KIEL INSTITUTE FOR THE WORLD ECONOMY

KIEL WORKING PAPER

Time to say goodbye? The impact of environmental regulation on foreign divestment

No. 2255 September 2023

Haiou Mao, Holger Görg, and Guopei Fang

Kiel Institute for the World Economy
ISSN 1862–1155

Leibniz Association

KIEL **WORKING PAPER** NO. 2255 | SEPTEMBER 2023

ABSTRACT

TIME TO SAY GOODBYE? THE IMPACT OF ENVIRONMENTAL REGULATION ON FOREIGN DIVESTMENT*

Haiou Mao, Holger Görg, and Guopei Fang

We look at divestments by foreign firms – a topic that has received comparatively little attention in the literature – and investigate how changes in the regulatory environment in the host country may impact on such divestment decisions. We use the implementation of China's Two Control Zone (TCZ) policy as a "quasi-natural experiment", using detailed firm level combined with city level data for the empirical analysis. Our results show that the implementation of TCZ policy has led to higher probabilities of divestments by foreign firms in targeted TCZ cities and industries. The mechanism behind this seems to be a TCZ-induced increase in discharge fees and efforts to reduce SO_2 emissions. Allowing for heterogeneity of effects, we find that the effect is particularly strong for firms from source countries with less stringent environmental regulation, and those using less advanced technology. We furthermore show that firms using intermediates from polluting industries also experience a higher probability of divestment.

Keywords: foreign divestment, environmental regulation, Two Control Zone Policy, China

JEL classification: F23; Q58

Haiou Mao
College of Economics & Management,
Huazhong Agricultural University, and
Kiel Centre for Globalization,
Kiel Institute for the World Economy
Wuhan, Hubei, China
Email:
maohaiou77@163.com
ic.hzau.edu.cn

Holger Görg
Kiel Centre for Globalization,
Kiel Institute for the World Economy
Kiellinie 66
D-24105 Kiel, Germany
Email:
holger.goerg@ifw-kiel.de
www.ifw-kiel.de

Guopei Fang
Huazhong University of Science and Technology, School of Economics
Wuhan, Hubei, China
Email:
gpfang1990@163.com
english.hust.edu.cn

* Haiou Mao would like to express her gratitude to the National Natural Science Foundation of China (No. 72203067) and the Fundamental Research Funds for the Central Universities provided by Huazhong Agricultural University (No.2023JGLW01). Holger Görg also acknowledges funding from the Leibniz Association through the Leibniz Science Campus "Kiel Centre for Globalization".

1 Introduction

Many countries around the world, be it in developing, emerging or developed economies, are concerned with foreign direct investment (FDI). The assumption is that attracting such FDI to the country can boost economic development and growth. Therefore, policies are designed that may help to attract foreign firms. What is striking is that, when it comes to the design and implementation of such policies, and of policies that may be detrimental to FDI (e.g., concerning regulation or tax) the focus of debate is clearly on their potential impact on attracting or deterring new foreign firm locations. What is much less in the debate is how such policies may affect already established foreign firms, who, after all have the possibility of leaving the country through divesting themselves of the foreign affiliate if the environment in the host country changes. This is also mirrored in academic research, where we know quite a lot about factors attracting new FDI, and the implications of such FDI for the host country – but comparatively little about drivers and effects of divestments of foreign firms.

This is not a negligible issue, as divestments by foreign firms in host countries are quantitatively important. For China, the country we look at in detail in this paper, the amount of closed foreign firms reached its annual peak in 2012, showing 30,812 foreign divestments by exit, compared to 24,934 new foreign firm openings.[1] For the years 1998–2006, the period our data relate to, the corresponding numbers are a total of 276,976 divestments and 327,527 new foreign establishments, respectively. This phenomenon is not limited to China. Borga et al. (2020) show that multinationals divested about 20 percent of their foreign-owned affiliates during 2007–2014. Understanding the causes of divestments, and in particular the role policy changes may have, is therefore highly important.

In this paper, we investigate in detail how changes in environmental regulation in the host country China may impact on divestment decisions of firms. While the early literature on divestments by foreign firms suggested that such a withdrawal be merely the reverse of an inward investment (e.g., Boddewyn, 1983), this assumption has since been challenged by various scholars (see Arte and Larimo, 2019, for an overview). From an economic modelling perspective, sunk costs play an important role here. A foreign investment incurs such sunk costs (building a production plant, setting up customer and supplier networks, etc.). Therefore, making decisions about divestments in the wake of changes in the policy environment may also consider these sunk costs again (Dewit et al., 2019). Somewhat relatedly, Kim et al. (2010) argue that if multinationals are operating in a cluster wherein knowledge sharing and learning takes place, the probability of divestments may be low. Hence, a policy change that may make a host country less attractive for new foreign investors may not necessarily also scare away already existing foreign firms, as they have incurred substantial costs for setting up their operations, or are benefitting from substantial knowledge exchange.

Whether a specific policy change – even if it discourages new foreign investments - does indeed lead to more divestments by incumbent foreign firms is therefore a priori not clear. Understanding this is highly relevant, however, as divestments are quantitatively important – as pointed out above – and may have substantial implications for the local economy (Javorcik and Poelhekke, 2017; Mohr et al., 2020).

---

[1] *Data of closed and new established foreign firms are from China Trade and External Economic Statistical Yearbook. This yearbook reports the existing registered and newly established foreign firms for each year. Only the amount of closed foreign firms could be calculated. Our definition in the empirical part of the paper also includes divestments by selling to local owners, which are not included in the numbers here. Hence, the amount of divestments by foreign firms is underestimated in these aggregate data.*

Furthermore, a country like China that is on the path of an emerging economy may also re-think its strategy of attracting FDI towards more "high quality investments". While the literature indicates that a tightening of environmental stringency may discourage new investments by polluting foreign firms (e.g., Cai et al., 2016), it is also important to establish what the implications are for already existing foreign firms – and whether the policy change leads to divestments by "low quality" polluting firms.

We exploit a change in environmental regulation in China as a "quasi-natural experiment" to investigate the link between regulation and divestment, using detailed firm level combined with city level data for the empirical analysis. Specifically, the policy change is the implementation of the so-called Two Control Zone (TCZ) policy, which led to a tightening of environmental regulation in the early 2000s. TCZ, the details of which will be discussed in the next section, led to stricter environmental regulation related to SO_2 emissions in designated cities, and within those particularly in designated "polluting industries". We exploit this city-industry heterogeneity in the implementation of the policy for our identification strategy in a difference-in-difference-in-differences setting.

Our paper contributes to the literature in a number of ways. Firstly, we provide evidence on the role of regulatory changes for divestment decisions of foreign firms. While the impact of policy changes on investments by foreign firms has been researched intensively, we know comparatively little about the implications for divestments.[2] The existing literature on determinants of divestments largely focuses on firm level drivers, leaving aside the role of policies (Mata and Portugal, 2000; Engel et. al., 2013; Tan and Sousa, 2018).[3] We expand on the existing literature by studying changes in environmental regulations as a potential driver of the divestment decisions of foreign firms, controlling for firm level heterogeneity using detailed firm level data for China, and also consider possible channels through which the policy affects firms.

Secondly, we also contribute to the strand of literatures about "pollution haven hypothesis". These studies look at the effect of environmental stringency on the location decisions of multinationals (Copeland and Taylor, 1994; Cole and Elliott, 2005; Ederington et al., 2005; Chung, 2014; Millimet and Roy, 2016). The papers from this literature that are most closely related to ours are Dean et al. (2009) and Cai et al. (2016), who look at the link between environmental regulation and inward FDI in China.[4] While Dean et al. (2009) look at the link between water pollution levies and new joint venture projects using a cross section of investments, Cai et al. (2016) also consider the implementation of the TCZ policy using city-industry level data.[5] We expand on these papers by looking at the other side of the coin, namely the divestment decision as an alternative identification strategy. Also, we use firm level panel data which allow us to investigate the role played by heterogeneity across firms, and enables us to look

---

[2] There is, e.g., work on the impacts on inward FDI of taxes (Ferrett et al., 2019; Konings et al., 2022), regulations (Contractor et al., 2020), pension reforms (Reece and Sam, 2012), employment protection (Kandilov and Senses, 2016), trade agreements (Osnago et al., 2019), environmental policy (Yu and Li, 2020), patent right protection (Ushijima, 2013).

[3] An exception is a paper by Dewitt et al. (2019) looking at the role of employment protection policies for relocations by foreign firms. Also related is a paper by Song (2014) who looks at the relationship between institutions and financial development, and foreign divestments.

[4] Greaney et al. (2017) is another paper that looks at the effect of TCZ on foreign direct investment in China. Specifically, they compare the exit probabilities of foreign and domestic firms and relate them to TCZ. They do not have a clear identification strategy, however, and their paper should therefore be seen as descriptive rather than attempting to estimate causal effects. Also, the focus of the paper is different looking at foreign vs domestic firms, while we consider foreign firms divestment decisions compared to those foreign firms remaining in the location.

[5] Exploiting the TCZ implementation as a quasi-natural experiment provides an identification strategy that circumvents the use of instrumental variable approaches (as, e.g., in Millimet and Roy, 2016) or propensity score matching methods (e.g., List et al., 2003; Millimet and List, 2004; List et al., 2004).

at potential mechanisms driving the effects. This has, to the best of our knowledge, not been done in the literature thus far.

Thirdly, we also expand the literature that looks specifically at implications of the TCZ policy. Given the character of the policy change as a “quasi-natural experiment”, it has attracted researchers’ attention on different topics, such as pollution reduction and economic growth (Chen et al., 2018), infant mortality (Tanaka, 2015), diseases (Wang et al., 2023) or exports (Hering and Poncet, 2014). Moreover, our paper also relates to work that considers other changes in environmental regulation in China, such as Shi and Xu (2018) who examine the link between environmental stringency in the 11th five-year plan and firm level exports, or Liu et al. (2021) who use China's Key Cities for Air Pollution Control (KCAPC) policy to examine how environmental regulation change firms’ production and employment. We contribute to this literature by using comprehensive micro data to study the implications of TCZ for firm level behaviour, and here in particular the foreign divestment decision. This has been neglected in the literature thus far.

Results show that the implementation of the policy has indeed had negative effects in the sense of leading to higher probabilities of divestments by foreign firms in TCZ cities and industries compared to foreign firms in the control group. The use of our firm level data also allows us to consider some of the economic mechanisms that may be at play for explaining divestments. In order to comply with the new regulations, firms incur additional costs for polluting fees, or to upgrade their production process to become “cleaner”. These additional costs may lead to divestments. Our evidence shows that TCZ has led to an increase in discharge fees and efforts to reduce SO_2 emissions. We also allow for heterogeneity of effects, in particular depending on measures of “technology”. We find that the effect is particularly strong for firms using less advanced technology, in line with theoretical arguments set out in Dean et al. (2009), which we discuss in Section 2. Also, firms headquartered in countries with more stringent environmental regulations are more resilient to the policy change. In an extension of the empirical analysis we also consider an alternative definition of the treatment. Rather than assuming that only firms in affected polluting industries experience an effect, we show that firms using intermediates from polluting industries also experience a higher probability of divestment. This is in line with the idea that cost of intermediates have increased for these firms.

The remainder of the paper is structured as follows. In Section 2 we set out the details of the TCZ policy. Section 3 presents our data, while Section 4 outlines our empirical methodology. Estimation results, including looking at mechanisms and heterogeneity, are in Section 5 while Section 6 presents an alternative approach. Section 7 concludes.

2 Policy background and mechanisms

2.1 Policy background

China’s economic growth since the 1980s was accompanied by a rapid growth of coal consumption, which led to substantial pollution caused by sulphur dioxide (SO_2) emissions (Hao et al., 2001). China emitted 23.5 million tons SO_2 at 1995, ranked number 1 around the world. To tackle the problem of SO_2 emissions, the Chinese government implemented the so-called “Two Control Zone” (TCZ) policy, targeted at specific cities (175 municipal cities; see Appendix Table A1 for a list) and specific high-polluting industries (new collieries, power plant and several manufacturing industries with high SO_2

emission, see Appendix Table A2 for a list). The timeline for the implementation of the policy was as follows:

- In 1995, the Air Pollution Prevention and Control Law of the People's Republic of China (APPCL), originally implemented in 1988 was amended by adding a section on SO_2 emission regulation. However, the APPCL 1995 fell short of setting any concrete policies or regulations on how to control SO_2.
- In 1998, "The Request for the Approval of the Proposal of Designation for Acid Rain Control Areas and SO_2 Control Areas" ("1998 Request" from here on) was approved by the Chinese State Council.[6] In this policy paper, 175 out of 380 municipal cities, accounting for 40.6 percent of the population, 62.4 percent of GDP, and 58.9 percent of total SO_2 emissions are designated as "Two Control Zone (TCZ)" cities.
- In April 2000, the APPCL was amended and a section on Two Control Zones was added. Cites in Two Control Zones could only emit a limited amount of air pollutant according to the emission license, while specific amounts, measures and rules were to be formulated by the state council.
- Enforceable rules and regulations were implemented only in September 2002, when "The Tenth Five-Year Plan for the Prevention and Control of Acid Rain and Sulphur Dioxide Pollution in the Two Control Zones" ("Tenth Five-Year Plan" from here on) was approved by the Chinese State Council.[7] In this plan, for the first time a specific target for SO_2 emissions was set for cities covered by TCZ, specifying that by 2005 SO_2 emission ought to be 20 percent lower than in 2000.[8] The plan specifies explicitly that the responsibility of SO_2 emission reduction lies with the local government and should be incorporated into the target responsibility system of provincial, municipal and county heads.[9] Besides, their performance on SO_2 emission would be under regular inspections and announced publicly. Specific regulations and rules to assure the implementation of policies set out in the 1998 Request are formulated, such as constructing monitoring stations, building a SO_2 emission database, forming SO_2 emission trading markets and so on.[10]

---

[6] *For details of this policy, see* http://www.gov.cn/zhengce/content/2010-11/22/content_5181.htm.

[7] *For details of this policy, see* http://www.mee.gov.cn/gkml/zj/wj/200910/t20091022_172128.htm. *For the approval of Chinese State Council, see* http://www.gov.cn/gongbao/content/2002/content_61804.htm.

[8] *In 2000, the Tenth Five-Year Plan stipulated that SO_2 emissions would be 10.53 million tons in 2005 for TCZ cities, which amounted to 80 percent of their emission in 2000. The overall reduction task was 2.63 million tons for the whole country. The central government set the goal of reducing SO_2 emissions by 20 percent till 2005. After that, every provincial government followed this goal and designed their targets accordingly. The promised reduction goals for TCZ cities in each province are shown in Table A3. Most provinces opted for a 20 percent reduction, with very few exceptions. Subsequently, cities followed and set their targets.*

[9] *The "promotion tournament" for governors in China helps to ensure that targets are implemented. This "promotion tournament" was first proposed by Zhou (2007) describing the relationship between officials' promotion and local GDP growth. Once GDP growth targets were announced by central and local governments, announced targets and Chinese local officials competed to deliver economic growth to gain promotion (Li et al., 2019). This works the same for SO_2 emission reduction targets announced in 2002 for local officials. It can be expected that officials who deliver reduction targets best got promoted. Table A2 shows that Guizhou province made the highest reduction promise and the capital city Guiyang contributed most in absolute terms. The Secretary of the Party Committee of Guiyang city (first leader) and the mayor of Guiyang city (second leader) were promoted as provincial leaders in 2006 and 2007 respectively.*

[10] *By strengthening the ability of environmental monitoring and information management, central and local government could observe the air quality, PH value of local rain, and the level of SO_2 emissions by specific projects in a timely manner. There were 472 measurement sites for acid rain set during that period. Automatic monitoring systems for urban ambient air quality were set up and SO_2 was among one of three mandatory tests. Furthermore,*

- Rules for enforcement of SO_2 emissions were further tightened in the eleventh Five-Year Plan in 2005.[11] In this 11th five-year plan, 113 cities were designated as Key City for air pollution prevention and control, among those many (though not all) TCZ cities, but also new cities were added. Those 113 cities are forced to follow air pollutant emission standards and control SO_2 emission strictly. The plan explicitly stipulated that local government leaders were to be held accountable for achieving environmental goals, including the reduction of SO_2 emissions (Chen et al., 2018).

There are several ways to emit less SO_2 as instructed by the 1998 Request and the 2002 Tenth Five-Year Plan (Cai et al. 2016):

a) To start with, reducing the sulphur content of coal was the basic way. New collieries based on coal with a sulphur content of 3 percent and above were prohibited, and existing collieries using a similar quality of coal had to gradually reduce the production or be shut down. Coal washing facilities should be equipped for collieries producing coal with a sulphur content more than 1.5 percent.

b) New coal-burning thermal power plants were prohibited in cities and in suburbs of larger or medium cities, except for cogeneration plants whose primary purpose was to supply heat. Furthermore, newly constructed or renovated coal-burning thermal power plants using coal with a sulphur content of 1.5 percent and above had to install sulphur-scrubbers, while existing powerplants using similar quality of coal had to adopt SO_2 emission-reduction measures.

c) In industries designated as "polluting industries", such as the chemical engineering, metallurgy, nonferrous metals and building materials industries, production technologies and equipment generating severe air pollution had to be phased out. Desulphurisation facilities must be provided if they do not meet emission standards.

The brief time line shows that, while the 1998 Request introduced the TCZ designation, it was merely a concept without clear enforceability. It was only in 2002 followed up by more tangible policies setting the overall emissions target, clearly allocating responsibility to the provincial and municipal governments, and providing detailed regulation on how to enforce the policy. Enforcement was then further tightened in 2005. For our evaluation of how the policy affected divestments, we therefore regard 2002 as the start of a valid and enforceable TCZ policy, and accordingly define the policy change from that year onwards.[12]

2.2 The mechanisms of TCZ policy impact foreign divestments

The TCZ policy can potentially impact firms located in designated cities in a number of ways. Firstly, firms in the specified polluting industries (chemical, metallurgy, nonferrous metals and construction materials) had to upgrade or eliminate production technologies and equipment generating severe air

the Tenth Five-Year Plan requested that online SO_2 emission monitors must be installed for new projects which emit SO_2.

[11] *See* http://www.gov.cn/zwgk/2007-11/26/content_815498.htm.

[12] *Some studies also define TCZ to have started in 1998 or 1999 (Cai et al., 2016; Hering and Poncet, 2014) though we prefer the later year as enforceability is only really assured from then on. Chen et al. (2018) investigate the implications of the further enforceability measures implemented in the eleventh Five-Year Plan from 2005 onwards. We prefer 2002, i.e., the first round of enforceability measures, as this is likely less anticipated and therefore more akin to a quasi-natural experiment.*

pollution. Also, firms would have to pay an additional SO_2 emission fee or install abatement facilities. This imposes severe costs on firms, in particular for firms using less advanced, more polluting technologies.

Secondly, firms in all industries may be affected by higher costs caused by the policy for other inputs sourced locally. Those industries that are highly targeted and regulated by TCZ are among the most upstream industries (Antràs et al., 2012) and, hence used as intermediate inputs in the production process of firms in other industries. Furthermore, electricity, chemical, metal, non-metal and construction related products are often locally purchased, due to local market segmentation in China (Schmitt, 1997; Swanson, 1998) or their high transportation cost (Krugman, 1991; Brooks, 1995).

From this we may infer that foreign firms in TCZ cities are likely to face cost increases due to the policy that other foreign firms in non-TCZ cities do not experience.[13] This may affect all foreign firms in TCZs, but may be particularly true for firms in the designated polluting industries, and those using less advanced technology that is not efficient enough in allowing for pollution abatement or reducing energy use. Dean et al. (2009) also make this point in their model of location decisions of multinationals, where they derive the hypothesis that a cost increase due to increased emission fees affects most strongly those firms that use less efficient technology that does not allow for abatement.

Hence, given that (expected) profitability is an important determinant of the location (Dean et al., 2009) and re-location/divestment (Dewitt et al., 2019) decision of foreign firms, the cost increase due to the implementation of the TCZ policy may be expected to increase divestment by foreign firms in TCZ compared to non-TCZ cities. This should be particularly the case if foreign firms operate in "polluting industries" or use less advanced technology. This is the main hypothesis that we set out to examine in the remainder of the paper. An alternative that we will also explore in the paper, is that TCZ also affects firms that use inputs from polluting industries intensively, regardless of whether they themselves are in polluting industries.

3 Data and Preliminary Evidence

Our analysis of the effect of TCZ policy enforcement on foreign firms' divestment behavior uses data that we assembled by combining two main databases. Our main source is firm level data from the Chinese Annual Survey of Industrial Enterprises (ASIE), which we combine with city level information from the Chinese City Statistical Yearbooks.[14] We use the data for the period 1998 to 2006. Given that 2002 is the critical time point at which the TCZ policy was fully enforceable, this provides us with a window of four years of data before and after the policy implementation.[15]

---

[13] *Such a hypothesis is supported by Chan et al. (2013), who find that the European Union Emissions Trading System (EU ETS) increased average material costs (including fuel) for regulated firms in the power, cement, and iron and steel sectors.*

[14] *City names are listed in Appendix Table A1. There are 267 prefecture level cities that have full records in Chinese City Statistical Yearbook from 1998 to 2006. Among the 178 cities that introduced TCZ, 157 have information in the Chinese City Statistical Yearbook*

[15] *To be precise, we use data up to 2007, in order to allow for the calculation of divestment as outlined below. The period of analysis is then 1998 to 2006. In principle, the data is also available after 2007, until 2014. However, we do not use this data here as this takes us too far away from our treatment year 2002, which would make identification of an impact of TCZ more difficult. Another concern is that several TCZ cities were removed from SO_2 control and several non-TCZ cities were added to SO_2 control with the 11th five-year plan, starting in 2006. This thus means a change in the treatment and control city group from 2006 onwards. Hence, we may expect the effect to be weaker as treatment group cities are not the initial 175 cities anymore. To illustrate this, we conducted two*

ASIE is constructed and maintained by the National Bureau of Statistics of China (NBSC) and reports key financial data for all firms that are state-owned or have sales values of more than 5 million RMB. We clean the data and delete observations if any of the following rules are violated (Cai and Liu, 2009; Feenstra et. al., 2014): (i) the total assets must be higher than the liquid assets; (ii) the total assets must be larger than the total fixed assets; (iii) the total assets must be larger than the net value of the fixed assets. We also drop observations with less than 10 employees or that have invalid establishment years.

In this paper, our focus is on foreign firms. We therefore only keep firms in our sample whose register type is "foreign owned" when it appears for the first time in the data. Following the literature that examines the effects of foreign divestments on firms (e.g., Javorcik and Poelhekke, 2017; Mohr et al., 2020; Fang et al., 2022) we define a divestment as a foreign firm selling to a local owner with ownership changing from foreign to domestic.[16] To be specific, a divestment dummy is equal to one if firms i's ownership type is "foreign" at year t but changed to domestic in year $\mathrm{t}+1$.[17]

The raw probabilities of foreign divestment over the 1998–2006 period are shown in Table 1. We divide firms into two groups based on their location and industry. TCZ_k=1 means a firm located in a TCZ city, while IND_j=1 means a firm operating in an industry that TCZ policy is targeted at. Hence, Group 1 is the treated group that firms locate in TCZ city and operate in TCZ industry, while Group 2 is the control group, comprised of firms in targeted industries but not cities, targeted cities but not industries, or neither city nor industry.

Looking across groups it is clear that firms had very similar divestment probabilities before TCZ policy was enforced, shown by the difference and related t- values of the two groups. One may note that the divestment rate of treatment group in 1999 was significantly higher than the control group. Recalling that the first policy paper about TCZ was released in 1998, it is understandable that it has some impact on foreign firms' re-location choice. However, this impact is not long-lasting shown by the insignificant difference from 2000 to 2002, as the succeeding and supporting rules of how such policy would be implemented was not released until September of 2002.

We argue in the policy background that the release of the Tenth Five-Year Plan in September of 2002 was the critical time that TCZ policy truly came into force. Divestment rates from 2003 to 2006 underline this argument. The rate of the treated group was significantly higher than that of the control group, by 1.22 points. Moreover, the impact was long-lasting to 2006, which is the end year of our sample. This data gives a rough indication that the TCZ policy might have impacted on foreign firms' divestment decision.

---

more regression analyses, one using the sample up to 2010, and another using the full time period up to 2014. ASIE covers industrial firms with product value more than 5 million RMB before 2011, and more than 20 million RMB after 2011. Therefore we look at 1998–2010 and 1998–2014 separately. Not surprisingly, the DDD coefficient, while remaining positive, gets smaller in both samples, and loses statistical significant in the sample using data up to 2014 (i.e., 12 years after the treatment happened). Results are reported in the Appendix Table A6.

[16] *In the data, a firm is defined as foreign if foreign investment accounts for at least 10 percent of paid-up capital (Girma et al., 2015). This definition of divestment as ownership change is also similar to papers studying the micro effects of foreign investments, which generally look at foreign acquisitions defined as ownership changes from domestic to foreign (e.g., Guadalupe et al., 2012; Arnold and Javorcik, 2009; Girma and Görg, 2007).*

[17] *An alternative may be to define divestments as the exit of foreign plants from the data. However, there is an ambiguity when defining foreign divestment by exit using ASIE database. This is because private firms are only included in the data if their sales values are more than 5 million RMB. Since the dataset is not a full census, a firm dropping out in only one year may not necessarily mean an exit, but could be due to that firm dropping below the threshold value for inclusion in the survey. This potentially leads to an inconsistency between dropping out of the ASIE database and exiting from the country. Still, we will use this alternative definition in a robustness check.*

[Insert Table 1 here]

4 Empirical Approach

In order to gauge the impact of the TCZ policy on foreign plants' divestment more formally, we conduct a difference in difference in difference (DDD) analysis by comparing foreign divestment in TCZ cities and TCZ targeted industries with those in non-TCZ cities or non-TCZ industries before and after policy re-enforcement. Specifically, our regression equation is

$$FD_{ikjt} = \alpha_0[TCZ_k \times IND_j \times T_t]$$

$$+\alpha_1[TCZ_k \times IND_j] + \alpha_2[TCZ_k \times T_t] + \alpha_3[IND_j \times T_t] \quad (1)$$

$$+\theta_{ikj} + f(t) + \boldsymbol{Y_k} * \boldsymbol{f(t)} + \boldsymbol{Z_j} * \boldsymbol{f(t)} + \mu_{ikjt}$$

where FD_{ikjt} is a dummy variable for a divestment by foreign firm *i* located in city *k* operating in industry *j* in year *t*. $FD_{ikjt} = 1$ when foreign divestment happens, otherwise $FD_{ikjt} = 0$. TCZ_k is a dummy variable equal to 1 if city *k* is classified as Two-Control Zone city, IND_j is a dummy variable equal to 1 if industry *j* belongs to the targeted industries in TCZ policy, and T_t is a variable equal to 1 once TCZ is in force. As discussed above, the variable is 0 before 2002 and 1 afterwards. As TCZ was released in September, firms were only impacted in the last quarter of 2002 hence, for 2002, $T_t = 1/4$.

θ_{ikj} is a firm fixed effect, capturing all time-invariant differences between firms. $\boldsymbol{f(t)}$ is a year fixed effect, capturing all yearly factors such as macro level shocks. μ_{ikjt} is the remaining error term. Standard errors are clustered at the firm level (Bertrand et al., 2004).

$\boldsymbol{Y_k}$ represents a vector of city level controls capturing determinants of TCZ selection. In order to avoid potential problems due to bad controls, these are measured pre-treatment (in 1995) and interacted with a set of year dummies $\boldsymbol{f(t)}$ (Chen et al., 2018). The Chinese central government, in the 1995 Air Pollution Prevention and Control Law (APPCL) 1995, selected cities to be specified as TCZ cities by their natural conditions, such as meteorology, topography etc. We include a set of variables to approximate such natural conditions: Roughness, measured by the standard deviation of slope; Elevation, measured by the average elevation in kilometres; Wind Speed, measured by the annual average wind speed; Precipitation, measured by the annual average precipitation; Temperature, measured by the annual average temperature; Coldness, measured by the percentage of months with a temperature of 5∘C or below.[18]

Furthermore, $\boldsymbol{Z_j}$ is a vector of sector-specific trade tariffs. This controls for the fact that foreign divestment could be driven also by changes in trade policy, most notably China's accession to WTO. To condition out such effects, we interact measures of China's import and export tariffs in 2001 with year dummies $\boldsymbol{f(t)}$.[19]

---

[18] Cities' slope and elevation were extracted from Shuttle Radar Topography Mission Database from the Resource and Environmental Science and Data Centre of Chinese Academy of Sciences. Wind speed, precipitation and temperature data are from Chinese National Meteorological Science Data Centre.

[19] By mapping the HS-6 digit products to four-digit ASIE industries through the concordance table from the National Bureau of Statistics of China and using import as weight, we can calculate the industry level import tariff. China's

Definitions and summary statistics for all variables included in the analysis are shown in Table 2.

[Insert Table 2 here]

Given the above specification, the coefficient estimate of α0 can be interpreted as the DDD estimate of the effect of introducing TCZ on firms in affected polluting industries and in affected cities. This is the coefficient of interest in our analysis. Under the assumption that there is no further unobserved heterogeneity that may bias our results, the estimate of α0 can then be interpreted as causal.

5 Empirical results

5.1 Baseline results

Table 3 presents the results of the baseline estimation of equation (1). The dependent variable, FD_{ikjt}, is a binary variable and we show a linear probability model with firm fixed effects in column (1). For robustness, we also provide estimation results from a complementary log-log model, logit model and probit model in columns (2), (3), (4). The baseline results show that the DDD estimate is positive and statistically significant. It means that the probability to divest is higher for a firm in a treated city and industry after the implementation of the TCZ policy after 2002, than for a comparable control group firm. The point estimate in column (1) indicates that the divestment probability is increased by around 4 percentage points due to the treatment. This is economically significant, given that the mean divestment probability, as shown in Table 2, is around 6 percent.

[Insert Table 3 here]

An important assumption for the validity of the DDD estimation is that of common trends of control and treated group. This implies that pre-TCZ establishment, there should not be any significant difference in divestment between the treated and control group. Though the mean divestment rates of the two groups, as shown in Table 1, suggest a parallel trend, they do of course not control for firm, city or industry heterogeneity. Therefore, we now conduct an event-study type test. We interact $TCZ_k \times IND_j$ with full sets of year dummies in order to obtain coefficients for each year. Figure 1 shows the plot of the estimated coefficients and their 90 percent confidence intervals.

The coefficients prior to 2002 are not significantly different from zero, indicating a parallel trend before the enforcement of TCZ policy. In addition, we find that the point estimates of the coefficients increase in size after 2002, and then decrease somewhat after 2005. This latter result should be interpreted with caution, however, as several TCZ cities exited while several non-TCZ cities entered into TCZ status following the 11th five-year plan starting from 2006. The weakened coefficient for 2006 could thus perhaps reflect the disturbance from the changes in the treatment and control groups.

[Insert Figure 1 here]

HS-6 digit level import tariff from the world is retrieved from world bank directly. The export tariff is measured as a weighted average of the destination country's tariff on China's imports, using China's imports of each destination country as the weight. Data source of tariff: https://databank.worldbank.org/reports.aspx?source= UNCTAD-~-Trade-Analysis-Information-System-%28TRAINS%29.

5.2 Robustness checks

We now conduct several checks to establish robustness of our baseline results. We consider additional firm level control variables, exclude Key-Cities designated in the 11th Five-Year Plan from our sample, and attempt to deal with city and industry spill-over effects. Results from linear probability models with firm fixed effects are shown in Table 4.

5.2.1 Control variable issue

To avoid problems due to "bad controls", our baseline estimation only includes city and industry level time varying controls, but none at the firm level. As previous empirical studies have shown that firm variables such as size, age, capital intensity, liquidity etc. also impact foreign exit (e.g., Mata and Portugal, 2000; Dewit et al., 2019; Luo and Si, 2020), we add a set of firm level control variables into our regression.[20] Results are in column (1). It can be seen that the coefficient on $TCZ_k \times IND_j \times T_t$ is very similar in sign and magnitude to our baseline regression result in Table 3.

5.2.2 Excluding Key Cities

As pointed out above, another policy related to SO_2 emissions was established as part of the 11th five-year plan on environmental protection in 2005. This policy designated another set of 113 cities as Key-Cities for controlling SO_2. There is a partial overlap of these Key-Cities and TCZ cities, i.e. not all TCZ cities are Key-Cities, while new cities were also added. Given the timing, this policy should not directly impact on our estimation of the effect of the 2002 policy change. However, in order to avoid any disturbance due to future expectations, we exclude all 113 Key-Cities from our sample. This left us with only 67 TCZ cities and 82 non-TCZ cites for the estimation. Results are shown in column (2). They are comparable to the baseline estimation in Table 3, though the point estimate is now somewhat larger.

5.2.3 Considering spillover effects

Another concern related to the cities included in the sample relates to the possibility of spillovers. Untreated cities that are neighbouring TCZ cities often share similar geographic and climatic characteristics, and closeness to a similar local market. This opens up the possibility for policy "spillovers". Either, these non-TCZ cities may choose to adopt TCZ policies to emulate their neighbours. Or, if they do not adopt policies, firms from TCZ cities may easily move to the non-TCZ neighbour cities. Either case may potentially bias our estimation results. In order to attempt to deal with this, we drop those non-TCZ neighbour cities from the control group, i.e. only cities that are not TCZ cities and not the neighbour of TCZ cities are included as control group cities. Empirical results in column (3) show that our findings are robust to this change.

Another potential spillover effect is at the industry level. The concern here is that less polluting industries in a TCZ city, though not directly targeted by the policy, may still react to the TCZ policy. To deal with this problem, we, firstly, keep only high polluting industries, i.e. all TCZ policy targeted industries, in our regression. Hence, any effect is identified only by variation of the treatment status

---

[20] These firm level controls variables include firm size $Size_{ijkt}$ (measured by log of production value), age Age_{ikjt} (measured by the log of 1 plus firm age), firm's capital intensity $lncap\_in_{it}$ (log of capital per capita), profit ratio $Profit_{ikjt}$ (measured by the ratio of total profit value to produce value), export intensity Exp_{ikjt} (measured by the ratio of export value to produce value), financial constraints Fin_c_{ikjt} (measured by the ratio of interest to fixed capital value), short time leverage $Short\_le_{ikjt}$ (measured by the ratio of current liability value to total capital value), long time leverage $Long\_le_{ikjt}$ (measured by the ratio of long term liability value to total capital value).

across cities. Secondly, we keep only high-polluting (as treatment) and non-polluting industries (as control group) in our regression and only drop low polluting industries.[21] Results of these exercises are reported in columns (4) and (5). They again underline the robustness of our baseline results.

5.2.4 Excluding coastal cities

During our sample period, China's accession to the WTO in 2001 is a notable trade policy shock. Arguably, eastern coastal cities were the most affected by this, as they were most exposed to trade. The majority of TCZ cities are also coincidentally located in the eastern coastal provinces. This may raise some doubt as to whether our estimated effects are are due to the TCZ policy or may be driven by the WTO accession. To investigate this, we perform another robustness check where we drop those coastal cities from our sample and run our baseline regression. The result, which is shown in column (6) of Table 4, is in line with our previous findings.

[Insert Table 4 here]

5.3 Alternative definitions of divestment

Our preferred definition of foreign divestments as ownership change from foreign to domestic closely follows previous studies on the impact of foreign divestments on firms (e.g., Javorcik and Poelhekke, 2017; Mohr et al., 2020; Fang et al., 2022). However, our data set also allows us to look at alternative definitions.

In the first instance, we can look at foreign divestment by exit – i.e., a foreign firm dropping out of the data set. However, given that our data does not cover the population of firms but only firms with sales value of more than 5 million RMB, dropping out of the data set does not necessarily reflect exit, but may be due to the firm slipping below the threshold value. Keeping this in mind, we define an alternative divestment measure based on a foreign firm existing in year t but disappearing in year t+1 and t+2.

We also calculate yet another divestment measure, based on firms reducing their equity share substantially, while still remaining in foreign ownership. Specifically, we define a divestment as occurring when a foreign firm reduces its ownership share by at least 20 percentage points between t and t+1 (e.g., foreign share is 80 percent in year t and 60 percent or less in year t+1). We also consider as alternative a reduction in the equity share of at least 30 percentage points.

[Insert Table 5 here]

The results of the estimations using these alternative definitions as dependent variable are reported in Table 5. They show that these types of divestments experienced initial effects in 2000 and 2001, when the TCZ policy was first added into the APPCL (see Section 2 above). There is also an additional increase in 2004, after the enforcement of the TCZ policy in 2002. The reactions in 2000 and 2001 may perhaps indicate that firms that do these types of divestment are more sensitive to changes in the policy environment (even if this is not strictly enforced yet) and therefore react more strongly to the 2000 policy announcement. One possible reason for this may be that these types of firms are worse performers (in terms of SO_2 emissions) than those that divest by selling to domestic owners.

---

[21] *There are 13 industries are classified as non-polluting industries, and they account for only 3.12 percent of overall SO_2 emission.*

To investigate this, we calculate the SO_2 related performance of foreign firms, separately for four groups: our preferred divestment measure (based on ownership change), divestment by exit, divestment by large share reduction, and continuously foreign firms (i.e., those that do not divest). We provide descriptive statistics in Table A4 in the appendix. This shows that firms that divest by exit or by a large share reduction clearly perform much worse than firms that opt for ownership change, or those that remain foreign owned. Hence, these types of firms may indeed be more sensitive to changes in environmental stringency.

In what follows, we turn back to our preferred definition of divestment, based on the literature, which indicates the strongest impact of the 2002 change in enforcement legislation on divestment.

5.4 Mechanisms

The TCZ policy stipulates that targeted firms can choose to eliminate SO_2 emissions, upgrade their production process to make it "cleaner", or pay a fee for pollution. All of these adjustments involve additional costs for firms. These are therefore potential mechanisms which may lead foreign firms to divest themselves of their affiliates in China if they are unwilling to bear these extra costs. We have some information available in our data which may enable us to proxy these mechanisms.

Firstly, we consider the additional costs due to SO_2 pollution fees. Unfortunately, our data set does not provide direct information on such a fee. However, we have SO_2 emission data from the Pollution Emissions Database of Chinese Industrial Enterprises, based on which we can approximate an SO_2 pollution fee based on official documents regarding the collection of waste charges. The calculation of the SO_2 emission fee is detailed in the Appendix Table A5.

Aside from paying an SO_2 pollution fee, firms can also implement more desulphurisation equipment and thus eliminate SO_2 rather than emit it directly. We use a measure of desulphurisation capacity, and the amount of eliminated SO_2 as alternatives to look at cost related to desulphurisation.

Finally, firms may also decide to install cleaner production technology in order to comply with regulation. To consider this, we use information on the intensity of SO_2 production. Furthermore, as proxies for new technology we look at patent applications.[22]

Results reported in Table 6 indicate that firms tend to pay higher discharge fees, install higher desulphurisation capacity and spend more on SO_2 elimination due to the introduction of the TCZ policy, while there is no evidence that they invest in cleaner production technology. Hence, on the basis of these measures, albeit imperfect, we may conclude that the adjustment firms make to the increased environmental regulation incurs higher costs and fees related to SO_2 emissions. These higher costs may then lead some foreign firms to divest of their concerns in China.

[Insert Table 6 here]

5.5 Exploring heterogeneity

We now consider two aspects of heterogeneity in the TCZ – divestment relationship. The first relates to the foreign multinationals' source country, the second to aspects of firm heterogeneity.

---

[22] *Firm level data on Pollution Emissions as well as Patents are available from the EPS platform (http://www.epschinadata.com/). The data can be linked to ASIE using a common firm identifier. Note that we cannot use data on R&D as ASIE only report R&D from 2005 to 2007.*

5.5.1 Source country's environmental stringency

The source country's environmental regulation level could potentially play a role for foreign affiliates' reactions to changes in the host country's environmental stringency. Specifically, multinationals from countries with stricter environmental regulation may have more advanced environmental technology, and their foreign affiliates may therefore be more resilient to host country's environmental regulation change. In line with this, Cai et al. (2016), for example, show that multinationals from countries with better environmental protection are less sensitive to the toughening of environmental regulation in the host country.

Unfortunately, our firm level ASIE data do not provide information on the source country of foreign firms.[23] However, according to the literature on multinational firms (see Antràs and Yeaple, 2014), there is a close trading relationship between parent firm and their affiliates, which we might be able to exploit. Foreign affiliates might supply intermediates to their parent firms. Therefore, the top export destination recorded for the foreign affiliate might plausibly be its source country. We have access to very detailed custom trade data which we can link to ASIE.[24] From this, we can calculate foreign firms' top export destination and treat this as the source country. Keeping in mind, of course, that this may not be a fully accurate measurement of the nationality of the foreign owners.

Once we have identified the source country, we can also approximate the level of environmental stringency and environmental related technology in the country. To do so, we use the value of the emissions limit on SO_2 as well as the level of the tax on Sulphur Oxides, both of which are available from the OECD to measure environmental regulation stringency particularly related to SO_2 emission. An alternative is to look at the source country's environmental technology level, which we approximate using the percentage of patents in environmental related technologies relative to all technologies, available from the OECD.[25]

As TCZ policy was reinforced in 2002, we use the 2001 values of these variables. We then interact them with $TCZ_k \times IND_j \times T_t$, to investigate effect heterogeneity along these lines. Results, reported in Table 7, are in line with our expectations: the more stringent environmental regulation, or the higher the share of environmental technology use in the source country, the lower the divestment rate of firms from those countries. In other words, firms from these countries are more resilient to the toughening of China's environmental policy.

[Insert Table 7 here]

5.5.2 Firm level heterogeneity

Another aspect of heterogeneity to be explored is at the level of the firm. As pointed out above, the way the policy is implemented suggests that the adjustment of a firm to TCZ may depend on its technological sophistication. This is also pointed out more generally in a theoretical discussion in Dean et al. (2009), who suggest that a firm's response to toughening of environmental regulation depends on the technology level of the firm. Firms using a higher technology may be better able to adjust to the change in regulation. We can use our firm level data to approximate technology using firm level productivity.

---

[23] The only information is related to whether the firm is "ethnic Chinese", i.e., from Hong Kong, Macao or Taiwan, or whether it is "foreign" (Girma et al., 2015).

[24] Firm level customs data is available from the EPS platform (http://www.epschinadata.com/) and can be linked to ASIE using a common firm identifier.

[25] OECD data available at https://stats.oecd.org/Index.aspx?DataSetCode=EPS#

We define low and high productivity firms by the mean value of labour productivity (shown in Table 8). Estimating the model separately for the two groups provides evidence that is in line with the theoretical argument. Divestments by foreign firms in the low productivity group are increased significantly after the implementation of TCZ, while this is not the case for divestments by high productivity firms.

[Insert Table 8 here]

Another approximation we use is high vs low capital-intensive firms, which provides direct evidence on how firm's capital-intensiveness hinders foreign firms' flexibility. We cut firms into two group by the mean value of capital intensity, i.e. we define a low and high capital-intensive group. Low and high capital-intensive groups are separately estimated, as shown in Table 9. We find that only relatively low capital-intensive firms are impacted by TCZ,[26] which is in line with our expectation.

[Insert Table 9 here]

6 Alternative treatment definition

In the analysis thus far, we assumed that the "treatment" depends on whether a foreign firm is in a treated city and polluting industry, while those in non-polluting industries are considered as untreated. However, this may not capture the full picture, as polluting industries are generally fairly upstream and therefore are important inputs, in particular for local firms. We therefore now turn to looking at a more indirect effect of TCZ, namely on firms that use intermediate inputs from polluting industries intensively.

To do so, we calculate a measure of the use of inputs from polluting industries. We calculate the input ratio of those pollution-intensive industries $Input_{jt}$ for firm *i* and interact it with $TCZ_k * T_t$. China's input-output data from World Input-Output Database are used to calculate $Input_{jt}$. By adding the total input of those pollution-intensive industries[27] and divide them by total output for each industry, we get each industry's $Input_{jt}$ from 1998 to 2005. We use this in an alternative specification of the empirical model

$$FD_{ikjt} = \alpha_0[TCZ_k \times Input_{jt} \times T_t] \tag{2}$$

$$\alpha_1[TCZ_k \times Input_{jt}] + \alpha_2[TCZ_k \times T_t] + \alpha_3 Input_{jt}$$

$$+\theta_{ikj} + \gamma_t + \boldsymbol{Y_k} * \boldsymbol{f(t)} + \boldsymbol{Z_j} * \boldsymbol{f(t)} + \mu_{ikjt}$$

[26] *As noticed, targeted industries of TCZ are chemical engineering, metallurgy, nonferrous metals and building materials industries and so on. Generally, they are seen as capital-intensive industries. However, we do find many firms who engage in such targeted industry and have relatively low capital-intensity. It shows that not all firms in capital-intensive industries have high capital intensity. Hence, our finding is not in conflict with the intuition that targeted industries are capital-intensive industries.*

[27] *The WIOD Data source is* http://www.wiod.org/release13*. The following industries in the 2013 released WIOD version are "polluting industries" defined in the TCZ policy: c2 Mining and Quarrying, c8 Coke, Refined Petroleum and Nuclear Fuel, c9 Chemicals and Chemical Products, c10 Rubber and Plastics, c11 Other Non-Metallic Mineral, c12 Basic Metals and Fabricated Metal. Since ASIE provides a more detailed industry classification in 4-digit code than WIOD, we manually match the* $Input_{jt}$ *in WIOD industry level to ASIE industry level.*

The results are reported in Table 10. They show that firms in industries using more pollution-intensive inputs have a higher divestment rate in TCZ cities after 2002. This is in line with the idea that firms that use pollution-intensive intermediates more are more likely to be divested by foreign owners.

[Insert Table 10 here]

7 Conclusions

In this paper, we investigate in detail how changes in the regulatory environment in the host country may impact on divestment decisions of firms. This issue is generally neglected in the vast literature on FDI. However, this is not a trivial issue, considering that the amount of divested foreign firms in China is fairly comparable with new established foreign firms in many years. In this paper, we model the divestment choice compared to remaining foreign firms and use the implementation of Two Control Zone (TCZ) policy as a "quasi-natural experiment" to investigate the link between regulation and divestment.

We find that TCZ policy has led to higher probabilities of divestments by foreign firms in TCZ cities and industries compared to foreign firms in the control group. Our examination of mechanisms shows that increased costs due to discharge fees and efforts towards desulphurisation may be reasons that may lead to divestment, while we do not find evidence that firms invest in technological upgrading to "cleaner" production. Further, foreign firms with lower technology levels are more likely to be affected by the policy, as are firms from source countries with laxer environmental regulations. In an extension we find that foreign firms using intermediates from polluting industries also experience a higher probability of divestment, which is in line with the idea that cost of pollution-intensive intermediates have increased for these firms.

Our study has policy implications. The sheer number of divestments happening suggests that governments, when thinking about their approach to FDI, should not only focus on attracting new investments but also on retaining existing foreign firms. The same goes for implementing policy changes. Here governments need to be aware that they may not only affect a country's attractiveness to new investments, but also to existing foreign firms. This may be especially important for emerging economies such as China, that may be re-considering their FDI strategy towards more "high quality FDI" (see Moran et al., 2017).

REFERENCES

Antràs, P., D. Chor, T. Fally, and R. Hillberry (2012). Measuring the upstreamness of production and trade flows. *American Economic Review*, *102*(3): 412–416.

Antràs, P., and S. R. Yeaple (2014). Multinational firms and the structure of international trade. *Handbook of international economics*, *4*: 55–130.

Arnold, J. M., and B. S. Javorcik (2009). Gifted kids or pushy parents? Foreign direct investment and plant productivity in Indonesia. *Journal of International Economics*, *79*(1): 42–53.

Arte, P., and J. Larimo (2019). Taking stock of foreign divestment: Insights and recommendations from three decades of contemporary literature. *International Business Review*, *28*(6): 101599.

Bertrand, M., E. Duflo, and S. Mullainathan (2004). How much should we trust differences-in-differences estimates? *The Quarterly journal of economics*, *119*(1): 249–275.

Borga M., P. Ibarlucea-Flores, and M. Sztajerowska (2020). Divestment Decisions by Multinational Enterprises: Trends, Impacts, and Drivers – A Cross-country Firm-level Perspective. OECD Working Papers on International Investment, No. 2019/03, OECD Publishing, Paris.

Boddewyn, J. (1983). Foreign direct divestment theory: Is it the reverse of FDI theory?. *Review of World Economics / Weltwirtschaftliches Archiv*, *119*(2): 345–55.

Brooks, G. R. (1995). Defining market boundaries. *Strategic Management Journal*, *16*(7): 535–549.

Cai, H., and Liu Q. (2009). Competition and corporate tax avoidance: Evidence from Chinese industrial firms. *Economic Journal*, 119(537): 764-795.

Cai, X., Y. Lu, M. Wu, and L. Yu (2016). Does environmental regulation drive away inbound foreign direct investment? Evidence from a quasi-natural experiment in China. *Journal of Development Economics*, *123*: 73–85.

Chan, H. S. R., S. Li, and F. Zhang (2013). Firm competitiveness and the European Union emissions trading scheme. *Energy Policy*, *63*: 1056–1064.

Chen, Y. J., P. Li, and Y. Lu (2018). Career concerns and multitasking local bureaucrats: Evidence of a target-based performance evaluation system in China. *Journal of Development Economics*, *133*: 84–101.

Contractor, F. J., R. Dangol, N. Nuruzzaman, and S. Raghunath. (2020). How do country regulations and business environment impact foreign direct investment (FDI) inflows?. *International Business Review*, *29*(2): 101640.

Chung, S. (2014). Environmental regulation and foreign direct investment: Evidence from South Korea. *Journal of Development Economics*, *108*: 222–236.

Cole, M. A., and R. J. Elliott (2005). FDI and the capital intensity of “dirty” sectors: a missing piece of the pollution haven puzzle. *Review of Development Economics*, *9*(4): 530–548.

Copeland, B. R., and M. S. Taylor (1994). North-South trade and the environment. *The quarterly journal of Economics*, *109*(3): 755–787.

Dean, J. M., M. E. Lovely, and H. Wang (2009). Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China. *Journal of development economics*, *90*(1): 1–13.

Dewit, G., H. Görg, and Y. Temouri (2019). Employment protection and firm relocation: Theory and evidence. *Economica*, *86*(344): 663–688.

Ederington J, A. Levinson, J. and Minier (2005). Footloose and pollution-free. *Review of Economics and Statistics*, *87*(1): 92–99.

Engel, D., V. Procher, and C. M. Schmidt (2013). Does firm heterogeneity affect foreign market entry and exit symmetrically? Empirical evidence for French firms. *Journal of Economic Behavior & Organization*, *85*: 35–47.

Fang, G., H. Görg, A. Hanley, and H. Mao (2022). Foreign Divestment–Crisis or Chance for China's Innovation Edge?. *China & World Economy*, *30*(6): 1–33.

Feenstra, R. C., Z. Li, and M. Yu (2014). Exports and credit constraints under incomplete information: Theory and evidence from China. Review of Economics and Statistics, *96*(4): 729–744.

Ferrett, B., A. Hoefele, and I. Wooton (2019). Does tax competition make mobile firms more footloose?" *Canadian Journal of Economics/Revue canadienne d'économique*, *52*(1): 379–402.

Girma, S., and H. Görg (2007). Evaluating the foreign ownership wage premium using a difference-in-differences matching approach. *Journal of International Economics*, *72*(1): 97–112.

Girma, S., Y. Gong, H. Görg, and S. Lancheros (2015). Estimating direct and indirect effects of foreign direct investment on firm productivity in the presence of interactions between firms. *Journal of International Economics*, *95*(1): 157–169.

Guadalupe, M., O. Kuzmina, and C. Thomas (2012). Innovation and Foreign Ownership. *American Economic Review*, *102*(7): 3594–3627

Greaney, T. M., Y. Li, and D. Tu (2017). Pollution control and foreign firms' exit behavior in China. *Journal of Asian Economics*, *48*: 148–159.

Hao, J., S. Wang, B. Liu, and K. He (2001). Plotting of acid rain and sulfur dioxide pollution control zones and integrated control planning in China. *Water, Air, and Soil Pollution*, *130*: 259–264.

Hering, L., and S. Poncet (2014). Environmental policy and exports: Evidence from Chinese cities. *Journal of Environmental Economics and Management*, *68*(2): 296–318.

Javorcik, B., and S. Poelhekke (2017). Former foreign affiliates: Cast out and outperformed?. *Journal of the European Economic Association*, *15*(3): 501–39.

Kandilov, I. T., and M. Z. Senses (2016). The effects of wrongful discharge protection on foreign multinationals: Evidence from transaction-level data. *Canadian Journal of Economics/Revue canadienne d'économique*, *49*(1): 111–146.

Kim, T.Y., A. Delios, and D. Xu (2010). Organizational geography, experiential learning and subsidiary exit: Japanese foreign expansions in China, 1979–2001. *Journal of Economic Geography*, *10*(4): 579–597.

Konings, J., C. Lecocq, and B. Merlevede (2022). Does a tax deduction scheme matter for jobs and investment by multinational and domestic enterprises?. *Canadian Journal of Economics/Revue canadienne d'économique*, *55*(4): 1966–1989.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of political economy*, *99*(3): 483–499.

List, J. A., W. W. McHone, and D. L. Millimet (2004). Effects of environmental regulation on foreign and domestic plant births: is there a home field advantage?. *Journal of Urban Economics*, *56*(2): 303–326.

List, J. A., D. L. Millimet, P. G. Fredriksson, and W. W. McHone (2003). Effects of environmental regulations on manufacturing plant births: evidence from a propensity score matching estimator. *Review of Economics and Statistics*, *85*(4): 944–952.

Li, X., C. Liu, X. Weng, and L. A. Zhou (2019). Target setting in tournaments: theory and evidence from China. *The Economic Journal*, *129*(623): 2888–2915.

Liu, M., R. Tan, and B. Zhang (2021). The costs of "blue sky": Environmental regulation, technology upgrading, and labor demand in China. *Journal of Development Economics*, *150*: 102610.

Luo, C., and C. Si. (2020). Determinants of Foreign Divestment: Evidence from Chinese Industrial Enterprises. *The Journal of World Economy*, *42*(8): 26–53. (In Chinese)

Mata, J., and P. Portugal (2000). Closure and divestiture by foreign entrants: the impact of entry and post-entry strategies. *Strategic Management Journal*, *21*(5): 549–562.

Millimet, D. L., and J. A. List (2004). The case of the missing pollution haven hypothesis. *Journal of Regulatory Economics*, *26*: 239–262.

Millimet, D. L., and J. Roy (2016). Empirical tests of the pollution haven hypothesis when environmental regulation is endogenous. *Journal of Applied Econometrics*, *31*(4): 652–677.

Mohr, A., P. Konara, and P. Ganotakis (2020). Explaining the performance of divested overseas subsidiaries. *International Business Review*, *29*(1): 101602.

Moran, T. H., H. Görg, A. Seric, and C. Krieger-Boden. (2017). How to Attract Quality FDI?" KCG Policy Paper, No. 2, Kiel Centre for Globalization (KCG), Kiel.

Osnago, A., N. Rocha, and M. Ruta (2019). Deep trade agreements and vertical FDI: The devil is in the details. *Canadian Journal of Economics/Revue canadienne d'économique*, *52*(4): 1558–1599.

Reece, C., and A. G. Sam (2012). Impact of pension privatization on foreign direct investment. *World Development*, *40*(2): 291–302.

Schmitt, B. (1997). Who is the Chinese consumer? Segmentation in the People's Republic of China. *European Management Journal*, *15*(2): 191–194.

Shi, X., and Z. Xu (2018). Environmental regulation and firm exports: Evidence from the eleventh Five-Year Plan in China. *Journal of Environmental Economics and Management*, *89*: 187–200.

Song, S. (2014). Unfavorable market conditions, institutional and financial development, and exits of foreign subsidiaries. *Journal of International Management*, *20*(3): 279–289.

Swanson, L. A. (1998). Market segmentation in the People's Republic of China. *Journal of Segmentation in Marketing*, *2*(2): 99–116.

Tan, Q., and C. M. Sousa (2018). Performance and business relatedness as drivers of exit decision: A study of MNCs from an emerging country. *Global Strategy Journal*, *8*(4): 612–634.

Tanaka, S. (2015). Environmental regulations on air pollution in China and their impact on infant mortality. *Journal of health economics*, *42*: 90–103.

Ushijima, T. (2013). Patent rights protection and Japanese foreign direct investment. *Research Policy*, *42*(3): 738–748.

Wang, Y., T. Eriksson, and N. Luo (2023). The health impacts of two policies regulating SO_2 air pollution: Evidence from China. *China Economic Review*, *78*: 101937

Yu, X., and Y. Li (2020). Effect of environmental regulation policy tools on the quality of foreign direct investment: An empirical study of China. *Journal of cleaner production*, *270*: 122346.

Zhou, L. A. (2007). A Study on the promotion tournament mode of local officials in China. *Economic Research*, 52(7): 36–50. (In Chinese)

Table 1: **Foreign firms' divestment rate from 1998 to 2006**

Year	Treatment Group $TCZ_k = 1$ and $IND_j = 1$	Control Group $TCZ_k = 0$ or $IND_j = 0$	Difference	T value
1998	0.0695	0.0685	-0.0010	-0.22
1999	0.0544	0.0470	0.0074**	-2.17
2000	0.0787	0.0752	-0.0035	-0.86
2001	0.0240	0.0244	-0.0004	-0.20
2002	0.0375	0.0373	0.0002	0.07
2003	0.1394	0.1272	0.0122***	2.71
2004	0.0470	0.0453	0.0017	0.74
2005	0.0608	0.0547	0.0061**	2.48
2006	0.0550	0.0494	0.0056**	2.50

Note: Divestment rate means the ratio of foreign divestment number to existing foreign firm number. We consider divestment by ownership change here.

Table 2: **Summary statistics**

	explanation	Mean	Std. Dev.	Min	Max
firm level dependent variables					
FD_{ikjt}	foreign divestment by selling, measured by ownership change from foreign owned to domestically owned	0.06	0.24	0	1
FD_alt1_{ikjt}	foreign divestment by exit, measured by whether disappear from ASIE database	0.11	0.32	0	1
FD_alt2_{ikjt}	Dummy variable of 1 when the foreign share is reduced by more than 20 point	0.03	0.16	0	1
FD_alt3_{ikjt}	Dummy variable of 1 when the foreign share is reduced by more than 30 point	0.02	0.15	0	1
$\ln(1+dis\_fee_{ikjt})$	The log of 1 plus SO_2 discharge fees	5.41	4.52	0	16.81
$\ln(1+Des\_ca_{ikjt})$	The log of 1 plus desulphurisation capacity	0.31	1.06	0.00	12.61
$\ln(1+SO2\_eli_{ikjt})$	The log of 1 plus SO_2 elimination intensity, measured by eliminated SO_2 per thousand yuan	0.07	0.29	0.00	7.44
$\ln(1+SO2\_int_{ikjt})$	The log of 1 plus SO_2 production intensity, measured by produced SO_2 per thousand yuan	0.31	0.57	0.00	8.36
$ln(1+patent_{ikjt})$	The log of 1 plus patent application	0.99	1.09	0.00	7.72
Key independent variable					
$TCZ_k \times IND_j \times T_t$	The interaction term of TCZ (dummy variable of targeted TCZ cities), IND_j (dummy variable of targeted industry of TCZ policy) and T_t (measuring the time of policy shock)	0.18	0.38	0	1
TCZ selection related city variables (interact them with year dummies for regression)					
Roughness	the standard deviation of slope 1995	6.98	3.42	1.57	13.46
Elevation	average elevation in kilometers 1995	0.26	0.48	0.01	3.13
wind speed	annual average wind speed in 1990–1995	2.66	0.76	0.88	4.89
precipitation	annual average precipitation in 1990–1995	0.05	0.01	0.01	0.09
coldness	percentage of months with a temperature of -5◦C or below in1990–1995	1.36	1.86	0.00	8.17
Trade related policy variables (interact them with year dummies for regression)					
Industry level export tariff of 2001	Weighted average of the destination country's tariff on China's imports, using China's imports of each destination country as the weight	5.16	3.67	0.99	18.59
Industry level import tariff of 2001	Import tariff	15.92	5.84	2.46	34.95
FDI source country's variables					
so_limit	Emission limit value of SOx from OECD database	2.58	1.46	0.00	5.00
so_tax	Sulphur Oxides (SOx) Tax from OECD database	0.04	0.38	0.00	6.00
$tech\_en$	Percentage of environment-related technologies to all technologies from OECD database	7.54	2.09	1.26	28.21
Firm level control variables					
Age_{ikjt}	firms' age measured by the difference between statistical year and registration year	1.82	0.65	0	4.06
$Size_{ijkt}$	log term of produce value to measure size	10.57	1.28	0	18.88
$lncap\_in_{it}$	the log term of capital intensity (capital per capita)	3.85	1.29	1.41	5.88
$Profit_{ikjt}$	profit rate measured by the ratio of profit to produce value	0.03	0.07	-0.12	0.16
Exp_{ikjt}	export intensity measured by the ratio of export to produce value	0.47	0.43	0.00	1
Fin_c_{ikjt}	financial constraints measured by the ratio of interest to fixed asset	0.02	0.05	0.00	0.22
$Short\_le_{ikjt}$	short term leverage measured by the ratio of current liabilities to total assets	0.03	0.07	0	0.34
$Long\_le_{ikjt}$	long term leverage measured by the ratio of long term liability to total assets	0.47	0.25	0.04	0.96

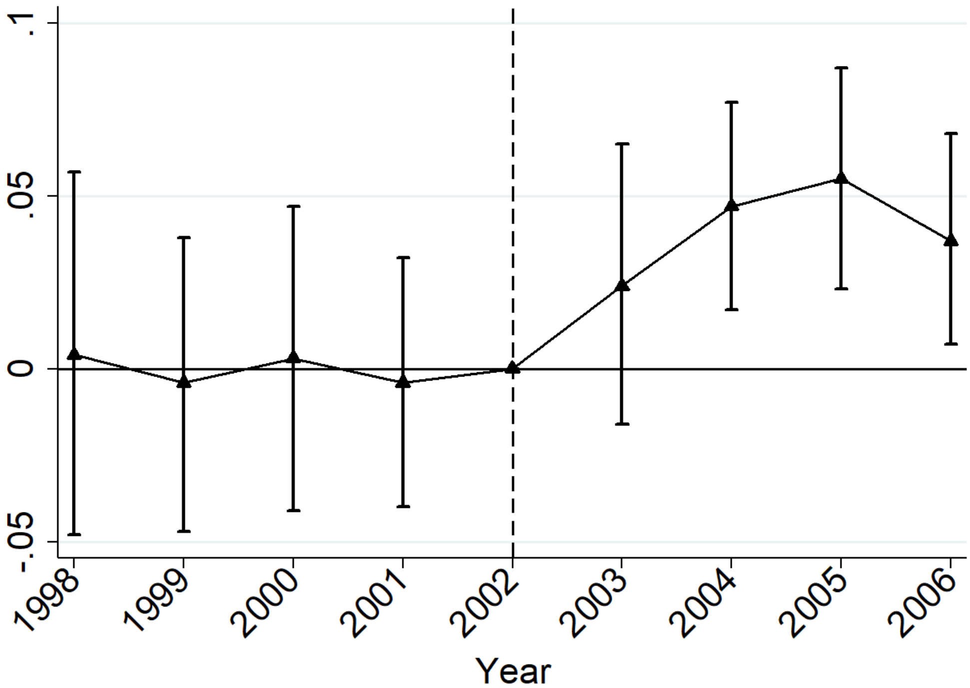
Note: Summary statistics are based on the sample used for the regression analysis.

Table 3: **Baseline regression**

	(1) OLS	(2) Cloglog	(3) Logit	(4) Probit
$TCZ_k \times IND_j \times T_t$	0.0429*** (2.93)	0.4803*** (2.66)	0.5043*** (2.67)	0.2488*** (2.69)
TCZ_k ×Year dummies	Yes	Yes	Yes	Yes
IND_j ×Year dummies	Yes	Yes	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes	Yes	Yes
TCZ controls×Year dummies	Yes	Yes	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	No	No	No
Obs	208576	208576	208576	208576

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses.

Figure 1: **Yearly effect of TCZ policy**



Note: By interacting $TCZ_k \times IND_j$ with year dummies, and replace them with $TCZ_k \times IND_j \times T_t$, we get the coefficients of $TCZ_k \times IND_j \times Y1998$, $TCZ_k \times IND_j \times Y1999$, $TCZ_k \times IND_j \times Y2000$, $TCZ_k \times IND_j \times Y2001$, $TCZ_k \times IND_j \times Y2003$, $TCZ_k \times IND_j \times Y2004$, $TCZ_k \times IND_j \times Y2005$, $TCZ_k \times IND_j \times Y2006$. 2002 is the benchmark. Figure 1 shows the estimated coefficients and their 90% intervals.

Table 4: **Robustness checks**

	(1)	(2)	(3)	(4)	(5)	(6)
$TCZ_k \times IND_j \times T_t$	0.0426*** (2.91)	0.0901*** (4.14)	0.0772** (2.00)		0.0299* (1.82)	0.0490* (1.81)
$TCZ_k \times T_t$				0.0347*** (2.59)		
Firm level controls	**Yes**	No	No	No	No	No
Excludes Key-Cities sample	No	**Yes**	No	No	No	No
Excludes TCZ neighbour cities from control group	No	No	**Yes**	No	No	No
Keep only highly polluted industry sample	No	No	No	**Yes**	No	No
Drop less polluting industry sample	No	No	No	No	**Yes**	No
Drop coastal area	No	No	No	No	No	**Yes**
TCZ_k ×Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
IND_j ×Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes	Yes	Yes	Yes	Yes
TCZ controls×Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs	208576	28969	195753	56857	149962	35326

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. Firm level controls added in column 1 are firm size $Size_{ijkt}$ (measured by log of production value), age Age_{ikjt} (measured by the log of 1 plus firm age), firm's capital intensity $lncap\_in_{it}$ (log of capital per capita), profit ratio $Profit_{ikjt}$ (measured by the ratio of total profit value to produce value), export intensity Exp_{ikjt} (measured by the ratio of export value to produce value), financial constraints Fin_c_{ikjt} (measured by the ratio of interest to fixed capital value), short time leverage $Short\_le_{ikjt}$ (measured by the ratio of current liability value to total capital value), long time leverage $Long\_le_{ikjt}$ (measured by the ratio of long term liability value to total capital value).

***Table 5:* Alternative definitions of foreign divestment**

	(1) Disappear from data set	(2) Reduce ownership share by > 20 percent	(3) Reduce ownership share by > 30 percent
$TCZ_k \times IND_j \times Y1998_t$	0.0507** (2.19)	-0.0076 (-0.45)	-0.0119 (-0.75)
$TCZ_k \times IND_j \times Y1999_t$	0.0002 (0.01)	0.0143 (1.01)	0.0101 (0.81)
$TCZ_k \times IND_j \times Y2000_t$	0.0458** (2.28)	0.0356** (2.47)	0.0274** (2.05)
$TCZ_k \times IND_j \times Y2001_t$	0.0406** (2.18)	0.0185 (1.56)	0.0187* (1.67)
$TCZ_k \times IND_j \times Y2003_t$	0.0237 (1.30)	0.0082 (0.63)	0.0060 (0.50)
$TCZ_k \times IND_j \times Y2004_t$	0.0345* (1.85)	0.0216* (1.74)	0.0092 (0.79)
$TCZ_k \times IND_j \times Y2005_t$	0.0235 (1.25)	0.0239* (1.85)	0.0161 (1.34)
$TCZ_k \times IND_j \times Y2006_t$		0.0194* (1.79)	0.0131 (1.31)
TCZ_k ×Year dummies	Yes	Yes	Yes
IND_j ×Year dummies	Yes	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes	Yes
TCZ controls× Year dummies	Yes	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Obs	268797	216797	216797

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses.

Table 6: Potential mechanisms

Variables	Cost			Cleaner technology	
	(1)	(2)	(3)	(4)	(5)
	SO_2 discharge fees	Desulphurisation capacity	The amount of SO_2 elimination	The intensity of SO_2 production	Patent application
	$\ln(1+dis\_fee_{ikjt})$	$\ln(1+Des\_ca_{ikjt})$	$\ln(1+SO_2\_eli_{ikjt})$	$\ln(1+SO_2\_int_{ikjt})$	$ln(1+patent_{ikjt})$
$FD_{it} \times TCZ_k \times IND_j \times T_t$	1.7950*** (8.92)	1.8365*** (9.16)	0.1614** (2.06)	-0.0058 (-0.20)	0.1257 (0.84)
TCZ_k ×Year dummies	Yes	Yes	Yes	Yes	Yes
IND_j ×Year dummies	Yes	Yes	Yes	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes	Yes	Yes	Yes
TCZ controls×Year dummies	Yes	Yes	Yes	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Obs	48650	48650	16103	48650	11157

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. We estimate SO_2 discharge fee according to sewage charge standards and SO_2 emission data. SO_2 discharge fee is collected based on <Interim Measures for the Collection of Sewage Charges (征收排污费暂行办法)> and <Trial Standards for Industrial "Three Waste" Emissions (工业"三废"排放试行标准)> before 2003, and based on <Management of sewage charge collection standards (排污费征收标准管理办法)> since 2003. The calculation of SO_2 discharge fee is shown in Appendix Table A5.

Table 7: **Source country's regulation stringency, technology and TCZ's effect**

variables	(1)	(2)	(4)
$TCZ_k \times IND_j \times T_t \times so\_limit$	-0.0050* (-1.67)		
$TCZ_k \times IND_j \times T_t \times so\_tax$		-0.0115* (-1.93)	
$TCZ_k \times IND_j \times T_t \times tech\_en$			-0.0057*** (-3.00)
TCZ_k ×Year dummies	Yes	Yes	Yes
IND_j ×Year dummies	Yes	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes	Yes
TCZ controls×Year dummies	Yes	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Obs	68422	68422	75729

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. en_string so_limit, $tech\_poli$ and inv_per indicates the environmental policy stringency, the emission limit value of SOx, environmental technology support policies and environmental related inventing patents per capita of FDI source country.

Table 8: **The impact of pollution control on low and high labor productivity firms**

variables	(1) Low productivity	(2) High productivity
$TCZ_{kt} * T_t * IND_{jt}$	0.0533** (2.24)	0.0301 (1.50)
TCZ_k ×Year dummies	Yes	Yes
IND_j ×Year dummies	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes
TCZ controls×Year dummies	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Obs	104264	104312

Notew: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. We use the log of production value per capita to measure labor productivity. And then divide foreign firms into high and low productivity firms by using mean value as thresh.

Table 9: **The impact of pollution control on high and low capital-intensive firms**

variables	(1) Low capital-intensive	(2) High capital intensive
$TCZ_{kt} * T_t * IND_{jt}$	0.0753*** (3.48)	0.0104 (0.50)
TCZ_k ×Year dummies	Yes	Yes
IND_j ×Year dummies	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes
TCZ controls×Year dummies	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Obs	104260	104316

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. We calculate the capital intensity (fixed capital per capita) for each firm and divide them into low and high capital-intensive firms by using mean value as thresh.

***Table 10:* Would rising intermediate input cost caused by TCZ policy drive foreign firms out?**

variables	(1)
$TCZ_{kt} * T_t * Input_{jt}$	0.0493*** (2.93)
TCZ_k ×Year dummies	Yes
IND_j ×Year dummies	Yes
$TCZ_k \times IND_j$	Yes
TCZ controls×Year dummies	Yes
Trade policy controls ×Year dummies	Yes
Year fixed effects	Yes
Firm fixed effects	Yes
Obs	208576

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses.

APPENDIX

Table A1: **List of Two Control cities in English and in Chinese**

Province	City	Province	City
Anhui(安徽)	Chaohu(巢湖)	Guizhou(贵州)	Anshun(安顺)
	Huangshan(黄山)		Guiyang(贵阳)
	Maanshan(马鞍山)		Zunyi(遵义)
	Tongling(铜陵)	Hebei(河北)	Baoding(保定)
	Wuhu(芜湖)		Chengde(承德)
Beijing(北京)	Beijing(北京)		Handan(邯郸)
Chongqing(重庆)	Chongqing(重庆)		Hengshui(衡水)
Fujian(福建)	Fuzhou(福州)		Shijiazhuang(石家庄)
	Longyan(龙岩)		Tangshan(唐山)
	Quanzhou(泉州)		Xingtai(邢台)
	Sanming(三明)		Zhangjiakou(张家口)
	Xiamen(厦门)	Henan(河南)	Anyang(安阳)
	Zhangzhou(漳州)		Jiaozuo(焦作)
Gansu(甘肃)	Baiyin(白银)		Luoyang(洛阳)
	Jinchang(金昌)		Sanmenxia(三门峡)
	Lanzhou(兰州)		Zhengzhou(郑州)
Guangdong(广东)	Chaozhou(潮州)	Hubei(湖北)	Ezhou(鄂州)
	Dongguan(东莞)		Huangshi(黄石)
	Foshan(佛山)		Jingmen(荆门)
	Guangzhou(广州)		Jingzhou(荆州)
	Huizhou(惠州)		Wuhan(武汉)
	Jiangmen(江门)		Xianning(咸宁)
	Jieyang(揭阳)		Yichang(宜昌)
	Qingyuan(清远)	Hunan(湖南)	Changde(常德)
	Shantou(汕头)		Changsha(长沙)
	Shanwei(汕尾)		Chenzhou(郴州)
	Shaoguan(韶关)		Hengyang(衡阳)
	Shenzhen(深圳)		Huaihua(怀化)
	Yunfu(云浮)		Loudi(娄底)
	Zhanjiang(湛江)		XIangtan(湘潭)
	Zhaoqin(肇庆)		Yiyang(益阳)
	Zhuhai(珠海)		Yueyang(岳阳)
Guangxi(广西)	Guilin(桂林)		Zhangjiajie(张家界)
	Guigang(贵港)		Zhuzhou(株洲)
	Hechi(河池)	Jilin(吉林)	Jilin(吉林)
	Hezhou(贺州)		Siping(四平)
	Liuzhou(柳州)		Tonghua(通化)
	Nanning(南宁)	Jiangsu(江苏)	Changzhou(常州)
	Wuzhou(梧州)		Nanjing(南京)

Province	City	Province	City
Jiangsu(江苏)	Nantong(南通)	Shanxi(山西)	Yaiyuan(太原)
	Suzhou(苏州)		Xinzhou(忻州)
	Taizhou(泰州)		Yangquan(阳泉)
	Wuxi(无锡)	Shanxi(陕西)	Tongchuan(铜川)
	Xuzhou(徐州)		Weinan(渭南)
	Yangzhou(扬州)		Xian(西安)
	Zhenjiang(镇江)		Yulin(榆林)
Jiangxi(江西)	Fuzhou(抚州)	Shanghai(上海)	Shanghai(上海)
	Ganzhou(赣州)	Sichuan(四川)	Chengdu(成都)
	Jian(吉安)		Deyang(德阳)
	Jiujiang(九江)		Guangan(广安)
	Nanchang(南昌)		Leshan(乐山)
	Pingxiang(萍乡)		Meishan(眉山)
	Yingtan(鹰潭)		Mianyang(绵阳)
Liaoning(辽宁)	Anshan(鞍山)		Nanchong(南充)
	Benxi(本溪)		Neijiang(内江)
	Dalian(大连)		Panzhihua(攀枝花)
	Fushun(抚顺)		Suining(遂宁)
	Buxin(阜新)		Yibin(宜宾)
	Huludao(葫芦岛)		Zigong(自贡)
	Jinzhou(锦州)		Luzhou(泸州)
	Liaoyang(辽阳)	Tianjin(天津)	Tianjin(天津)
	Shenyang(沈阳)	Xinjiang(新疆)	Wulumuqi(乌鲁木齐)
Neimenggu(内蒙古)	Baotou(包头)	Yunnan(云南)	Kuiming(昆明)
	Chifeng(赤峰)		Qujing(曲靖)
	Huhehaote(呼和浩特)		Yuxi(玉溪)
	Wuhai(乌海)		Zhaotong(昭通)
Shandong(山东)	Dezhou(德州)	Zhejiang(浙江)	Hangzhou(杭州)
	Jinan(济南)		Huzhou(湖州)
	Jining(济宁)		Jiaxing(嘉兴)
	Laiwu(莱芜)		Jinhua(金华)
	Qingdao(青岛)		Ningbo(宁波)
	Taian(泰安)		Shaoxing(绍兴)
	Weifang(潍坊)		Taizhou(台州)
	Yantai(烟台)		Wenzhou(温州)
	Zaozhuang(枣庄)		Quzhou(衢州)
	Zibo(淄博)		Nanchong(南充)
Ningxia(宁夏)	Shizuishan(石嘴山)		
	Yinchuan(银川)		
Shanxi(山西)	Datong(大同)		
	Jinzhong(晋中)		
	Linfen(临汾)		
	Shuozhou(朔州)		

Table A2: **Treated Industries of TCZ policy (in percent)**

Industry Code in ASIE	Industry name	Ratio of SO_2 emission to manufacturing industry total (1998)	Ratio of SO_2 production to manufacturing industry total (1998)
33	Non-ferrous metal smelting and rolling processing industry 有色金属冶炼及压延加工业	14.21	33.62
32	Ferrous metal smelting and rolling processing industry 黑色金属冶炼及压延加工业	10.41	7.35
28	Chemical fiber manufacturing 化学纤维制造业	10.54	7.23
25	Petroleum, coal, and other fuel processing industries 石油、煤炭及其他燃料加工业	6.21	4.85
26	Chemical raw material and chemical product manufacturing industry 化学原料和化学制品制造业	2.80	3.28
31	Non-metallic mineral products industry 非金属矿物制品业	2.64	1.89
29	Rubber products manufacturing industry 橡胶制品业	1.78	1.32
27	Pharmaceutical manufacturing industry 医药制造业	0.74	0.55
30	Plastic products manufacturing industry 塑料制品业	0.39	0.30
34	Metal products manufacturing industry 金属制品业	0.29	0.20
total		50.02	60.58

Note: Those industries are set as treated industries according to the official document named "The Approval of the State Council on issues related to acid rain control area and sulphur dioxide pollution control area". It named several industries as severely SO_2 polluted industries, such as Chemical, metallurgical, building materials, non-ferrous metal industries. The original sentence is "化工、冶金、建材、有色等污染严重的企业，必须建设工艺废气处理设施或采取其他减排措施". We relate those industries with 2-digit industry in ASIE and calculate their SO_2 emission and production ratio in 1998 based on Pollution Database for Chinese Industrial Enterprises.

Table A3: **The SO_2 reduction task for TCZ cities in each province (measured in thousand tons)**

Province	2000	2005	Reduction	Percent
Beijing	215.9	170.0	45.9	21
Tianjin	256.4	205.0	51.4	20
Hebei	803.2	643.0	160.2	20
Shanxi(山西)	737.1	590.0	147.1	20
Neimenggu	358	286.0	72.0	20
Liaoning	550	440.0	110.0	20
Jilin	90	72.0	18.0	20
Shanghai	465	400.0	65.0	14
Jiangsu	1000	800.0	200.0	20
Zhejiang	562.5	450.0	112.5	20
Anhui	143	114.0	29.0	20
Fujian	193.7	155.0	38.7	20
Jiangxi	166	133.0	33.0	20
Shandong	1163	930.0	233.0	20
Henan	463.3	371.0	92.3	20
Hubei	402.1	322.0	80.1	20
Hunan	673	538.0	135.0	20
Guangdong	818.3	655.0	163.3	20
Guangxi	637.5	510.0	127.5	20
Sichuan	993	794.0	199.0	20
Chongqing	692	554.0	138.0	20
Guizhou	849.2	630.0	219.2	26
Yunnan	272.4	218.0	54.4	20
Shanxi(陕西)	234.1	187.0	47.1	20
Gansu	255.8	230.0	25.8	10
Ningxia	77.7	62.0	15.7	20
Xinjiang	91.8	73.0	18.8	20
Total	13164	10532	2632.0	20

***Table A4:* SO_2 related performance between groups**

Variables	Ownership change (Group A)	foreign exiting firms (Group B)	Share reduction more than 30% (Group C)	Continuous foreign firms (Group D)	Difference between group A and B	Difference between group A and C	Difference between group A and D
Intensity of SO_2 emission (kg/thousand yuan)	0.7514	2.2354	1.0111	0.6675	-1.2988**	-0.2597***	0.0838*
Intensity of SO_2 production (kg/thousand yuan)	1.1454	3.3045	1.1825	0.8917	-2.1591*	-0.0371	0.2536**
Amount of desulphurisation facilities (set)	0.2260	0.1730	0.2236	0.2092	0.0530*	0.0024	0.0168
Desulphurisation capacity (kg/hour)	51.5243	8.8518	8.9455	47.9908	-42.6726	42.5788	3.5335

Table A5: **The calculation of SO_2 discharge fee**

Time	Policy	Calculation
Before 2003	Interim Measures for the Collection of Sewage Charges (征收排污费暂行办法) Trial Standards for Industrial "Three Waste" Emissions (工业"三废"排放试行标准)	The allowed discharge amount of SO_2 is 110kg per hour and 963600kg per year. SO_2 emission amount over such standard will be charged 0.04 Yuan per kg. Firms with SO_2 emission lower than 963600kg per year pay 0 discharge fee and pay the discharge fee of (SO_2 emission -963600kg)*0.04 if its emission amount higher than the standard.
Since 2003 and before 2008	Management of sewage charge collection standards (排污费征收标准管理办法)	2003: 0.2 Yuan per SO_2 pollutional equivalent; 2004: 0.4 Yuan per SO_2 pollutional equivalent; 2005 and after: 0.6 Yuan per SO_2 pollutional equivalent. SO_2 pollutional equivalents= $\frac{SO_2\ emission\ (kg)}{equivalent\ value\ of\ SO_2} = \frac{SO_2\ emission\ (kg)}{0.95kg}$. SO_2 discharge fee in 2003= $\frac{SO_2\ emission\ (kg)}{0.95kg} * 0.2$ SO_2 discharge fee in 2004= $\frac{SO_2\ emission\ (kg)}{0.95kg} * 0.4$ SO_2 discharge fee since 2005= $\frac{SO_2\ emission\ (kg)}{0.95kg} * 0.6$

***Table A6:* Using longer time periods**

	(1)	(2)
$TCZ_k \times IND_j \times T_t$	0.0184* (1.82)	0.0144 (1.50)
$TCZ_k \times T_t$		
Sample from 1998-2010	**Yes**	No
Sample from 1998-2014	No	**Yes**
TCZ_k ×Year dummies	Yes	Yes
IND_j ×Year dummies	Yes	Yes
$TCZ_k \times IND_j$	Yes	Yes
TCZ controls×Year dummies	Yes	Yes
Trade policy controls ×Year dummies	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Obs	461797	626214

Notes: *, **, *** denote statistical significance at 10, 5 and 1 percent respectively. Robust standard errors clustered at the firm level are reported in parentheses. ASIE covers industrial firms with product value more than 5 million RMB before 2011, and more than 20 million RMB after 2011. Therefore we look at 1998–2010 and 1998–2014 separately.