change in output in response to abatement ($\frac{\partial \mathrm{Y}}{\partial \mathrm{Z}}$) is negative if increases in pollution abatement do not result in cost savings for firms, as is suggested by the traditional assumption of cost minization. However, this assumption is challenged by the "Porter hypothesis," which suggests that production processes which reduce pollution may in fact result in greater efficiencies, leading to cost savings (Porter and van der Linde 1995). More clearly, reductions in output in most cases can be expected to reduce labour supply ($\frac{\partial f(\mathrm{Y,Z,P})}{\partial \mathrm{Y}}$ is positive). Finally, the response of labour to increased pollution abatement (the sign of $\frac{\partial f(\mathrm{Y,Z,P})}{\partial \mathrm{Z}}$) is uncertain. New technology or methods used to reduce pollution may require additional workers, or replace existing workers. If the latter is the case for a particular firm, then with the assumption that abatement increases a firm's costs, environmental regulation necessarily reduces firm's labour demand. Folowing Berman and Bui (2001), for convenience, I refer to $\frac{\partial \mathrm{Y}}{\partial \mathrm{Z}}$ as "output effects" and $\frac{\partial f(\mathrm{Y,Z,P})}{\partial \mathrm{Z}}$ as "substitution effects" in subsequent discussion.

Due to uncertainty over the sign of substitution and output effects, it is difficult to predict effects of regulation using theory. However, empirical estimates of β in the following equation reveal some information on the above mechanisms:

$$\mathrm{L} = \alpha + \beta(Z) + \mu \qquad (5)$$

For example, assuming negative output effects, if β is negative, it is uncertain whether pollution abating activities and labour are substitutes or complements. However, if β is positive, this suggests that labour and pollution abating activities are complements.

In the dataset used in this paper, I observe a broad measure of abatement: whether a firm engages in abatement or not, i.e., if a firm treats environmental factors (TE). This creates an issues, as TE is not exogenously determined.

The determination of TE may be thought of as:

$$TE = j(\mathrm{Y}, \mathrm{X}) \tag{6}$$

Where X represents determinants of treatment other than output. Importantly, output is expected to appear on the right hand side of the equation, as firm size likely determines whether a firm treats environmental factors. For example, larger firms may be more visible to authorities, and therefore failure to comply with regulation may be more likely to result in fines or punishment. This creates an issue of endogeneity, as larger and more succesful firms with higher idiosyncratic productivity would be expected to have higher output (and therefore demand for labour) and be more likely to treat environmental factors. In other words, firm-specific productivity simultaneously determines labour demand and TE. This makes a naïve regression of equation 5 where R is replaced with TE unreliable. Furthermore, firms likely have time-varying characteristics which determine productivity. Therefore controlling for fixed effects is insufficient in addressing this endogeneity issue. Nevertheless, exogenous factors included in X in equation (6) which do not appear in equation (1) or (3), may be used to extract exogenous variation in compliance in a two-stage-least squares model.

Motivated by the literature, I suggest a variable which satisfies the above condition (inclusion in (6) but not (1) or (3)): the share of firms in the same district also treating environmental factors. This variable captures compliance with environmental regulation by neighbouring firms and knowledge spillovers from other firms' implementing pollution abatement methods. Use of this instrument is supported by evidence that peer behaviour is an important determinant of a firm's decision to comply with environmental regulation, in order to avoid bing singled out by authorities (Luo and Tang 2016). Similarly, Anton et al. (2004) find that the behaviour of other firms is a determinant of self-regulation among US firms. This evidence comes from voluntary environmental programs in developed countries, although the voluntary nature

of these programs might have particular relevance to the developing contexts, where small firms often have discretion over whether to comply with environmental legislation (Blackman 2010). These terms also capture knowledge spillovers, motivated by the concept of agglomoration economies, where the number of firms adopting clean technology can be expected to lower the cost of adoption for other firms in the same area through direct or indirect knowledge sharing. As firms are often confused by difficult and changing regulation, the amount of other firms complying with regulation may improve knowledge of how to comply with environmental regulation, improving take-up. Finally, take-up of abatement from neighbouring firms may also work through competitive effects, for example, increasing demand for green products from customers. Nguyen, Beeton, Halog, & Duong (2015) document that pressure from customers is an important determinant of compliance with environmental regulation among small textile manufacturers in Vietnam. I discuss validity and relevance conditions in more detail in the following sections.

It should be noted that estimates of ß in the following equation do not reflect abatement undertaken directly as a result of government regulation.

$$\mathrm{L} = \alpha + \beta(Z) + \mu \qquad (5)$$

It may be that firms may engage in pollution abatement for reasons other than enforcement by officials, including personal motivations or in order to satisfy customers requirements. Strictly, ß reflects the effect of treatment of environmental factors by firms, for any reason. This includes the effect of both abatement due to direct regulatory pressure and abatement due to other reasons. Nevertheless, sources of pressure other than that from direct enforcement are particularly relevant to developing countries; sources of pressure such as that from locals and customers is a key part of pollution control strategies in lieu of resources to effectively monitor abatement on an individual basis (Blackman 2010). Pollution abatement resulting from these channels is therefore reflective of the current state of pollution control strategies in developing countries, and

estimates of ß provide evidence as to whether such strategies have effects on labour demand.

5. Data

I use the 2011, 2013, and 2015 survey rounds of the Vietnamese SME survey, retrieved from UNU-Wider. SMEs in this data are defined as firms with less than 300 employees, as they are by the General Statistics Office of Vietnam (GSO). The sample covers SME manufacturing firms in Vietnam in 10 provinces and cities. The survey data includes businesses not possessing formal registration documents, also known as non-farm independent business establishments (NFIBE). NFIBE are classified as businesses not registered according to the Enterprise law, referred to here as informal enterprises (GSO 2015). Although informal firms are included in the sample, they are drawn from a GSO survey not representative of the informal sector, and so this sample is similarly not representative of the informal sector. I supplement this data with provincial-level unemployment and wage data from the 2014, 2012, and 2010 Statistical Yearbooks of Vietnam made available by the GSO (GSO 2014) (GSO 2012) (GSO 2010). All nominal variables in terms of VND are deflated using a geographic and time price index provided by UNU-Wider, base values occurring in 2010 in Hanoi, Vietnam.

The SME survey dataset includes rich detail on a variety of firm characteristics. This dissertation's main variables of interest concern labour demand and treatment of environmental factors.[4] The dataset includes information on whether individual firms treat specific environmental factors (air, noise, water, waste, heat, lighting, fire, soil) and records the amount firms invest (if any) in equipment used to treat such factors. As noted in section III, I focus only on the factors most often referred to in environmental law: air, noise, waste and water.

[4] All key variables are self-reported.

The main independent variable is a dummy indicating whether a firm treats at least one environmental variable specified in environmental law. This is a cumbersome measure of pollution abatement, as it does not reflect either the intensity or method of environmental factor treatment. Furthermore, this dummy does not reflect only forced compliance with government regulation, as firms may treat environmental factors for other reasons. As non-governmental sources of pressure are important mechanisms in the pollution control strategies of developing countries, this variable does however reflect the efficacy of such strategies (Blackman 2010). For interpretation, coefficients on this variable reflect the effects of engaging in pollution abatement among Vietnamese manufacturing SMEs on labour outcomes.

The dataset also includes a measure of firm's investments in equipment used to treat environmental factors, although this variable does not reflect very well whether firms engage in pollution abatement. In 2015, only 54% of firms with investments in equipment actually treated environmental factors, while 18% of firms treating environmental factors had recorded no investments in equipment. Case studies across Vietnam have noted that many firms do not make lumpy investments in the treatment of environmental factors. Instead, firms often rely on low-cost changes in the production process in order to comply with environmental laws, such as reuse of cooling water in textile industries to reduce consumption of water, or the use of wet sawdust in wood manufacturing to reduce air pollution (Frijins 2000; Konstadakopulos 2008). As Konstadakopulos (2008) notes, these low-cost methods are often the only feasible abatement methods available to capital and labour-constrained SMEs. Furthermore, Nhat (2006) notes that investments made in equipment used to treat environmental variables are often only used to show to officials during inspections, and that small changes in the production processes are more efficacious in treating environmental factors among SMEs. For this reason, I focus on the simple dummy of whether a firm treats environmental variables, as this likely better

captures all the methods available to firms, especially smaller firms, more accurately than a variable detailing whether investments are made.

I begin by comparing firms on the basis of whether they treat environmental factors. Table 1 compares firms who treat factors with firms that do not, based on dependent variables and controls. Low compliance with environmental regulation is apparent within the sample: only about 19% of firm-observations record treatment of environmental factors. In terms of dependent variables, firms treating environmental variables tend to employ more workers and pay higher wages. As for controls, treating firms have attributes generally indicative of larger firms and have larger revenues. These results are consistent with the idea that causality runs from firm size to treatment of environmental variables, that is, the idea that larger firms are more likely to be noticed by authorities and therefore more likely to comply with regulation in order to avoid legal action. However, treatment of environmental factors in turn may have additional effects on employment. The difficulty lies in separating out exogenous variation in treatment of environmental factors and determining whether this variation contributes to labour demand negatively or positively.

Table 1: Descriptive Statistics

Variable	Not treating factors Mean/SE/N	Treating factors Mean/SE/N	Difference
Total employment	12.07 [0.32] 6258	33.04 [1.88] 1442	20.97***
Average hours worked per month by regular employees	200.04 [0.44] 6258	202.69 [0.80] 1442	2.65***
Average. wage for production workers	2315.03 [20.05] 5728	2698.12 [29.75] 1354	383.08***
Revenue (thousand VND)	5,182,074 [1,379,375] 6258	15,400,000 [2,687,870] 1442	10,200,000***
Share of foreign customers	0.01 [0.00] 6215	0.05 [0.01] 1434	0.04***
Size of network	34.69 [0.58] 6259	47.89 [2.14] 1442	13.21***
Is a household firm	0.68 [0.006] 6259	0.43 [0.013] 1442	-0.25***
Firm age	15.46 [0.13] 6255	14 [0.23] 1440	-1.42***
Has a union	0.07 [0.00] 5807	0.26 [0.01] 1406	0.18***

The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

One important concern is that I may be comparing large firms which consistently treat environmental variables with smaller firms that do not grow to large enough sizes to warrant either attention from authorities or treatment of environmental variables. With the availability of panel data, this concern can be partly addressed by controlling for fixed effects within firms. Table 2 illustrates that there is association between treatment of environmental

variables and employment outcomes within particular firms. In this table, I limit the sample to firms which treat environmental variables in at least one period and do not in at least one other period ('switching' firms). This allows me to compare similar firms in terms of compliance with regulation. The first result which is apparent is that a sizable amount of the observations of firms treating environmental factors are of firms which also do not treat environmental variables in other periods.

In other words, there is a significant amount of variation within firms in the treatment of environmental factors. Table 2 shows that the same firms tend to employ more workers when treating environmental variables. This is still consistent with individual firms treating environmental variables as a result of increased visibility during growth, causing correlation, but not causation, between firm size and treatment of environmental variables. This also addresses potential concerns over measurement error, specifically whether the changes in firm's treatment of environmental factors are simply recording errors: if these are simply mistakes, then it is unclear why firms significantly differ along the observed characteristics.

Closer examination of this subset of 'switching' firms reveals that visibility is not an adequate explanation in variation of compliance with regulation. Of the 'switching' firms, 508 switch from not treating environmental factors in one period to treating them in the next, while 538 switch from treating environmental variables to no longer treating them. In other words, in the sample, firms are more likely to switch *away* from treatment of environmental factors rather than switch *to* treatment of environmental factors. This result is surprising in the context of the story in which firms are more 'visible' to authorities due to growth and therefore treat environmental factors. Although this argument makes sense in the context of growing firms treating environmental variables, it is less plausible in the case of firms stopping treatment of environmental variables. If it was the case that increased firm visibility to officials as a result of growth was the key determinant of take-up of

environmental regulation, then this implies that firms are able to stop treatment of environmental variables between periods as a result of officials being less able to detect them due to decreased growth.

Table 2: Switching Firms

Variable	Not treating factors Mean/SE/N	Treating factors Mean/SE/N	Difference
Total employment	19.30 [0.97] 1318	27.18 [2.34] 1006	7.88***
Average hours worked per month by regular employees	201.48 [0.88] 1318	202.24 [1.01] 1006	0.75
Average wage for production workers	2444.488 [48.802] 1254	2627.750 [35.713] 927	183.26***
Revenue (thousand VND)	6,348,318 [879,176] 1317	12,800,000 [3,637,159] 1006	6,456,700*
Share of foreign customers	0.02 [0.004] 1314	0.05 [0.006] 1000	0.02***
Size of network	37.71 [1.30] 1318	42.17 [1.61] 1006	4.46**
Is a household firm	0.58 [0.01] 1318	0.53 [0.02] 1006	-0.05***
Firm age	15.17 [0.26] 1317	14.86 [0.29] 1005	0.31
Has a union	0.154 [0.01] 1240	0.197 [0.01] 983	0.04***

The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

This does not seem plausible as it is unlikely that officials are unable to keep track of firms fixed in the same location from year to year, even if there is some variation in their size. Another potential explanation may be that firms which shrink produce less waste and are therefore more difficult to identify as potential violators of environmental law, thus reducing the incentive to treat environmental variables.

Indeed, this analysis cannot adequately control for other factors which may simultaneously determine labour demand and the decision to treat environmental variables. However, this preliminary analysis has revealed some key points: there is rich variation in the treatment of environmental factors among firms in our sample; the correlation between treatment of environmental variables and firms' labour force is not adequately explained through increased 'visibility' to officials as a result of growth; and the correlation between treatment of environmental variables and employment does not appear to be explained well by variation in firm income. Determining causal effects is the goal of the next section, in which instrumental variables are used to extract exogenous variation in the determination of treatment of environmental factors.

Table 3

	Treats environmental variables (1)	Knowledge index (3)
Share of firms in same district treating environmental variables	0.33***	-0.21***

Starred values (***) indicates significance at the 1% level.

An instrumental variable approach requires variables which determine treatment of environmental factors but do not determine labour supply through other channels. Our main instrument, as motivated by the discussion in section III, is the share of firms in the district who also treat environmental variables. This variable is constructed by calculating the share of other firms who treat environmental factors in the same district for each firm-observation. Table 3 shows that the instruments are well correlated with treatment of environmental factors. The table also shows that the instrument is well correlated with an index

indicating a firm's level of knowledge of environmental variables, supporting the suggestion of knowledge spillovers as an important channel.[5]

Usefully, the dataset allows for deeper exploration of the costs of compliance with regulation than a simple comparison of compliers with non-compliers, as which factors firms actually treat (air, noise, water, or waste) are recorded. Treatment of certain factors may be accomplished with methods which have differing effects on labour supply: for example, treatment of air may involve machinery which replaces workers (labour substitution), whereas treatment of waste may be accomplished through processes which require additional labour (labour complementing). In heterogeneity analysis I explore, to the extent the data allows, whether treatment of different factors has different effects on key outcomes.

6. Empirical Framework

The goal of this dissertation is to determine how pollution abatement affects workers in abating firms through changes in firm's labour demand. With frictionless markets, firms may be expected to exercise changes in labour demand through increasing or decreasing labour on intensive or extensive margins, although in the presence of market imperfections, changes in labour demand may more often be manifested through changes in worker compensation (Forster 1984). This has been documented in the case of Mishra and Smyth (2012), so I also examine effects on wages. I only observe average wages paid to production workers, so this variable does not reflect all employees of observed firms, and cannot control for worker-specific characteristics.

Pollution abatement as required by Vietnamese law requires treatment of environmental factors. I look at the effects of treatment of environmental factors

[5] The index is recorded as: 4 = No knowledge/not of interest; 3 = Poor knowledge; 2 = Average Knowledge; 1 = Good knowledge.

on labour outcomes using the following specification:

$$y_{itsdp} = \alpha_1 + \beta_1(\mathrm{TE}_{it}) + \delta'\left(X_{itsp}\right)' + \varphi_i + \sigma_s + \mu_d + \rho_p + \omega_t + \varepsilon_{itsdp}$$

For firm i in year t in sector s, district d and province p. y_{itsdp} represents either employment, average hours worked per month by regular employees, or average monthly wages paid to production workers. TE is a binary variable equal to one if firm i treats at least one environmental factor (air, noise, waste, water) in year t. X represents the vector of controls detailed above, limited to time-varying characteristics in fixed-effect specifications. With the availability of panel data, I am able to control for firm heterogeneity using a fixed-effects model. The terms $\varphi_i, \sigma_s, \mu_d, \rho_p$ and ω_t represent firm, sector, district, province and time fixed effects, respectively. ε_{itsdp} is a time variant idiosyncratic error. As shown in table 2, there is significant variation in the number of firms which treat environmental variables, which allows feasible use of a fixed-effects approach.

In order to mitigate endogeneity concerns and reduce noise in regressions, I include a rich set of controls that determine either environmental compliance or firms' labour outcomes. Firm age is noted as an important determinant of both take-up of new technology and firm growth, with younger firms more likely to grow existing establishments (Haltiwanger et al. 2013). For this reason, I control for firm age. Collective bargaining has been documented as having negative effects on employment across developing countries (Feldmann 2009). As unions may be important sources of rigidity in wages and labour supply, I control for whether the firm has a local level trade union. Finally, household firms are not required to register with labour offices, which suggests that household firms face different constraints than non-household firms in terms of labour costs (Rand and Torm 2012). Whether the firm is a household firm may also affect whether it controls for environmental factors; if the firm owner and family live near the production processes, they understandably have greater influence over the treatment of environmental variables.

I also include a set of time-varying firm controls suitable for fixed-effect models. Labour prices and supply are important determinants of employment, so I control for provincial average wages and unemployment rates. A firm's network size may improve its ability to find labour. Indeed, networks have been identified as important channels for dissemination of employment opportunities among small firms in other developing countries (Mano et al. 2011). Firm's social networks have also been linked to worker compensation in the form of benefits within Vietnam (Rand and Tarp 2011). For this reason, I control for the size of an employer's social network.

Whether a firm exports to foreign customers is likely correlated with decisions over compliance with environmental regulation and labour demand, as foreign companies are more likely to require certifications and exporting is associated with higher wages (Potoski and Prakash 2009; Verhoogen, 2008). The international recognition of domestic environmental standards is somewhat dubious, although treatment of environmental factors likely constitutes at least an intermediate step to more stringent environmental standards. For this reason, I also control for the share of foreign country customers. Finally, as Hasan et al. (2007) note, shocks to demand are important determinants of labour supply. In order to control for these shocks I include the lagged value of revenue averaged across province-sectors.

A major concern is that treatment of environmental variables and employment may be simultaneously determined by other factors including firm productivity or other unobservables that cannot be controlled for, in other words, that $\text{cov}(\varepsilon_{itdsp}, \text{TE}_{it}) \neq 0$ in the above specification. Due to these endogeneity concerns I use an instrumental variable approach, with first stage:

$$TE_{itsdp} = \alpha_0 + \beta_2(STF_{tdp}) + \gamma'(X_{itsp})' + \varphi_i + \sigma_s + \mu_d + \rho_p + \omega_t + \varepsilon_{itdsp}$$

The instrument, STF, represents the share of other firms in the same district also treating environmental factors. As documented in the data section, this measure is well correlated with take up of environmental factors by a particular firm

(relevance). It is also unlikely that this instrument directly affects employment, or compensation by individual firms through channels other than through encouraging an individual firm to comply with regulation (validity). This instrument also reflects knowledge spillovers in methods used to treat environmental factors. Similar instruments, focused on investment in R&D or knowledge spillovers among firms, which attempt to capture the influence of other firms' actions have been used in other studies attempting to capture causal effects of quality standards and compliance with regulation, although typically such instruments are interacted with a firm's network or the availability of business services (for example, see Trifkovic 2017; Rand and Torm 2012; and Liu et al. 2018). As networks may be an important direct determinant of labour demand, I refrain from doing so here.[6]

A key assumption of this approach is that STF and the error term in equation (1) are uncorrelated. One potential source of correlation may be a demand shock. For example, firms may receive increased demand from customers who also demand higher standards of product quality from foreign customers. This may have follow-on effects, encouraging firms within the same industry to treat environmental variables. In order to control for shocks to demand within industries, I include the lagged value of revenue averaged across province-sectors, as noted above. However, it should be noted that the presence of other correlated shocks present in the error term and affecting STF and would invalidate the use of this instrument.

[6] In order to use the instrument, in two-stage-least-squares regressions, I limit the sample to observations where I observe more than one firm in each district removing 28 firm-observations from the sample. As a robustness check, I report whether results are sensitive to these observations being set to maximum or minimum values of zero of one.

7. Results

Results from the main specification are show in table 4, where the key independent variable is whether a firm treats at least one environmental factor. OLS results show that treatment of environmental factors is associated with a 23% increase in labour supply (column 1) and a 17% increase in monthly wages (column 7) for production workers (for comparison, average wages in the sample are 2388 thousand VND per month, or around £110 per month). Fixed effects reduce these results significantly: effects on overall employment and wages are only around 7% (column 2 and 8, respectively). This suggests that there are fixed firm characteristics correlated with treatment of environmental factors, which are also correlated with higher employment and wages. This also indicates there may be time-variant firm characteristics further biasing the results. I prefer the fixed-effects two-stage-least-squares (FE-IV) model as it controls for endogeneity from time-varying characteristics. Tests of instrument strength reported in the final two rows indicate that our instruments are strongly correlated with compliance. FE-IV results show more modest, but significant effects on key variables. Employment increases are found to be marginally significant, and on the order of 10% (column 3). This result is not robust to imputation of minimum values for missing values of our instrument, although the result is only marginally insignificant in the imputed regressions, suggesting any negative effects are negligible (the 95% confidence interval in the imputed regression is [-2%, 21%]). Results on total hours per worker become significant and show a modest decrease of about 9 hours per month (column 6). This negative result is more consistent with evidence from China. Results on wages (column 9) are insignificant and imprecisely estimated around zero, which makes it difficult to rule out large negative or positive effects on wages (95% confidence intervals include both 20% increases and decreases in wages). All results are robust to restriction on a balanced sample.

One advantageous aspect of our data is the ability to view the particular factors which firms treat. In the following analysis, I analyse the treatment of air, noise,

waste, and water separately. Similarly, for identification, our instrument is divided into components indicating the share of firms treating the respective factor in the same district. The same motivation holds as above. I.e., treatment of specific factors by other firms in the same district is not expected to directly affect the labour choices of particular firms other than through motivating compliance with environmental factors. Instrument strength is tested through Kleinbergen and Paap (2006) test statistics for underidentification and weak identification, which are reported in the final two rows. Table 5 reports results. Following the discussion above I focus only on results from the FE-IV model. Unlike the former results, estimates on total employment are insignificant (column 3).

Table 4: Effects of treatment of environmental variables

Dependent Variable:	Employment			Hours Worked			Wages		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	OLS	FE	FE-IV	OLS	FE	FE-IV	OLS	FE	FE-IV
TE	0.23***	0.07***	0.10*	-0.53	1.22	-9.24**	0.17***	0.07**	-0.03
	(0.03)	(0.02)	(0.06)	(0.98)	(1.30)	(4.37)	(0.03)	(0.03)	(0.13)
Unemployment	-1.25	-1.54***	-1.43**	-190.47***	-59.33	-88.20*	-4.57***	-7.06***	-7.32***
	(1.39)	(0.58)	(0.62)	(55.49)	(43.76)	(45.54)	(1.72)	(1.16)	(1.22)
Average provincial wage	-0.00	-0.00***	-0.00***	-0.01*	-0.00	-0.00	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lagged prov.-sec revenue	0.00	0.00*	0.00*	-0.00	-0.00	-0.00	0.00**	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Share foreign customers	0.82***	0.52***	0.52***	2.95	-1.48	1.32	0.05	0.07	0.10*
	(0.10)	(0.15)	(0.15)	(2.15)	(3.96)	(4.32)	(0.05)	(0.05)	(0.06)
Network size	0.00***	0.00	0.00	0.01*	-0.01	-0.00	0.00***	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Household firm	-1.03***			-2.93***			-0.40***		
	(0.02)			(0.93)			(0.03)		
Firm age	0.00			0.16***			0.00***		
	(0.00)			(0.05)			(0.00)		
Union	1.09***			-0.71			-0.01		
	(0.04)			(0.98)			(0.03)		
Observations	7,139	7,648	6,585	7,139	7,648	6,585	6,527	7,014	5,798
R-squared	0.60	0.03	0.03	0.10	0.00	-0.01	0.28	0.01	0.01
Firm FE	NO	YES	YES	NO	YES	YES	NO	YES	YES
Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Number of FirmID		3,497	2,457		3,497	2,457		3,456	2,259
KP-LM			180.72			180.72			161.90
KP-Wald			350.96			350.96			233.82

OLS reports robust standard errors and FE and FE-IV regressions report cluster robust standard errors, in parentheses. Dependent variables are log(employment) in columns 1, 2, 3; total hours worked per month by average regular employee in columns 4, 5, 6; and log(avg. production worker wage) in columns 7, 8, 9. The endogenous variable in FE-IV regressions is whether a firm treats environmental variables (TE). Fixed effect models are limited to time-varying controls. FE-IV regressions report Kleibergen-Paap (2006) LM statsitics for underidentification and Kleibergen-Paap (2006) Wald statistics for weak identification. Significance levels are indicated as: *** p<0.01, ** p<0.05, *p<0.1.

Results on average hours worked per month are interesting (column 2); while air and waste are found to have significant positive effects (an increase of about 40 and 30 hours, respectively), results on water treatment show a significant decrease of about 65 hours per month, indicating that the negative result in the above regression mainly stems from treatment of waste factors.
These results suggest that treatment of different factors result in different labour adjustments. Using the Berman and Bui (2001) framework, this suggests that treatment of air and waste are complementary to labour, while water treatment either has large negative output effects or is labour substituting. Results on wages are generally insignificant, as in the above regressions. A noticeable issue is that these regressions appear to suffer from weak instruments. Although an Anderson and Rubin (1949) Wald test consistently rejects the null that coefficients on endogenous regressors are jointly equal to zero, the low Kleinbergen and Paap (2006) Wald test (KP-Wald) statistics suggest instrument weakness. This problem is exacerbated in the wage regression due to missingness in the data.

There is no benchmark to compare the KP-Wald statistics against, since in cases with non i.i.d errors, Stock and Yogo (2005) critical values are no longer viable benchmarks (Andrews et al. 2019). Andrews et al. (2019), note that one method of inference in the presence of multiple weakly-identified endogenous regressors is the creation weak instrument robust confidence intervals by inverting the Anderson and Rubin (1949) Wald test results. Confidence intervals constructed via inversion of the Anderson Rubin (1949) Wald test are robust to instrument weakness in that they grow in size in accordance with the weakness of the instruments.

Table 5: Effects of treatment of environmental variables

	Employment	Hours Worked	Wages
	(1)	(2)	(3)
VARIABLES	FE-IV	FE-IV	FE-IV
Treats Air	0.21	39.50***	-0.03
	(0.15)	(13.02)	(0.42)
Treats Noise	0.24	-16.01	-0.67
	(0.27)	(25.21)	(0.76)
Treats Waste	-0.30	30.07*	-0.23
	(0.19)	(17.03)	(0.39)
Treats Water	0.16	-64.93***	0.66
	(0.25)	(23.63)	(0.54)
Average provincial wage	-1.59**	4.76	-7.50***
	(0.68)	(56.52)	(1.42)
Lagged prov.-sec revenue	-0.00***	-0.00	-0.00***
	(0.00)	(0.00)	(0.00)
Share foreign customers	0.00*	-0.00	0.00
	(0.00)	(0.00)	(0.00)
Network size	0.51***	5.25	0.05
	(0.15)	(6.59)	(0.10)
Household firm	0.00	0.00	0.00
	(0.00)	(0.01)	(0.00)
Observations	6,585	6,585	5,798
R-squared	-0.01	-0.25	-0.04
Number of FirmID	2,457	2,457	2,259
Firm FE	YES	YES	YES
Sector FE	YES	YES	YES
District FE	YES	YES	YES
Province FE	YES	YES	YES
Time dummies	YES	YES	YES
KP-LM	25.66	25.66	8.94
KP-Wald	5.98	5.98	2.06

Cluster robust standard errors are reported in parentheses. Dependent variables are log(employment) in column 1; total hours worked per month by average regular employee in columns 2; and log(avg. production worker wage) in column 3. The endogenous variables are whether a firm treats environmental variables (treats air, treats noise, treats waste, treats water). Regressions report Kleibergen-Paap (2006) LM statsitics for underidentification and Kleibergen-Paap (2006) Wald statistics for weak identification. Significance levels are indicated as: *** p<0.01, ** p<0.05, *p<0.1.

Construction of intervals is accomplished through a grid search which requires gridpoints in the dimension of endogenous regressors, which makes the construction of confidence intervals in a four endogenous regressor case cumbersome (Mikusheva 2013). Nevertheless, I utilize a coarse grid search to provide additional robustness to our results. I report Anderson-Rubin confidence intervals for a 10,000-point (10x10x10x10) grid search on each coefficient in

table 6. One feature of these intervals is that they are not necessarily bounded, resulting in the one-sided confidence intervals. However, if confidence intervals do not include zero, this may give indication of whether it is possible to determine the correct sign of the estimated effect. Our grid search is not large, although the results of the grid search should be able to provide some conservativity regarding our significant coefficients.

The results indicate that the signs of the effects of treatment of air and water on total hours per worker are robust to a coarse grid search, although the results on waste are not. Results on labour demand and wages are too large to draw any meaningful conclusions. The results on the effect of water and air treatment on hours worked are also robust to restriction to a balanced sample.

Table 6: Anderson-Rubin confidence intervals

	Total Labour	Total Hours	Wages
treats Air	[-.25, .67]	[11.15, ...]	entire grid
	(-.39, .80)	(-11.53, 90.53)	(-1.66, 1.61)
Treats Noise	entire grid	entire grid	entire grid
	(-.82, 1.30)	(-114.82, 82.80)	(-3.65, 2.31)
Treats Waste	[... , .28]	[-7.01, ...]	entire grid
	(-1.05, .45)	(-36.68, 96.82)	(-1.75, 1.29)
Treats Water	[-.62, .93]	[... ,-13.47]	entire grid
	(-.84, 1.15)	(-157.57, 27.70)	(-1.44, 2.76)

95% Anderson Rubin Confidence intervals are reported in brackets. A 95% confidence interval includes the interval for values of estimated parameters for which the probability of rejection is less than 95%. Grid limits are reported below confidence intervals in parenthesis around the estimate from the main regression. The width of the grid is double the size of the confidence interval from a standard Wald test. Ellipses indicate an unbounded set.

These results provide positive evidence on the effect of treatment of environmental variables on labour demand of firms. Overall effects on employment rule are small or positive, which is in line with empirical literature from developed countries. Although small negative effects are found on hours worked by employees, they are only around 9 hours per month. Interpretation of these results within the framework detailed in section III allows for some suggestion as to why these effects are observed. One possible explanation is that a negligble amount of workers are onboarded to facilitate use of new methods or

technology required for treatment of environmental factors, while the costs of operating such machinery has negative effects on overall production. Within theoretical framework, this matches with negative output effects, and suggests that pollution abating technology is labour complementary. However, it is also possible that output effects are positive and production efficiency increases, resulting in small increases in employment, while substiution effects are negative, with labour-substituting technology reducing hours worked in general by employees. Without further information on the actual methods used by firms to treat environmental factors, it is difficult to determine the sign of output and substitution effects without strong assumptions on the potential sign of output effects.

Further exploration of the particular factors treated shows that treatment of different factors result in different labour demand responses. While treatment of air factors results in an increase in the amount of hours worked by regular employees, treatment of water results in a decrease in the amount of hours worked. This suggests that while substitution or output effects are postive for air treatment, water treatment has negative substitution effects or negative output effects. The weakness of our instruments prevents strong comment as to the magnitude of effects of different factors, though the sign of estimates is still maintained by weak-instrument robust inference. In general, these result indicate that the details of environmental regulation are important; treatment of different factors may result in different effects on labour. Depending on which factors are most closely enforced, there may be positive or negative effects on the intensive margin of employment.

It is important to note that the main treatment variable does not only reflect whether a firm complies with environmental regulation, as firms may treat environmental variables for other reasons. As such, these results illustrate the effects of engaging in pollution abatement for any reason. Additionally, the LATE interpretation of the coefficients on the instrumented variable is that they are the effect on firms who treat environmental variables due to knowledge spillovers or pressure from neighbouring firms.

8. Conclusion

This dissertation has presented evidence on the effects of pollution abatement on labour demand among SMEs in Vietnam. The results found provide evidence that pollution abatement does not result in reductions in employment on the extensive margin among Vietnamese manufacturing SMEs. This is in line with empirical evidence from developed countries, which finds small positive or negligible effects of on labour demand. These results may be interpreted positively, suggesting that the methods of pollution abatement implemented by Vietnamese firms does not negatively affect employment outcomes in general. This does not suggest that pollution abatement has no distributional consequences among Vietnamese workers, as results do not rule out whether firms replace incumbent workers, or if firms which would have otherwise hired more workers do not. Future research making use of employee-level data is required to determine whether abatement has distributional effects on workers.

This analysis has also shown that the effects of abatement depend on the specific type of pollution addressed. Results indicate that methods used to treat water generally result in reductions in hours worked, while treatment of air results in increases in hours worked. However, it is unclear whether effects are a result of changes in production methods or cost efficiencies. Further information on the methods used by firms to treat factors is necessary to disaggregate these effects.

As environmental pressures mount in Vietnam, the numbers of firms engaging in pollution abatement will likely increase. Although these results show that abatement among Vietnamese firms does not cause unemployment, it is unclear whether this will still be the case if regulation increases in stringency. Since the final year of the survey data used in this paper, additional environmental laws have been introduced in Vietnam. As regulations become tighter alongside continued environmental degradation and urbanisation, firms may be required to engage in more pollution abatement. The results presented here are not

informative as to how more stringent environmental regulation may affect the outcomes of workers, as they only reflect generally how engagement in pollution abating activities (not necessarily as a result of government enforcement) affects labour outcomes. As such, identification of the particular effect of compliance with environmental regulation is still required to provide stronger answers to this important question.

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