R&D, Industrial Policy and Growth

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Abstract

An issue with estimating the impact of industrial support is that the firms that receive support may be politically connected, introducing omitted variable bias. Using Vietnamese data containing several proxies for political connectedness, we find that firms that receive industrial support in the form of tax holidays experience more rapid productivity growth, particularly in R&D-intensive industries, and less-so among politically connected firms. These findings do not appear to be due to the presence of financing constraints. We then develop a second-generation Schumpeterian growth model with many industries, and show that tax holidays disproportionately raise productivity growth in R&D-intensive industries, as in the data, without the need for financing constraints.

Keywords: Industrial subsidies, R&D intensity, productivity growth, Schumpeterian models, tax holidays, political connections.

JEL: D24, L25, L52, O25, O41

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1 Introduction

Industrial policy is common around the world, yet the mechanisms through which industrial support might affect firms are not fully understood. For example, does industrial support encourage growth by stimulating innovation? Does industrial support enable firms to overcome financing constraints? A clouding factor is that industrial support may not be exogenous: politically connected firms may be more likely to receive support, leading to omitted variable bias.

We identify the channels through which industrial support affects economic outcomes by focusing on *industry variation* in the impact of industrial support. It is known since at least Cobb and Douglas (1928) that industries vary in the technology of production: for example, the production of Machinery is more capital-intensive and more R&D-intensive than the production of Textiles. By examining which technological characteristics interact with industrial support, we can narrow down the key channels whereby industrial support affects firm performance. While industrial policy can take various forms e.g. tax subsidies, directed credit and preferential interest rates to technical assistance, investment in human capital, and selective protectionist measures including tariffs and quotas, we mainly explore tax subsidies as the proxy for industrial policy. In the section on robustness checks, we explore tariff as another possible proxy for industrial policy.

We address the problem of omitted variable bias by using a firm-level database from Vietnam. Vietnamese data are particularly useful because they contain a series of proxies we can use to measure the political connectedness of firms.

We find that industrial support, measured using tax holidays as in Aghion et al. (2015), raises firm productivity growth. Tellingly, we find that it particularly raises productivity growth for firms in *R&D-intensive industries*. This suggests that the appropriate class of models for understanding the impact of industrial support on economic growth is the class of R&D-based growth models. This finding is consistent with Ang and Madsen (2011), who find that R&D-based growth models are the class of models most consistent with the growth experience of the East Asian "miracle" economies. Interestingly, we do *not* find that firms in industries that might be expected to suffer from financing constraints experience disproportionate increases in productivity growth in the face of industrial support. This indicates that our results concerning R&D are due to channels that do not involve financing constraints, in spite of the well-documented link between R&D intensity and financing constraints.[1] We also find that industrial support is less beneficial to politically connected firms, underlining the importance of conditioning on connections.

Finally, we develop a general equilibrium R&D-driven growth model with many industries, building on the one-sector framework of Howitt (1999). In the model, we show that industrial support encourages productivity growth particularly among firms that are in R&D-intensive industries, as in the data. This is so even though there are no financing constraints in the model. Instead, it occurs simply because lower taxes increase the returns to successful R&D. We conclude that industrial support mainly encourages growth by increasing the return to R&D, rather than by alleviating financing constraints that might hinder R&D, and that politically connected firms are less likely to benefit from this support.

This paper relates to several bodies of literature, including those on industrial policy, political connections and R&D-based growth models. Aghion et al. (2015) explore industrial policy in China, but do not control for political connectedness nor explore the importance of industry R&D intensity. Acemoglu et al. (2013) develop and calibrate a model in which operational subsidies that target innovation by highly productive firms would improve welfare, however, they lack supporting empirical evidence. Harrison et al. (2019) find that both privatized state owned enterprises (SOEs) and SOEs in China, while still having access to government assistance, still fall behind private firms in terms of productivity. Nevertheless, it is not clear what mechanism underlies this observation.

[1] See Ilyina and Samaniego (2011, 2012). This finding does not imply that financing constraints do not exist, nor that they are not important for growth, just that the main impact of *industrial support* is not to relieve financing constraints.

We follow Williams (2014) in identifying a number of binary indicators to proxy for the unobserved heterogeneity in a model, showing that these binary proxies represent different dimensions of political connections that need to be accounted for in examining the impact of industrial policy on firm productivity – otherwise the model would suffer from a negative omitted variable bias. We use multiple proxy variables, thus improving on studies that have only one such as Khwaja and Mian (2005) or Li et al. (2008). The analysis of multiple industry interactions also allows us to sort between different channels whereby industrial support might impact economic outcomes. Our model shows that an R&D-based growth model that does not suffer from the curse of scale effects can be extended to a heterogeneous multi-industry context to account for our empirical findings without resort to financing constraints.

Section 2 provides an overview of related literature regarding industrial policy. Section 3 describes the sources of data, and section 4 provides details on our empirical strategy. Section 5 reports empirical results, and section 6 reports robustness checks. Sections 7 describes the model economy, and section 8 describes its equilibrium. Section 9 concludes. The estimation strategy and results for total factor productivity are presented in Appendix A. Proofs for our model economy are shown in Appendix B. The experience of industrial policy in East Asia as well as the recent history of the implementation of industrial policy in Vietnam with a particular focus on the incentives targeting the small and medium firms are respectively discussed in Appendices C and D.

2 Related Literature

In the extensive literature on industrial policy partly inspired by the success of the East Asian miracle economies, most studies pursue one of two approaches. A first approach, qualitative in nature, offers a historical lens into the stages of development of these successful economies and draws on such experience to generate policy framework that would explain their achievements. A second approach employs quantitative tools with theoretical models and/or relevant data analysis to explore the economic impact of certain policies.

Early studies on industrial policy, which include, *inter alia*, Wade (1990), Amsden (1992), Chang (2002), and Lin (2003), largely followed the first approach as their authors' main purpose was to provide a historical perspective on the development experiences of Japan, South Korea, Singapore, Taiwan and Hong Kong, putting them into a comparative framework of analysis with those of more developed economies. These studies argue that industrial policy prescriptions, or strategic government interventions against market signals, are key to the rapid growth of these economies, and reject the propositions made by the more mainstream school of thought that these economies succeeded mainly because they promoted deregulation, privatization, and international trade and investment (World Bank 1993).

More recent work on industrial policy employs quantitative econometric and/or macroeconomic modeling tools to examining linkages between industrial policy and economic development. For example, Aghion et al. (2015) explore industrial policy in the context of the Chinese economy among large and medium enterprises between 1998 and 2007. Using the Lerner Index as a measure of competition and the dispersion of industrial policies including tax holidays, loans and tariffs, they show that industrial policies targeted at competitive sectors or at promoting competition in a sector improve productivity growth. They argue that these industries benefit from support because competitive pressure motivates firms to innovate in order to differentiate horizontally, which in turn fosters productivity growth. This contrasts with the consensus regarding industrial policy in more developed economies, which is generally viewed as having reduced productivity by propping up failing firms – see Leonard and Audenrode (1993) and Samaniego (2006).

Meanwhile, Acemoglu et al. (2013) use U.S. Census micro data to estimate the parameters of a model of firm-level innovation, productivity growth and reallocation with endogenous entry and exit. They show that industrial policy subsidizing the operations of existing firms that are of "low type" in terms of innovative capacity would negatively affect growth and aggregate welfare. Their policy experiment of a subsidy of 5 percent of GDP for incumbent firms' operations leads to a reduction of welfare by about 1.5 percent because it deters entry by new "high-type" firms. Meanwhile, a reduction of subsidies to low-type firms coupled with an increase in financial support to R&D activities of high-type firms would encourage the entry of more productive firms and the exit of low type firms. Their paper places a strong emphasis on innovation and recommends the type of industrial policy that focuses on subsidizing R&D by highly productive firms. This argument is echoed by Boeing et al. (2016) who find that R&D spending has a positive effect on the productivity of publicly listed Chinese firms in the 2001-2011 period.

Also using a panel data set of Chinese firms, Harrison et al. (2019) finds that while private firms that used to be state owned enterprises (SOEs) still have access to government assistance vis-a-vis private firms, both those so-called privatized SOEs and SOEs fall behind in their performance in terms of profitability compared to the private firms. These results suggest that industrial support may be endogenous: firms that have ties with the government tend to get more state support, and these firms may be less productive or have other characteristics related to outcome variables. This indicates the importance of conditioning on political connectedness when estimating the impact of industrial support.

Akcigit et al. (2017) presents further evidence that businesses with political connections tend to perform worse than average. Investigating the linkages between innovation and political connections, Akcigit et al. (2017) develop a firm dynamics model in which firms face a tradeoff between investing in innovation and strengthening their political connections by "hiring" a politician in order to overcome administrative and legislative burdens. Using Italian data from 1993 to 2014, they find that firm-level political connections are ubiquitous especially among large enterprises. However, the industries with more politically connected firms are found to have weaker firm performance: political connections are associated with higher survival rates and employment growth, but not with productivity growth. They also find that the firms that lead the market are much more likely to invest in political connections and less likely to innovate.

Additionally, some studies have uncovered evidence that firms with political connections enjoy better access to financing. For example, Rand et al. (2017) find in Vietnamese small and medium enterprise data that political connectedness, proxied by Communist party membership of the owner or manager of each firm, decreases the likelihood of firms being credit-constrained by four percentage points. Also using Communist party membership to measure connectedness, Li et al. (2008) find that political connections improve Chinese firms' access to loans from banks and other state institutions, and that private firms with political connections perform better after controlling for human capital and other variables. Their paper concludes that political connections have a positive impact on firm performance in countries with weaker market institutions and legal frameworks. Meanwhile, Khwaja and Mian (2005) define political connectedness as the participation of a firm's director in an election. Using loan data from over 90,000 Pakistani firms from 1996 to 2002, the authors investigate rent-seeking activities among politically connected firms through firm fixed-effects and variations for the same firm across lenders over time, finding that politically connected firms borrow 45 percent more and have 50 percent higher default rates.However, as pointed out in Rajan and Zingales (1998), observing that a firm draws on external finance does not tell the observer whether this occurred because the firm obtained more financing because credit constraints were relieved, or whether they obtained more financing because they were more productive for some other reason and this increased their demand for financing.

Our strategy to measuring the impact of political connections is to draw on the extensive literature that studies the impact of industry variation in the technology of production. For example, Rajan and Zingales (1998) define external finance dependence (EFD) as the tendency of an industry to rely on external funds, and use it to study the impact of financial development on industry growth, finding that financial development encourages growth in high-EFD industries. Ilyina and Samaniego (2011) find a link between EFD and R&D intensity. Braun and Larrain (2005) study whether industries where firms have a greater tendency to use intangible assets are more sensitive to the business cycle, as a way of detecting whether changes in financing conditions are an important channel of the business cycle. We will instead exploit industry variation in the technology of production to identify the channels through which industrial support affects firm performance. For example, if we find that industrial support disproportionately increases productivity growth in high-EFD industries or low-tangibility industries, we might conclude that industrial support works by relieving credit constraints. Given that the literature indicates that politically connected firms are not the same as a typical firm, we also require data that contain proxies for political connections.

Political support measures tend to be single binary proxy variables. Harrison et al. (2019) measure connections based on whether or not a firm was once a SOE. Others such as Li et al. (2008) use Communist party membership, and Wu et al. (2012) define political connectedness according to whether or not a firm's manager or chairman currently serving or having previously served in the government or the military, which is another single binary proxy variable. In this paper, however, we will measure political connectedness using multiple binary proxy variables. This way, unlike the related literature, we do not rely on one particular proxy being or not being a suitable proxy.

We now turn to a description of the data.

3 Data Description

This paper relies mainly on two sources of data: (i) data from six rounds of the bi-annual survey conducted by the Institute of Labor Science and Social Affairs on Vietnamese small and medium enterprises or SMEs (henceforth SME survey) in the manufacturing sector between 2005 and 2015, and (ii) data from the Compustat database of financial, statistical and market information on active and inactive companies in the United States. While the SME survey provides firm-level data on industrial support, productivity growth and political connections, the Compustat database gives access to the calculations of technological variables that proxy for R&D intensity and financing constraint at the industry level in exploring possible mechanisms underlying industrial support's impact on productivity growth.

The SME survey follows the World Bank's definitions of micro, small and medium enterprises: micro enterprises employ up to 10 workers, small enterprises up to 50 workers and medium enterprises up to 300 employees. The sampling strategy is consistent across all rounds of survey including 2,500 and 2,800 enterprises and re-interviewing surviving firms every survey year. This survey focuses on non-state enterprises, including private and cooperative companies, limited liability companies, joint stock companies without capital from the state, and household enterprises which are defined as a privately owned economic organization not registered and operational under the Enterprise Law (Central Institute for Economic Management 2015).

The population of non-state manufacturing enterprises is drawn from a representative sample of the Establishment Census from 2002 and the Industrial Survey 2004-2006 conducted by the General Statistics Office (GSO) of Vietnam. The survey is conducted in selected districts in 10 provinces or central cities including Hanoi, Ho Chi Minh City, Hai Phong, Long An, Ha Tay, Quang Nam, Phu Tho, Nghe An, Khanh Hoa and Lam Dong, and uses stratified sample by type of ownership to make sure all types of ownership are represented. Informal firms are defined as those that do not have a Business Registration License or tax code and are not registered with district authorities according to Central Institute for Economic Management (2015).

Descriptively, Table 1 shows number of firms in the survey by province and year while Table 2 shows the distribution of firms by number of workers and type of ownership. Since each round of survey obtains data on the previous year, the reported years are those to which survey data correspond.

Table 1: **Distribution of Firms by Province and Year**

Province	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**
Ha Noi	310	296	299	291	284	297
Phu Tho	283	255	271	254	261	255
Ha Tay	400	394	383	349	347	372
Hai Phong	217	206	227	220	203	223
Nghe An	394	359	370	353	358	343
Quang Nam	176	173	167	166	167	171
Khanh Hoa	102	92	97	99	91	99
Lam Dong	94	89	74	82	85	90
HCMC	701	630	635	591	632	658
Long An	143	138	133	126	136	133
Total	**2,820**	**2,632**	**2,656**	**2,531**	**2,564**	**2,641**

Table 2: **Distribution of Firm Observations by Number of Employees and Type of Ownership (unbalanced panel)**

	Number of Employees				
Type of ownership	**1-50**	**51-100**	**101-200**	**201-300**	**>300**
Household enterprise	10,305	35	3	3	0
Private enterprise	1,153	74	34	13	11
Partnership	36	6	0	0	1
Cooperative	369	43	17	4	3
Private limited company	2,456	390	235	55	20
Joint stock company with state capital	13	7	8	6	5
Joint stock company without state capital	368	79	65	9	9
Joint venture with foreign capital	0	2	0	0	0
Local state enterprise	3	0	1	0	2
Total	**14,703**	**636**	**363**	**90**	**51**

As shown in Table 2, about 70% of the firm observations in this data set are small household enterprises, which reflects the situation of the Vietnamese economy where the majority of small and medium businesses are micro enterprises. At the same time, small and medium businesses are considered the central momentum of economic development for the Vietnamese economy: in 2013, non-state enterprises employed almost 60% of the country's total workforce (Central Institute for Economic Management 2015). As such, it is important to understand the structure and characteristics of this SME sector in order to identify the best policy options to encourage productivity growth for a developing economy such as Vietnam.

It is also worth noting that the industries represented in this data set are not limited to the manufacturing sector: they also include agriculture/primary production and services because there was a lot of sector switching among firms over time in the sample, which is common for SMEs in a transition economy such as Vietnam.

The dataset is winsorized at the 1% and 99% levels to minimize the possibility that outliers might distort the results of our analyses.

Table 3 provides descriptive statistics on some key variables in this paper.

Table 3: **Descriptive Statistics**

Variable	Mean	Std. Dev.
Labor (number of employees)	17.75	50.3
Gross output (million VND)	1048.4	2669.7
Value added (million VND)	269.9	620.5
Fixed assets (million VND)	1396.15	4264.45
Material cost (million VND)	74.5	243.8
TFP growth (Olley-Pakes) (%)	3.09	0.8
Tax rate	0.06	0.12
Indicator of state ownership status	0.002	
Indicator of export status	0.062	

Notes: Labor measures the total number of employees working for an enterprise. The measurement of total factor productivity (TFP) growth follows Olley-Pakes method and is described in Appendix A. Mean and standard deviation are reported for all non-binary variables.

4 Empirical Strategy

We employ fixed effects panel regressions to explore (i) the relationship between political connectedness and industrial policy and (ii) the impact of industrial support in the form of tax holiday on firm performance, controlling for political connections. Then, we examine possible mechanisms underlying that impact including (i) the channel of R&D intensity and (ii) the easing of financing constraint.

4.1 Impact of Political Connections on the Allocation of Industrial Support

According to Khwaja and Mian (2005) and Rand et al. (2017), firms with political connections can borrow more and thus are less likely to be financially constrained, which gives rise to the likelihood that political connections help these firms gain access to government's resources as it is a common observation in developing countries.

We first explore the relationship between political connectedness and government support. Affirmative results would highlight the magnitude of controlling for political connectedness in understanding the impact of industrial policy on productivity growth.

To this purpose, we estimate the following equation:

$$Taxholiday_{ijt} = \theta_1 Z_{ijt} + \theta_2 S_{jt} + \beta Pc_{ijt} + f_i + D_t + \varepsilon_{ijt} \tag{1}$$

where $Taxholiday_{ijt}$ measures the amount of tax holiday firm i in industry j enjoys each year. Pc_{ijt} measures the level of political connectedness of each firm in a given year, f_i is firm fixed effects and D_t is time fixed effects. Z is a vector of firm-level control variables including state ownership indicator, export status and firm size (total number of workers) and S is a vector of industry-level control variables including number of firms and the level of intra-industry competition measured by the Lerner Index.

We expect a positive and statistically significant coefficient on Pc_{ijt} i.e. β which means that the more politically connected a firm is, the more tax holiday it receives, controlling for firm heterogeneity and time-variant factors.

The level of political connectedness is represented by seven dummy variables already available in the dataset thanks to the innovative contents of the questionnaire which is targeted at understanding firms' social networks and technological capacity. For each of these variables, the value of 1 represents political connectedness and 0 represents the lack thereof. These seven binary proxies are listed and defined in Table 4

The inclusion of these seven binary proxies for political connectedness is a major innovation of this paper since the literature in political connections has traditionally used only one variable to represent political connectedness. In previous studies, for example Li et al. (2008), a typical proxy for political connectedness is political party membership of the firm's

Table 4: **Binary Variables Representing Political Connectedness**

Variable name	Definition
Pc 1	Assistance at startup received from local authorities
Pc 2	Previous work status: whether manager was an employee of an SOE
Pc 3	Political Party Membership: whether manager was a Party member
Pc 4	Sales structure: % of goods sold to SOEs or local authorities of 30% or higher
Pc 5	% of procurement: % of goods procured from SOEs of 30 percent or higher
Pc 6	Selection of SOEs as suppliers or under direction by local authorities
Pc 7	Obtainment of services from SOEs

owner or manager. In Akcigit et al. (2017)'s study on firms' political connections in Italy, political connectedness is represented by firms' hiring of politicians. In Khwaja and Mian (2005), political connection is defined as the participation of a firm's director in political election.

Here, the political party membership of the firm's director or manager is represented by the third binary variable of political connection (*Pc 3*). In addition, the other six binary variables show other aspects of political connectedness, for example whether the firm received and assistance from local authorities at its early stage (*Pc 1*), or whether the firm is directed by local authorities to select state-owned enterprises (SOEs) as its suppliers (*Pc 6*). The fourth and fifth variables (*Pc 4* and *Pc 5*), which represent a firm's structure of sales and procurement (percentage of goods sold to or procured from government-related entities), were converted into binary variables from the original continuous format in order to facilitate the interpretation of the results in the regression.

This paper follows Williams (2014) in the recognition of the multi-dimensionality of political connectedness as represented by these seven variables. This assertion on the multi-dimensional nature of political connectedness is supported by the low values of correlations between these seven binary proxies as shown in Table 5, which tells us that these variables represent very distinctive dimensions of political connectedness.

In the regression model, political connectedness is constructed in two ways: (i) as a vector of all seven of its dimensions i.e. we include all seven binary variables in the regression, and

(ii) collapsed into a sum of the seven dimensions for each firm in each year. The sum variable represents each firm's degree of political connected in an aggregate sense, and would thus be meaningful for the assessment of how political connection interacts with the allocation of tax subsidies.

Table 5: **Correlations between binary proxies for political connectedness**

	Pc 1	Pc 2	Pc 3	Pc 4	Pc 5	Pc 6	Pc 7
Pc 1	1						
Pc 2	0.0081	1					
Pc 3	0.0317	0.2469	1				
Pc 4	0.0403	0.0738	0.0484	1			
Pc 5	0.0254	0.0533	0.0236	0.1134	1		
Pc 6	-0.0108	-0.0024	0.0065	0.0082	0.034	1	
Pc 7	0.0942	-0.0523	0.0264	0.0279	-0.0183	0.0219	1

Among the industry-level control variables, the Lerner Index represents the magnitude of importance of markups, defined as the difference between price and marginal cost with respect to the firm's total value added. We follow Aghion et al. (2015) in first aggregating operating profits, capital costs and sales at the industry level then calculating the Lerner index as the ratio of operating profits less capital costs to sales. The value of Lerner index should vary between 0 and 1 with 0 reflecting perfect competition in which there should be no excess profits above capital costs. Therefore, the variable representing the degree of competition is defined as $(1 - Lerner\_Index)$ so that a greater value of this variable represents a greater level of competitiveness. The level of intra-industry competition has been argued in Aghion et al. (2015) as an important variable to control for in exploring the impact of industrial policy on firm performance, which justifies the inclusion of this variable in our regression model.

Regarding tax holiday, we follow Aghion et al. (2015) in defining a firm as a recipient of tax holiday in a year if that firm paid either less than the statutory income tax rate. The amount of tax holiday for each firm is calculated as the difference between the amount of tax firm would have to pay given the statutory tax rates and the amount of tax they actually paid. For example, if the statutory income tax rate is 25% while a firm actually paid 20%, the tax holiday that firm enjoyed would be calculated by multiplying that firm's operating profits by 5%. According to PricewaterhouseCoopers (2017), corporate income tax rate in Vietnam was 25% until 2014.

Table 6 shows the amount of tax holiday that Vietnamese SMEs enjoyed from 2005 to 2015. The first row of the table shows the number of firms which did not enjoy any tax incentive each year i.e. value of 0 for tax holiday.

Table 6: **Vietnamese SMEs' tax holidays between 2005 and 2015 (Unit: Million VND)**

Amount of tax holiday	Year						
(million VND)	2004	2006	2008	2010	2012	2014	Total
0	256	75	93	109	2,536	206	3,275
>0 to 10	1,736	1,474	1,477	1,334	28	1,512	7,561
10 to 50	534	748	684	706	0	631	3,303
50 to 100	126	147	173	171	0	131	748
100 to 300	122	121	154	143	0	93	633
>300	46	67	75	68	0	68	324
Total	2,820	2,632	2,656	2,531	2,564	2,641	15,844

As shown in Table 6, the number of firms that did not receive any tax holiday declined from 2004 to 2008 and then slightly increased in 2010 before reaching an unusually high number in 2012 and going back to similar level with pre-2012 period in 2014. A possible reason why there are as many as 2,536 firms that did not enjoy any tax benefit in 2012 is that out of 2,564 firms in the winsorized sample, 2,435 firms reported making zero gross profit for that year. This shows that the SME sector of Vietnam was struggling after the global financial crisis and in particular in the years of 2011 and 2012 - consistent with the information that 49,000 SMEs closed down in 2011.[2] Even if we consider year 2012 as an outlier, in the robustness checks section we show that the pattern of our results is robust to the exclusion of year 2012 from the dataset.

Moreover, since the distribution of tax holiday is quite skewed in the data, I use the natural log tax holiday (denoted Lntax)$insteadofitsabsolutevalueinordertoavoidhavingoutliersdriveourresults.T$

4.2 Impact of Industrial Support on Firm Productivity Growth

Next, we explore the effects of industrial policy in the form of tax holidays on firm-level productivity. Our hypothesis is built on the results from Akcigit et al. (2017) that industries with politically connected firms feature worse firm dynamics. We expect that firms with political connections are less productive than other firms, and that the former would use tax benefits less productively than firms that are not politically connected. To this purpose, our regression includes the log of TFP as the dependent variable instead of tax holiday, and the log of tax holiday now as one of the explanatory variables:

$$lnTFP_{ijt} = \theta_1 Z_{ijt} + +\theta_2 S_{jt} + \beta_1 Lntax_{ijt} + \beta_2 Tech_{ijt} + f_i + D_t + \varepsilon_{ijt} \tag{2}$$

$$lnTFP_{ijt} = \theta_1 Z_{ijt} + +\theta_2 S_{jt} + \beta_1 Lntax_{ijt} + \beta_2 Tech_{ijt} + \delta_1 P_{ijt} + \delta_2 P_{ijt} * Lntax_{ijt} + f_i + D_t + \varepsilon_{ijt} \tag{3}$$

where $Lntax_{ijt}$ is the log of tax holiday, $lnTFP_{ijt}$ is the log of TFP of firm i in industry j at time t, $Tech_{ijt}$ is a dummy variable representing whether the firm received technical assistance from government at each time, P_{ijt} is the vector of political connection indicator variables at the firm level including seven different binary variables drawn from the SME survey's questionnaire. Similarly to Equation 1, Z is a vector of firm-level control and S is a vector of industry-level control variables, f_i is firm fixed effects and D_t is time fixed effects. The definition and measurement of TFP follows Olley-Pakes method and is detailed in Appendix A.

[2] http://vietnamnet.vn/vn/ban-doc/49000-doanh-nghiep-pha-san-moi-truong-kinh-doanh-gap-kho-43982.html

We predict a positive relationship between the log of tax holiday and the log of TFP, as shown in this graph of simple correlation with a simple linear trend line as in Figure 1 below:

Figure 1: **TFP and Tax Holiday**

Equation 2 shows, through the coefficient on $Lntax_{ijt}$, the impact of percentage change in tax holiday on average firm-level productivity growth without accounting for political connections. Equation 3 features the political connection indicator variables and their interaction terms with tax holiday in addition to the existing explanatory variables already specified in Equation 2. As such, the coefficient on $Lntax_{ijt}$ in Equation 3 shows the impact of tax holidays on the performance of firms that are not politically connected.

As mentioned above, we use the log of tax holiday instead of the amount of tax holiday because the distribution of tax holiday is quite skewed as shown in the kdensity graph in Figure 2 in Appendix E, as such, the outliers might be driving the results. $Lntax_{ijt}$ is also a better variable to use for interpretation of its relationship with TFP since it shows the percentage change in the amount of tax holiday and not just the absolute amount itself.

4.3 Underlying Mechanism of Industrial Policy

Finally, we explore the potential mechanisms under which tax holidays would help boost firm performance. We focus on two mechanisms as identified in the literature: (i) the level of R&D intensity and (ii) the level of financing constraint, proxied by four technological variables. In the robustness checks section, we test an additional mechanism identified in Aghion et al. (2015) that is focused on competition: tax holidays that are targeted at more competitive industries tend to generate more productivity growth. As such, we re-run the regression of Equation 3 with additional interaction terms between log of tax holiday and the variables representing such characteristics. The specification is as follows:

$$lnTFP_{ijt} = \theta Z_{ijt} + \beta_1 Lntax_{ijt} + \beta_2 Tech_{ijt} + \delta_1 P_{ijt} + \delta_2 P_{ijt} * Lntax_{ijt} + X_{jt} + X_{jt} * Lntax_{ijt} + f_i + D_t + \varepsilon_{ijt} \quad (4)$$

where X_{jt} is the variable representing either R&D intensity or financing constraint while other variables are as already defined in the previous specifications. In the literature, several technological characteristics have been identified as proxies for financing constraint, including the level of depreciation, external finance dependence, asset fixity and investment lumpiness.

The measures for asset fixity (FIX_{jt}), capital depreciation rate (DEP_{jt}) and R&D intensity (RND_{jt}) follow Samaniego and Sun (2015). Investment lumpiness (LMP_{jt}) is defined as in Ilyina and Samaniego (2011) as the "average number of investment spikes experienced by Compustat firms in a given industry" over a given period of time, in this case over every five year period. External finance dependence is as defined in Rajan and Zingales (1998): "the amount of desired investment that cannot be financed through internal cash flows generated by the same business" The formula to measure each variable is defined as follows:

(i) Asset fixity is the ratio of fixed assets to total assets.

(ii) Depreciation is measured as ratio of the value of depreciation to the value of property, plant and equipment..

(iii) R&D intensity is measured as R&D expenditures over total capital expenditures.

(iv) Investment lumpiness is defined as the average number of investment spikes experienced by firms in each industry while an investment spike is defined as an annual capital expenditure exceeding 30% of the firm's fixed assets stock. LMP_{jt} is thus a dummy variable that takes on the value of 1 if the ratio of annual capital expenditure to fixed assets is equal to or greater than 0.3. We take the average across all firms for each industry to represent the technological characteristic of investment lumpiness for the industry in a certain year.

(v) A firm's dependence on external finance is defined as capital expenditures minus cash flows from operations divided by capital expenditures. Cash flow from operations is calculated as the sum of cash flow from operations plus decreases in inventories, decreases in receivables, and increases in payables (Rajan and Zingales 1998).

While external finance dependence clearly represents the extent to which a firm might be constrained financially, asset fixity, depreciation and investment lumpiness are also indicators of financial constraint. Specifically, according to Hart and Moore (1994), non-fixed assets are intangible and consequently less transferrable, rendering the firm more vulnerable to financing constraint. Faster depreciation rate of capital would also give its users less flexibility especially in using the capital as collateral on their loans. Finally, Samaniego (2010) proposes that investment lumpiness may also suggest that a substantial portion of a firm's capital cannot be transferred without losing value, associating this technological characteristic to the value of specificity of capital and thus susceptibility to financing constraint.

All five technological variables are measured at the industry level using Compustat database for firms in the United States. The years of the data taken from the Compustat database match the years of the survey in the Vietnamese SME dataset, namely every two years from 2004 to 2014. Each technological variable is calculated at the industry level by aggregating the value of each component over the time period for each firm, then take the respective ratio for each firm, and take either the mean (for investment lumpiness, since this is a dummy variable) or median (for the other four variables in order to eliminate the impact of outliers) of each industry.

Since the Compustat database uses the North American Industry Classification System (NAICS) to map firms into industries while the Vietnamese SME database follows the International Standard Industrial Classification of All Economic Economic Activities (ISIC) and the Vietnam Standard Industrial Classification 2007 (which is constructed based on ISIC Revision 4), we matched the industry codes across these different coding systems (at three-digit level) and merged the industry-level technological variables into the SME dataset. The use of Compustat data for the United States is based on the assumption that the United States economy is frictionless and thus can be used as a benchmark for measuring industry-level characteristics exogenous to the various frictions and changes in conditions of the Vietnamese economy in the last decades. Our results indicate that only R&D intensity explains the relationship between tax holidays and firm productivity.

The figures for five technological characteristics across different industries in the Compustat database are presented in Table 7.

Table 7: **Measurements of Technological Characteristics**

NAICS	Industry	FIX	EFD	DEP	LMP	RND
311	Food	0.292	-0.199	0.129	0.047	0
312	Beverage and Tobacco	0.245	-0.621	0.143	0.032	0
313	Textiles	0.367	-0.203	0.138	0.091	0.004
315	Apparel	0.133	-0.932	0.234	0.034	0
316	Leather and Allied Product	0.11	-0.825	0.24	0	0
321	Wood	0.448	-0.227	0.098	0	0
322	Paper	0.464	-0.327	0.112	0	0
323	Printing and Related	0.234	-0.96	0.227	0	0
324	Petroleum and Coal Product	0.497	-0.194	0.086	0.021	0
325	Chemical	0.067	1.813	0.282	0.029	0.363
326	Plastics and Rubber Products	0.298	0.077	0.157	0.029	0.004
327	Nonmetallic Mineral Product	0.387	0.171	0.114	0.079	0
331	Primary Metal	0.345	0.321	0.11	0.008	0
332	Fabricated Metal Product	0.232	-0.313	0.161	0.047	0.003
333	Machinery	0.137	0.702	0.212	0.026	0.024
334	Computer and Electronic Product	0.088	0.972	0.368	0.022	0.121
335	Electrical Equipment	0.16	1.343	0.204	0.028	0.026
336	Transportation Equipment	0.194	0.401	0.188	0.046	0.017
337	Furniture and Related Product	0.261	-0.246	0.163	0	0
339	Miscellaneous Manufacturing	0.101	1.432	0.318	0.016	0.061

Notes: FIX (asset fixity), EFD (external finance dependence), DEP (depreciation), LMP (investment lumpiness), and RND (R&D intensity) are either the mean (for LMP) or median (for the others) value of all firms in an industry. The value of each variable for each firm by taking the respective ratio of its components which are aggregated over the period from 2004 to 2014 of Compustat data, matching the years of the Vietnamese SME survey. Industry codes follow the North American Industry Classification System.

Given our objective to identify the impact of government support on firm level performance, we restrict the sample to formal firms only because informal firms are not officially registered with the authorities and would thus be ineligible for formal government support policy. We define a firm as formal if the firm has either a tax code or a business registration license or an enterprise code number.

5 Findings

5.1 Impact of Political Connections on the Allocation of Industrial Support

The first regressions of tax holiday allocation over binary proxies of political connectedness show a positive and significant relationship between political connections and tax subsidies. Table 8 shows the results with political connectedness being represented by the sum of all political dummies while Table 9 shows the results of the regression using all binary proxies of political connections. While the coefficient on the sum of the binary variables is significant and positive, the coefficients on *Pc 4* and *Pc 7* in Table 9 are significant and positive, suggesting that there are at least two dimensions of political connectedness that generate the differentials in tax holiday distribution across firms.

Table 8: **Effects of Political Connectedness (one proxy) on Tax Holiday Allocations**

	(1)
	Log of Tax Holiday
Total of All Political Binary Variables	0.0692***
	(0.0196)
SOE Indicator	0.0451
	(0.210)
Industry Competition Level	-1.194***
	(0.401)
Industry Size (Number of Firms)	0.00108
	(0.00130)
Firm Fixed Effects	Yes
Year Dummies	Yes
Number of observations	9260
R^2	0.0790

Robust standard errors in parentheses, clustered at the industry level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: **Effects of Political Connections (seven proxies) on Tax Holiday Allocations**

	(1)
	Log of Tax Holiday
Pc 1	0.0956
	(0.0611)
Pc 2	0.0459
	(0.0399)
Pc 3	0.0411
	(0.0738)
Pc 4	0.104*
	(0.0541)
Pc 5	0.0497
	(0.0444)
Pc 6	0.610
	(0.431)
Pc 7	0.0963*
	(0.0517)
SOE Indicator	0.0391
	(0.204)
Industry Competition Level	-1.199***
	(0.401)
Industry Size (Number of Firms)	0.00110
	(0.00130)
Firm Fixed Effects	Yes
Year Dummies	Yes
Number of observations	9260
R^2	0.0796

Robust standard errors in parentheses, clustered at the industry level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.2 Impact of Industrial Policy and Underlying Mechanism

Table 10 below shows the results of the fixed effects panel regressions for each of the three model specifications. Model specification (1) controls for firm-level variables without controlling for political connectedness. Model specification (2) provides an extension to model specification (1) with seven binary proxies representing various dimensions of political connectedness and the interaction terms between the political connection binary proxies and tax holiday variable (the *intax* variables). Model specification (3) tests the underlying mechanism by adding each of the five technological measures at the industry level and its interaction term with the tax holiday variable.

Table 10: **Effects of Tax Holiday on Firm Productivity**

	(1) TFP_OP	(2) TFP_OP
Log of Tax Holiday	0.244***	0.267***
	(0.0144)	(0.0160)
Technical Assistance (Dummy)	-0.0612	-0.0585
	(0.0612)	(0.0594)
SOE indicator	0.171	0.185
	(0.219)	(0.235)
Industry Size (Number of Firms)	0.000499	0.000456
	(0.000637)	(0.000642)
Industry Competition Level	0.142	0.157
	(0.238)	(0.240)
Pc 1		-0.0614
		(0.0829)
Pc 2		0.0597
		(0.0519)
Pc 3		-0.105
		(0.0760)
Pc 4		0.0713
		(0.0766)
Pc 5		0.0554
		(0.0782)
Pc 6		-0.871
		(0.621)
Pc 7		0.0499
		(0.0472)
Interaction Term Pc 1 & Log of Tax Holiday		0.0556**
		(0.0279)
Interaction Term Pc 2 & Log of Tax Holiday		-0.0299*
		(0.0173)
Interaction Term Pc 3 & Log of Tax Holiday		-0.00418
		(0.0234)
Interaction Term Pc 4 & Log of Tax Holiday		-0.0180
		(0.0238)
Interaction Term Pc 5 & Log of Tax Holiday		-0.0410
		(0.0250)
Interaction Term Pc 6 & Log of Tax Holiday		0.234
		(0.227)
Interaction Term Pc 7 & Log of Tax Holiday		-0.0150
		(0.0130)
Number of observations	8583	8513
R^2	0.162	0.167

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be seen from the results that tax benefits lead to an increase in firm-level productivity as the coefficients on the log of tax holiday are positive and significant in all three model specifications. The coefficient of the log of tax holiday which is 0.244 in model specification (1) results means that an increase in tax holiday by 1% would be associated with an increase of 0.244% in firm-level TFP. This coefficient of the log of tax holiday increases to 0.267 in the results on model specification (2), showing that when political connectedness is controlled for, tax holiday has a greater effect on firm productivity, serving as the evidence that the model would suffer from a negative omitted variable bias otherwise, and that firms without political connections would be more productive with tax holiday than firms that are politically connected.

The positive and significant value of the coefficient of the interaction term between R&D intensity and tax holiday in Table 11 on mechanism testing suggests that industries that are more R&D intensive would be more productive with tax subsidies from the government. Lack of significant results on the other technological variables representing financing constraint indicate that relieving financing constraint is not the way industrial policy takes effect in terms of improving firm-level productivity. Government's technical assistance to firm does not seem to have a significant impact on firm's performance either.

Table 11: **Mechanism Testing with Five Technological Characteristics**

	(1) TFP_OP	(2) TFP_OP	(3) TFP_OP	(4) TFP_OP	(5) TFP_OP
Log of Tax Holiday	0.265***	0.272***	0.251***	0.265***	0.271***
	(0.0161)	(0.0154)	(0.0383)	(0.0205)	(0.0351)
RND	-0.362				
	(0.388)				
Interaction Term RND & Log of Tax Holiday	0.274**				
	(0.137)				
Technical Assistance (Dummy)	-0.0606	-0.0596	-0.0579	-0.0585	-0.0585
	(0.0593)	(0.0595)	(0.0594)	(0.0594)	(0.0594)
SOE Indicator	0.198	0.187	0.183	0.183	0.184
	(0.239)	(0.236)	(0.234)	(0.235)	(0.235)
Industry Size (Number of Firms)	0.000539	0.000510	0.000460	0.000492	0.000457
	(0.000647)	(0.000645)	(0.000654)	(0.000640)	(0.000660)
Industry Competition Level	0.152	0.146	0.159	0.169	0.158
	(0.240)	(0.239)	(0.241)	(0.241)	(0.241)
Pc 1	-0.0629	-0.0638	-0.0596	-0.0605	-0.0613
	(0.0828)	(0.0828)	(0.0831)	(0.0829)	(0.0830)
Pc 2	0.0607	0.0615	0.0600	0.0607	0.0597
	(0.0519)	(0.0517)	(0.0518)	(0.0519)	(0.0519)
Pc 3	-0.102	-0.105	-0.105	-0.106	-0.105
	(0.0758)	(0.0762)	(0.0762)	(0.0762)	(0.0762)
Pc 4	0.0776	0.0813	0.0709	0.0685	0.0708
	(0.0763)	(0.0764)	(0.0774)	(0.0761)	(0.0771)
Pc 5	0.0543	0.0561	0.0555	0.0556	0.0557
	(0.0781)	(0.0777)	(0.0778)	(0.0783)	(0.0781)
Pc 6	-0.878	-0.846	-0.863	-0.883	-0.869
	(0.622)	(0.620)	(0.622)	(0.630)	(0.621)
Pc 7	0.0494	0.0483	0.0482	0.0500	0.0495
	(0.0472)	(0.0470)	(0.0471)	(0.0472)	(0.0471)
Interaction Term Pc 1 & Log of Tax Holiday	0.0562**	0.0569**	0.0552**	0.0558**	0.0556**
	(0.0279)	(0.0280)	(0.0280)	(0.0279)	(0.0279)
Interaction Term Pc 2 & Log of Tax Holiday	-0.0306*	-0.0309*	-0.0301*	-0.0302*	-0.0299*
	(0.0172)	(0.0172)	(0.0172)	(0.0172)	(0.0173)
Interaction Term Pc 3 & Log of Tax Holiday	-0.00620	-0.00572	-0.00422	-0.00425	-0.00411
	(0.0234)	(0.0235)	(0.0234)	(0.0234)	(0.0234)
Interaction Term Pc 4 & Log of Tax Holiday	-0.0197	-0.0210	-0.0180	-0.0172	-0.0178
	(0.0236)	(0.0236)	(0.0239)	(0.0236)	(0.0239)
Interaction Term Pc 5 & Log of Tax Holiday	-0.0401	-0.0407	-0.0412*	-0.0411	-0.0411
	(0.0250)	(0.0248)	(0.0249)	(0.0250)	(0.0250)
Interaction Term Pc 6 & Log of Tax Holiday	0.236	0.217	0.231	0.241	0.233
	(0.228)	(0.229)	(0.227)	(0.232)	(0.227)
Interaction Term Pc 7 & Log of Tax Holiday	-0.0150	-0.0149	-0.0144	-0.0150	-0.0149
	(0.0130)	(0.0128)	(0.0128)	(0.0130)	(0.0129)
EFD		-0.0639			
		(0.0581)			
Interaction Term EFD & Log of Tax Holiday		0.0291			
		(0.0203)			
FIX			-0.135		
			(0.315)		
Interaction Term FIX & Log of Tax Holiday			0.0560		
			(0.115)		
LMP				0.840	
				(1.289)	
Interaction Term LMP & Log of Tax Holiday				0.0652	
				(0.407)	
DEP					0.0659
					(0.544)
Interaction Term DEP & Log of Tax Holiday					-0.0257
					(0.215)
Number of observations	8513	8513	8513	8513	8513
R^2	0.168	0.168	0.168	0.168	0.167

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6 Robustness Checks

The robustness of the results is checked with respect to (i) alternative measures of TFP i.e. TFP calculated using OLS Fixed Effects (FE) and the Levinsohn-Petrin methods, (ii) alternative underlying mechanism i.e. the mechanism proposed by Aghion et al. (2015) where industrial policy works through fostering competition measured by the Herfindahl index representing the dispersion of subsidies within each industry, (iii) the setting of tariff rates at the industry level as an alternative proxy of industrial policy, and (iv) the same dataset but with the exclusion of 2012 data to make sure the results hold without major outliers.

6.1 Alternative Measures of Firm Performance

The pattern of results hold with TFP calculated using OLS FE method as well as Levinsohn-Petrin method i.e. the coefficient on the log of tax holiday in model specification (2) is greater than that in model specification (1), and the coefficient on the interaction term of the log of tax holiday and level of R&D intensity is significant and positive. In the following tables, we present the mechanism checking with R&D intensity and indicate the presence of political dummies and interaction terms.

Table 12: **Robustness Checks with TFP Measured Using OLS FE method (TFP_OLSFE)**

	(1)	(2)	(3)
	TFP_OLSFE	TFP_OLSFE	TFP_OLSFE
Log of Tax Holiday	0.280***	0.308***	0.306***
	(0.0155)	(0.0163)	(0.0164)
Technical Assistance (Dummy)	-0.0497	-0.0474	-0.0492
	(0.0561)	(0.0544)	(0.0543)
SOE Indicator	0.215	0.235	0.246
	(0.199)	(0.213)	(0.215)
Industry Size (Number of Firms)	0.000349	0.000285	0.000351
	(0.000612)	(0.000617)	(0.000623)
Industry Competition Level	0.268	0.289	0.284
	(0.217)	(0.219)	(0.218)
RND			-0.356
			(0.388)
Interaction Term RND & Log of Tax Holiday			0.244*
			(0.143)
Political Dummies	No	Yes	Yes
Interaction Terms Political Dummies & Log of Tax Holiday	No	Yes	Yes
Number of observations	8583	8513	8513
R^2	0.221	0.227	0.227

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 13: **Robustness Checks with TFP Measured Using Levinsohn-Petrin method (TFP_LP)**

	(1)	(2)	(3)
	TFP_LP	TFP_LP	TFP_LP
Log of Tax Holiday	0.251***	0.276***	0.274***
	(0.0146)	(0.0160)	(0.0161)
Technical Assistance (Dummy)	-0.0676	-0.0655	-0.0676
	(0.0603)	(0.0585)	(0.0584)
SOE Indicator	0.185	0.203	0.216
	(0.208)	(0.223)	(0.226)
Industry Size (Number of Firms)	0.00129	0.00131	0.00142*
	(0.000833)	(0.000841)	(0.000846)
Industry Competition Level	0.194	0.210	0.204
	(0.224)	(0.225)	(0.224)
RND			-0.362
			(0.387)
Interaction Term RND & Log of Tax Holiday			0.274*
			(0.141)
Political Dummies	No	Yes	Yes
Interaction Terms Political Dummies & Log of Tax Holiday	No	Yes	Yes
Number of observations	8586	8516	8516
R^2	0.178	0.183	0.184

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.2 Alternative Mechanisms

Using the Herfindahl Index formulae to measure the degree of competition at the industry level, we test the predictions made based on Aghion et al. (2015)'s argument that a tax policy targeted at a more competitive industry would have a greater impact on output and innovation and consequently productivity, and that there exists complementarity between tax holidays and the degree of competition in the presence of political constraints. For that purpose, we include a new variable called Compherftax which measures the degree of dispersion of tax incentives within each industry, consistently with Aghion et al. (2015). Comperftax is measured using the following formula:

$$Compherftax_{i,j,t} = 1 - Herf\_tax = \sum_{h \in j, h \notin i} \left(\frac{TaxHoliday_{ijt}}{Sum\_TaxHoliday_{jt}} \right)^2 \tag{5}$$

$Herf\_tax$ is the Herfindahl index of tax holiday measured using the share of tax incentive each firm receives relative to the total amount of tax benefits given to the industry. The square of this Herfindahl index is an indicator of the level of competitiveness within that industry: the smaller this value is, the greater the degree of tax holiday dispersion and thus competitiveness within the sector. $Compherftax_{i,j,t}$ is measured by taking 1 subtracted by the square of Herfindahl index for tax holiday to make this measure correlate positively with level of competitiveness: a greater value of $Compherftax_{i,j,t}$ indicates a more competitive industry. Note that the firm's own tax holiday is subtracted from the Herfindahl measure for each firm, making $Compherftax_{i,j,t}$ exogenous to the firm's performance in order to mitigate the potential endogeneity of this policy instrument.

As such, in the regression specification, the variable $Compherftax_{i,j,t}$ (denoted as $C_{i,j,t}$ in the equations below) would replace the Lerner index variable as the variable representing competition, and instead we add the interaction term between the Herfindahl index and the log of tax holiday. Our regression specification is as follows:

$$lnTFP_{ijt} = \theta_1 Z_{ijt} + \theta_2 S_{jt} + \beta_1 Lntax_{ijt} + \beta_2 Tech_{ijt} + \beta_3 C_{i,j,t} + \gamma_1 Lntax_{ijt} * C_{i,j,t} + f_i + D_t + \varepsilon_{ijt} \tag{6}$$

and

$$lnTFP_{ijt} = \theta_1 Z_{ijt} + \theta_2 S_{jt} + \beta_1 Lntax_{ijt} + \beta_2 Tech_{ijt} + \beta_3 C_{i,j,t} + \gamma_2 Lntax_{ijt} * C_{i,j,t} + \delta_1 P_{ijt} + \delta_2 P_{ijt} * Lntax_{ijt} + f_i + D_t + \varepsilon_{ijt} \tag{7}$$

An affirmative appraisal of the mechanism would suggest significant and positive values of γ_1 and γ_2.

However, the coefficients on the interaction term between $Lntax_{ijt}$ and $C_{i,j,t}$ are statistically insignificant in both regression specifications as shown in Table 14. This suggests that targeting more competitive industries is not the way that industrial policy works in Vietnam, especially in the presence of political constraints.

Table 14: **Robustness Checks with Targeting Mechanism Focusing on Competition**

	(1) TFP_OP	(2) TFP_OP
Log of Tax Holiday	0.270***	0.294***
	(0.0392)	(0.0428)
Comp_HerfTax	0.140	0.144
	(0.142)	(0.145)
Interaction Term Comp_HerfTax & Log of Tax Holiday	-0.0307	-0.0289
	(0.0438)	(0.0446)
Technical Assistance (Dummy)	-0.0565	-0.0519
	(0.0612)	(0.0595)
SOE Indicator	0.171	0.182
	(0.219)	(0.234)
Industry Size (Number of Firms)	0.000302	0.000230
	(0.000668)	(0.000675)
Industry Competition Level	0.125	0.142
	(0.241)	(0.243)
Political Dummies	No	Yes
Interaction Terms Political Dummies & Log of Tax Holiday	No	Yes
Number of observations	8547	8477
R^2	0.161	0.167

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.3 Inclusion of Tariff Rates as Industrial Policy

In the industrial policy literature, tariff is also considered a measure of industrial policy. A higher tariff rate signifies protectionism against foreign competition. A low tariff rate, however, means cheaper imports of inputs for production. Therefore, it is not clear what impact tariff rate has on firm performance since it can go either way. We test this industrial policy measure by including tariff rate at the industry level instead of tax holiday as the proxy for industrial policy in the regression model.

We obtained tariff data from the World Bank Integrated Trade Solution (WITS) platform for corresponding years and calculated tariff rates imposed by Vietnam at the industry level. The tariff rate in use is the average max input tariff rate that the Vietnamese government set for countries with Most Favored Nations status. The tariff rates by industry from 2004 to 2014 are shown in Table 15. It is interesting to observe that the tariff rates for raw materials and basic production inputs such as chemical products and basic metals are much lower than those applied to other industries.

When we include the measure of tariff at the industry level instead of tax holiday in the right hand side of the regressions, we do not obtain significant results for the coefficients on the tariff variable, which suggests that preferential treatment in terms of tariff rate at the industry level does not seem to have an impact on firm productivity. These results are shown in Table 16 below.

Table 15: **Vietnam's Average Tariff Rates by Manufacturing Industry from 2004 to 2014 (%)**

Sector	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**
Primary production/ Agriculture	15.2	15.3	12.6	10.1	9.8	10.1
Food and beverages	32.8	32.6	24.5	21.5	20.3	20.7
Tobacco	65.0	65.0	82.5	80.0	78.6	80.0
Textiles	32.8	32.8	10.1	10.0	10.0	10.0
Apparel	48.4	48.4	20.4	20.1	19.8	19.8
Leather	29.0	29.0	23.0	20.2	18.4	18.4
Wood	12.9	12.9	11.1	9.1	8.6	8.4
Paper	20.1	20.1	16.9	14.4	12.8	12.7
Publishing and printing	21.9	21.9	16.5	13.6	12.7	12.3
Refined petroleum etc.	5.6	5.6	3.4	4.7	3.7	4.6
Chemical products etc.	4.4	4.4	3.6	3.0	2.6	2.6
Rubber	18.5	18.5	16.4	14.5	13.2	12.8
Non-metallic mineral products	24.4	24.4	21.3	20.0	19.0	19.1
Basic metals	4.2	4.2	2.4	2.7	2.5	2.9
Fabricated metal products	18.8	18.8	16.4	15.2	14.5	14.7
Electronic machinery, computers, radio, tv, etc.	10.7	10.7	8.1	7.1	6.2	6.3
Motor vehicles etc.	53.8	53.9	36.7	40.1	35.7	34.3
Other transport equipment	15.4	15.4	14.3	13.4	12.3	12.3
Furniture, jewellery, toys, music equipment etc.	17.2	17.2	13.9	12.1	11.5	11.6
Services	8.5	8.3	7.4	6.6	6.2	6.4

Table 16: **Robustness Checks with Tariff Rates at the Industry Level as Additional Policy Measure**

	(1) TFP_OP
Tariff	-0.000654
	(0.000530)
Technical Assistance (Dummy)	0.0333
	(0.0552)
SOE Indicator	0.0946
	(0.163)
Industry Size (Number of Firms)	-0.000195
	(0.000448)
Industry Competition Level	-0.0891
	(0.196)
Firm Fixed Effects	Yes
Year Dummies	Yes
Number of observations	14008
R^2	0.0115

Robust standard errors in parentheses, clustered at the firm level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.4 Analysis on the Data Set Excluding Year 2012

Table 17 below shows the results of the fixed effects panel regressions for each of the three model specifications on the data set excluding data for year 2012. The major pattern of results also hold for this subsample.

Table 17: **Robustness Checks with the Dataset Excluding Year 2012**

	(1)	(2)	(3)
	TFP_OP	TFP_OP	TFP_OP
Log of Tax Holiday	0.245***	0.266***	0.263***
	(0.0145)	(0.0161)	(0.0162)
Technical Assistance (Dummy)	-0.0639	-0.0598	-0.0618
	(0.0611)	(0.0593)	(0.0592)
SOE Indicator	0.0832	0.112	0.126
	(0.221)	(0.242)	(0.247)
Industry Size (Number of Firms)	0.000506	0.000443	0.000527
	(0.000637)	(0.000643)	(0.000649)
Industry Competition Level	0.148	0.162	0.157
	(0.238)	(0.240)	(0.240)
RND			-0.322
			(0.392)
Interaction Term RND & Log of Tax Holiday			0.259*
			(0.139)
Political Dummies	No	Yes	Yes
Interaction Terms Political Dummies & Log of Tax Holiday	No	Yes	Yes
Number of observations	8564	8494	8494
R^2	0.163	0.167	0.168

Robust standard errors in parentheses, clustered at the firm level. All regressions include firm fixed effects and year dummies.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7 Economic Model

Here we present a version of the Howitt (1999) framework, generalized to allow for many heterogeneous industries as well as a variety of taxes.[3] In our model, industries vary in terms of their market size and, as in Schmookler (1966), this leads R&D intensity to vary endogenously across industries, because larger product markets encourage innovation by offering greater returns to successful innovators. Some empirical studies of specific products or industries find some evidence of a demand-innovation link – for example, Newell et al. (1999), Popp (2002) and Acemoglu and Linn (2004). These findings underline the importance of demand in providing incentives for R&D. There is also broad aggregate empirical support for creative-destruction style models, see for example Ha and Howitt (2007), Madsen (2008) or Ang and Madsen (2011). In particular, Ang and Madsen (2011) finds that this class of model best explains the experience of the East Asian "miracle" economies. An interpretation of our paper is that it provides new cross-sectional support for this kind of model.

7.1 *Household preferences*

Time is continuous, and there is a $[0, 1]$ continuum of dynasties, each of mass $L_t = L_0 e^{g_L^t}$. We assume that the rate of population growth $g_L^t > 0$ is exogenous.

There are $I \in \mathbb{N}$ types of final good in the economy, each produced by a separate industry. There exists in turn $[0, Q_{it}]$ continuum of varieties of each good $i \leq I$. Let c_{hit} be consumption of variety h of good i at date t. Dynastic preferences over consumption c_t are:

$$\int_0^\infty e^{-rt} L_t u(c_t)\, dt \tag{8}$$

where r is the discount rate. Consumption c_t is an aggregate of the agent's consumption c_{it}

[3] Howitt (1999) presents a version of the Aghion and Howitt (1992) and Aghion and Howitt (1996) model of growth through creative destruction, but modified so as to avoid scale effects.

of each good $i \leq I$, which is in turn an aggregate over the varieties $h \in [0, Q_{it}]$:

$$c_t = \prod_{i=1}^{I} \left(\frac{c_{it}}{\omega_i} \right)^{\omega_i}, \; c_{it} = \int_0^{Q_{it}} c_{hit} dh, \quad i \in \{1, .., I\} \tag{9}$$

Each agent is also endowed with one unit of labor that may be spent working in production, or in research, as described below. In either case, it earns the competitive wage w_t.

Their budget constraint is

$$\sum_{i=1}^{I} q_{it} \int_0^{Q_{it}} c_{iht} dh \leq \Pi_t + w_t (L_t - R_t) + T_t \equiv LS_t \tag{10}$$

where we have used the fact that all varieties h of any good i are perfect substitutes, so they all command the same price q_{it} in market equilibrium. Here Π_t equals after-tax profits from various sources, and T_t is a lump sum transfer, both in terms of the numeraire. R_t, to be expanded upon later, is the use of labor in research rather than production. Also $w_t = 1$ is the competitive wage. We define S_t as income per capita, in terms of the numeraire.

7.2 Final goods

Each variety h of good i is supplied by a monopolist (below the variety index h is suppressed for simplicity). Each monopolist holds a patent on the technology for producing that variety, indexed by the date v at which the innovation took place (its vintage). At any date t, the production function for any given variety of good i for this monopolist is $y_{it}(v) = A_{iv} x_{it}^{\alpha}$, where $y_{it}(v)$ is output, x_{it} is input of a variety-specific intermediate and A_{iv} is the productivity of the monopolist's technology. The monopolist solves:

$$\max \{ q_{it} A_{iv} x_{it}^{\alpha} - p_{it} x_{it} \} (1 - \tau_p) \tag{11}$$

where q_{it} is the price of good i and p_{it} is the marginal cost of the intermediate. Here τ_p is the tax rate on producers of final good varieties.

The solution to (15) implies:

$$p_{it}\left(x_{it}\right)=\alpha q_{iv}A_{it}x_{it}^{\alpha-1} \tag{12}$$

Let $\pi_{ip}\left(v,t\right)$ be the pre-tax profits of the final good producers.

7.3 Intermediate goods

A patent-holding monopolist produces the intermediate x_{it} using labor. The monopolist solves the static profit maximization problem:

$$\max_{x_{it}}\left\{p_{it}\left(x_{it}\right)x_{it}-w_{t}x_{it}\right\}\left(1-\tau_{i}\right), \tag{13}$$

where the inverse demand curve $p_{it}\left(\cdot\right)$ is given by (12), so this becomes

$$\left(1-\tau_{i}\right)\max_{x_{it}}\left\{\alpha q_{it}A_{iv}x_{it}^{\alpha}-w_{t}x_{it}\right\}.$$

The solution to this problem is

$$x_{i}\left(v,t\right)=\left(\frac{\alpha^{2}q_{it}A_{iv}}{w_{t}}\right)^{\frac{1}{1-\alpha}}, \tag{14}$$

so that output of the variety equals $y_{it}\left(v\right)\equiv A_{iv}\left(\frac{\alpha^{2}q_{it}A_{iv}}{w_{t}}\right)^{\frac{\alpha}{1-\alpha}}$. Thus, pre-tax profits for a patent holder are:

$$\pi_{ir}\left(v,t\right)\equiv\left(\frac{q_{it}A_{iv}}{w_{t}^{\alpha}}\right)^{\frac{1}{1-\alpha}}\pi \tag{15}$$

where $\pi\equiv\left[\alpha\times\alpha^{\frac{2\alpha}{1-\alpha}}-\alpha^{\frac{2}{1-\alpha}}\right]$. This also implies that

$$\pi_{ip}\left(v,t\right)=\left(1-\alpha\right)\left(q_{it}A_{iv}\right)^{\frac{1}{1-\alpha}}\left(\frac{\alpha^{2}}{w_{t}}\right)^{\frac{\alpha}{1-\alpha}} \tag{16}$$

7.4 Vertical innovation

Agents may invest in R&D in order to uncover the technology to produce a variety of good i at the current frontier productivity $A_{it}^{\max}$, which grows at rate g_i. If an agent dedicates N_{it} units of labor to R&D in industry i, she harvests innovations at rate λN_{it}. It will be convenient to define $\bar{N}_{it}$ as the total resources devoted to vertical innovation in industry i, and $\bar{n}_{it} = \frac{\bar{N}_{it}}{Q_{it}}$ as the amount of vertical R&D per variety of good i. Since one firm produces each variety it is also interpretable as the vertical R&D per firm in industry i.

Growth in the frontier technology $A_{it}^{\max}$ is determined by *spillovers* from research. If the total amount of R&D in industry i is N_{it}, then the flow of new technologies for producing good i is

$$\dot{A}_{it}^{\max} = \frac{\lambda \bar{N}_{it} A_{it}^{\max}}{Q_{it}} \sigma. \tag{17}$$

This function assumes that new technologies depend on the rate of innovations $\lambda \bar{N}_{it}$. The parameter σ indicates the intensity of technological knowledge spillovers. The numerator Q_{it} reflects the idea that research effort is disippated across varieties Q_{it}, the key mechanism of the Howitt (1999) model for avoiding scale effects. Finally, the spillover function (17) depends positively on the current frontier level $A_{it}^{\max}$, reflecting the "standing on shoulders" effect for which Ngai and Samaniego (2011) among others find evidence.

As a result, the growth rate of the technology frontier in industry i is:

$$g_i \equiv \frac{\dot{A}_{it}^{\max}}{A_{it}^{\max}} = \frac{\lambda \bar{N}_{it}}{Q_{it}} \sigma = \lambda \bar{n}_{it} \sigma. \tag{18}$$

A successful innovator replaces the incumbent monopolist, and earns expected discounted profits $\tilde{V}_{it}$ where

$$\tilde{V}_{it} = \int_t^{\infty} e^{-(r+\lambda \bar{n}_{is})s} \left(1 - \tau_i\right) \pi_{is}\left(t, s\right) ds. \tag{19}$$

The exponent $\lambda \bar{n}_{is}$ reflects the fact that, in expectation, future researchers may displace the innovator. This displacement rate is $\lambda\frac{\bar{N}_{is}}{Q_{is}}$, because it is increased by the research effort of others, and dissipated by there being more varieties across which future innovation might occur.

Notice that τ_i, the tax on the intermediate goods producers, enters $\tilde{V}_{it}$. This is because taxes reduce the potential earnings of the successful researchers. It will be convenient to define $V_{it} \equiv \tilde{V}_{it}/\left(1-\tau_i\right)$, which does not depend on any taxes.

Thus, we have that the marginal return to spending a unit of labor on research in industry i is $\lambda V_{it}\left(1-\tau_i\right)$. The marginal cost is w_t, the price of labor. We have these must be equal when R&D input is optimal:

$$\lambda\left(1-\tau_i\right)V_{it} = w_t. \tag{20}$$

Combining (15), (19) and (20), we have that optimal vertical R&D choices satisfy:

$$w_t = \left(1-\tau_i\right)\lambda\int_0^{\infty} e^{-\left(r+\lambda\bar{n}_{is}\right)s}\left[\left(\frac{q_{is}A_{it}^{\max}}{w_s}\right)^{\frac{1}{1-\alpha}}\pi\right]ds. \tag{21}$$

7.5 Horizontal innovation

Agents may also choose to invest in producing new varieties of any good i. If agents invest M_{it} units of labor in the production of new varieties in industry i, the flow of new varieties is given by:

$$\dot{Q}_{it} = \Psi\left(M_{it}, Q_{it}\right) \tag{22}$$

where Ψ is increasing and homogeneous of degree one. This structure assumes that having more varieties aids the production of new varieties, another "standing-on-shoulders" effect.

Let $h_{it} = M_{it}/Q_{it}$, the horizontal R&D per firm, and define $\psi\left(\cdot\right) \equiv \Psi\left(\cdot,1\right)$. We can rewrite (22) as:

$$\begin{aligned}\dot{Q}_{it} &= \Psi\left(h_{it},1\right)Q_{it}\\ &= \psi\left(h_{it}\right)Q_{it}.\end{aligned}$$

A horizontal innovation draws its productivity level A_{iv} from the existing distribution in industry i. It is straightforward to show that the expected discounted profits of a monopolist with technology of vintage v is $\left(\frac{A_{iv}}{A_{it}^{\max}}\right)^{\frac{1}{1-\alpha}}\tilde{V}_t$. As a result, the expected profits from a horizontal innovation are:

$$E\left[\left(\frac{A_{iv}}{A_{it}^{\max}}\right)^{\frac{1}{1-\alpha}}\right]\tilde{V}_t$$

where the expectation is taken over the distribution of A_{iv} at date t. Let $f_i(v,t)$ be the distribution of firms over v at date t, then this expectation becomes $\int_{-\infty}^{t}\left(\frac{A_{iv}}{A_{it}^{\max}}\right)^{\frac{1}{1-\alpha}}f_i(v,t)\,dv$.

For horizontal R&D allocations to be optimal, the marginal cost of R&D w must equal this expression, times the marginal effect of an additional unit of labor devoted to production of new varieties in industry i. The marginal flow of new varieties is $\Psi_1\left(M_{it},Q_{it}\right) = \frac{d\left[\Psi\left(\frac{M_{it}}{Q_{it}},1\right)Q_{it}\right]}{dM_{it}} = \Psi_1\left(\frac{M_{it}}{Q_{it}},1\right) = \psi'\left(h_{it}\right)$. Thus, optimal horizontal R&D allocations satisfy:[4]

$$w_t = \psi'\left(h_{it}\right).E\left[\left(\frac{A_{iv}}{A_{it}^{\max}}\right)^{\frac{1}{1-\alpha}}\right]V_t\left(1-\tau_i\right). \tag{23}$$

7.6 Government

Government collects taxes and redistributes them as a lump sum tax T_t, balancing its budget every period. If $f_i(v,t)$ is the distribution of firms over v at date t industry i, the

[4]Later we show that $f_i(v,t) = f(a)$, where $a = A_{vt}/A_{it}^{\max}$. The form of f is such that:

$$E\left[\left(\frac{A_{it}}{A_{it}^{\max}}\right)^{\frac{1}{1-\alpha}}\right] = \frac{1}{1+\frac{\sigma}{1-\alpha}}.$$

corresponding *measure* is $Q_{it} f_i(v,t)$, and the balanced budget condition becomes:

$$T_t = w_t \left(L_t - \sum_i N_{it} - \sum_i M_{it} \right) + \tau_p \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ip}(v,t) f_i(v,t)\, dv + \tau_i \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ir}(v,t) f_i(v,t)\, dv$$

This notation also allows us to define after-tax profits Π_t :

$$\Pi_t = (1-\tau_p) \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ip}(v,t) f_i(v,t)\, dv + (1-\tau_i) \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ir}(v,t) f_i(v,t)\, dv.$$

This means that in equilibrium the household's balanced budget condition must satisfy:

$$L_t S_t = w_t \left(L_t - \sum_i N_{it} - \sum_i M_{it} \right) + \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ip}(v,t) f_i(v,t)\, dv + \sum_i Q_{it} \int_{-\infty}^{t} \pi_{ir}(v,t) f_i(v,t)\, dv.$$

8 Stationary equilibrium

Definition 1 *A stationary equilibrium (or "equilibrium" henceforth) is a set of initial conditions $\{Q_{i0}, f_i(\cdot,0)\}_{i \leq I}$ and allocations such that households are optimizing based on their budget constraints, the government balances its budget every period, $n_{it} = n_i$ at all dates t and $h_{it} = h_i$ at all dates.*

Proposition 1 *Equilibrium exists and is unique.*

Proof. All proofs are derived in the Appendix. □

Definition 2 *Research intensity in industry i at date t is defined as research expenditure per firm,*

$$\begin{aligned} \rho_{it} &= \frac{(N_{it} + M_{it})\, w_t}{Q_{it}} \\ &= (n_{it} + h_{it})\, w_t. \end{aligned}$$

Without loss of generality, assume that labor is the numeraire, so $w_t = 1$ at all dates. In the Appendix we show that, in equilibrium,

$$n_{it} = \bar{n}_i = \max\left\{0, \frac{(1-\tau_i)\,\pi\omega_i S L_0}{\alpha^{\frac{2\alpha}{1-\alpha}} Q_{i0}} - \frac{r}{\lambda\left(1+\frac{1}{1-\alpha}\sigma\right)}\right\}. \tag{24}$$

which does not depend on time. In addition, we are able to show that h_{it} does not vary across time *nor across industries*. It follows that variation in research intensity depends only on $\bar{n}_i$, so that:

Proposition 2 *In equilibrium,*

i) research intensity is constant over time in all industries – $\rho_{it} = \bar{\rho}_i$*;*

ii) equilibrium research intensity is positive in at least one industry, provided r *is sufficiently small,* λ *is sufficiently large or* σ *is sufficiently large;*

iii) equilibrium research intensity $\bar{\rho}_i$ *is increasing in* ω_i/Q_{i0} *– strictly among* $i : \bar{\rho}_i > 0$*.*

Proposition 2 tells us that, in our multi-industry environment, the key determinant of research intensity is market size, normalized by the initial number of varieties. This is a twist on the original idea of Schmookler (1966): the market size that is available to an innovator depends both on the overall size of the market ω_i and on the intensity of competition in that market, given by Q_{i0}, which dissipates the returns to R&D.

Proposition 2 might also appear to suggest that a larger economy (i.e. with a larger initial value of L_0) might have higher R&D intensity and thus productivity growth – even if the model structure avoids the "scale effects" problem that economies with a growing population grow at an accelerating rate. However it is worth underlining that the model as it stands takes L_0 and $\{Q_{i0}\}_i$ as given and independent variables – it does not provide a theory of $\{Q_{i0}\}_i$. A further extension of the model might imply that a larger economy would also have a larger number of varieties – i.e. that, just as growth over time in L_t leads to proportional growth in Q_{it}, one might expect the same to be true in cross section across countries with different levels of L_0, so that a higher value of L_0 is related to a proportional increase in Q_{i0}. In this case the scale effect in levels of L_0 would be absent. We leave this for future work as it is not the focus of the paper.

Our most important result is that the pattern observed in the data – that tax holidays particularly increase productivity in research-intensive industries – holds in the model economy.

Definition 3 *Industrial support (or a tax holiday) is a decrease in* τ_i.

Proposition 3 *Industrial support has a non-decreasing impact on productivity growth in all industries. Moreover, industrial support disproportionately increases productivity growth in high-R&D industries.*

In partial equilibrium, equation (24) and Proposition 2 would suggest that $\frac{d^2\bar{n}_i}{d\tau d(\omega_i/Q_{i0})} < 0$, so that lowering taxes would disproportionately increase R&D activity in the industries that were more R&D intensive to begin with. The fact that g_i depends positively on $\bar{n}_i$, and that $\bar{n}_i$ depends non-negatively on ω_i/Q_{i0}, would then seem to deliver the result in Proposition 3. However, in general equilibrium, income S is endogenous and depends on taxes τ. As a result, the proof of Proposition 3 requires also showing that this result continues to hold in general equilibrium and is not overturned when S is endogenous to taxes.

To conclude, the model economy indicates that the positive interaction of research intensity with industrial support is to be expected in a multi-sector Schumpeterian growth model. A more nuanced conclusion would take into account that in the model economy the only source of variation in research intensity is ω_i/Q_{i0}. The model has additional determinants of research intensity, such as λ and σ, which could in principle differ across industries. We do not do so as equation (24) indicates that the interaction between R&D and taxes – whether direct or indirect through S – must involve the market size parameter ω_i, not λ nor σ. Thus, the broader conclusion is that a multi-sector Schumpeterian growth model delivers the interaction in the data provided that the main determinants of cross-industry variation in research intensity are market-size or competition effects along the lines of Schmookler (1966).

9 Conclusion

In this paper, we have shown that industrial support targeting R&D-intensive industries should improve productivity growth through a multi-industry Schumpeterian growth model. Empirically, we explore the impact of government's industrial policy on firm-level productivity using a dataset of Vietnamese SMEs that allows for deeper analytical insights into the various dimensions of firms' political connections. Featuring seven binary proxies representing various dimensions of political connectedness that acts as a latent control variable, our fixed effects panel regression results suggest that while tax benefits help increase overall firm-level productivity, their effect on firm productivity are stronger among firms that are not politically connected, and that technical assistance, on the other hand, does not seem to help improve firm performance. In addition, the positive and statistically significant coefficient on the interaction term between the industry-level R&D intensity variable and the log of tax holiday variable shows that firms in more R&D intensive industries are more productive with the tax holiday.

As such, the model and results of this paper induce a major policy implication for transition economies like Vietnam that such industrial policy, given tight fiscal constraints as usually observed in developing countries, would have greater positive impacts on firm productivity if firms that are not well politically connected and those that are in more R&D intensive industries take the priority in receiving these benefits.

APPENDIX A: Derivation and Estimation Results of Olley-Pakes TFP Measure

A1. Derivation

We estimate total factor productivity (TFP) for each firm using the two step approach commonly adopted in the firm dynamics literature, for example Bloom and Van Reenen (2007), Black and Lynch (2001), and Newman et al. (2015). The first step is to estimate the parameters of the production function, assuming that it takes a Cobb-Douglas form. The second step is to back out TFP estimate at the firm level after plugging in the parameters of production function. We assume that the production function takes the following Cobb-Douglas form for the purpose of empirical estimation:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it} \tag{25}$$

where y_{it} is the log of sales, l_{it} is the log of labor input, k_{it} is the log of capital input, m_{it} is the log of materials or intermediate inputs, ω_{it} is log of unobserved productivity (lnTFP in our regression model specification) and ε_{it} represents unobserved shocks to production or productivity. While ε_{it} captures shocks that are unobservable to firms before they make decisions on their inputs, for example deviations in expected rainfall in a year, ω_{it} represents productivity shocks that firms can potentially observe upon making input decisions such as the level of management capacity, expected down time of the production process due to technical issues or electricity blackout etc.

While ω_{it} is potentially observable or predictable by the firm, it is not observable to the econometrician. This means that firms might be able to observe their productivity before they choose their k_{it},l_{it} and m_{it}., generating correlations between (k_{it},l_{it} and m_{it}) and ω_{it}. As a result, OLS estimates of k_{it},l_{it} and m_{it}, which rest on the assumption that input choices of labor, capital and materials are exogenously made with regard to the firm's productivity level, would be biased. For example, more productive firms might choose to employ more workers, which would lead to an upward bias in the OLS estimated coefficient of labor if productivity is not controlled for. Such potential endogeneity of input choices has been a well-recognized problem as identified in studies as early as Marschak and Andrews (1944), and among the solutions that have been proposed in the literature, semi-parametric approaches to structurally estimate the parameters of the production function controlling for productivity in choices of inputs, including Olley and Pakes (1992) (henceforth OP), Levinsohn and Petrin (2003) and Ackerberg et al. (2015) are the most commonly used.

The description of the OP method below borrows from Ackerberg et al. (2015). Note that throughout the following description we have added the variable of materials or intermediate input into the right hand side of the equation as controlling for intermediate input would improve the explanatory power of our model.

OP construct a firm's investment decision as a policy function resulting from a dynamic optimization problem with k_{it} being the dynamic input whose amount in period t was determined in period $(t-1)$. On the other hand, they argue that labor is a nondynamic input as a firm's choice of labor in period $t$would not affect the firm's future profits. The role of materials in the investment process follows the same logic with that of labor. As such, the firm's investment decision can be represented by the following policy function:

$$i_{it} = f_t(k_{it}, \omega_{it}) \tag{26}$$

where i_{it} is the log of investment made in time t.

In addition, OP highlight the assumption that $f_t(k_{it}, \omega_{it})$ is strictly increasing in ω_{it} as an important property of the investment policy function. As such, in order to obtain a productivity estimate for the firm, one can invert the investment policy function to obtain the first stage moment condition of the OP method:

$$\omega_{it} = f_t^{-1}(k_{it}, i_{it}) \tag{27}$$

Substituting this formula into the production function gives:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + f_t^{-1}(k_{it}, i_{it}) + \varepsilon_{it} = \beta_l l_{it} + \beta_m m_{it} + \phi_t(k_{it}, i_{it}) + \varepsilon_{it} \tag{28}$$

As deriving the functional form of $f_t^{-1}(k_{it}, i_{it})$ might necessitate the solution of a sophisticated dynamic programming problem, OP treat f_t^{-1} nonparametrically, as a result the composite term $\phi_t(k_{it}, i_{it})$ is also treated nonparametrically. The first stage of OP would thus generate GMM estimates $\hat{\beta}_l$, $\hat{\beta_m}$, and $\hat{\phi}_t$ consistently. If ϕ_t is approximated by a polynomial, this first stage estimation would be equivalent to running OLS of y_{it} on l_{it}, m_{it} and the polynomial.

In the second stage, ω_{it} is decomposed into its conditional expectation at time $(t-1)$ and an innovation term ξ_{it} as follows:

$$\omega_{it} = E[\omega_{it} \mid \omega_{i,t-1}] + \xi_{it} = g(\omega_{i,t-1}) + \xi_{it} \tag{29}$$

Plugging this formula into the production function gives:

$$\begin{aligned} y_{it} &= \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + g(\omega_{i,t-1}) + \xi_{it} + \varepsilon_{it} \\ &= \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + g(\phi_{t-1}(k_{i,t-1}, i_{i,t-1}) - \beta_0 - \beta_k k_{i,t-1}) + \xi_{it} + \varepsilon_{it} \end{aligned} \tag{30}$$

Let I_{it} be firm i's information set at time t, by construction $E[\xi_{it} \mid I_{i,t-1}] = 0$ and $E[\varepsilon_{it} \mid I_{it}] = 0$ (which also implies $E[\varepsilon_{it} \mid I_{i,t-1}] = 0$. Therefore, the moment condition for

OP method's second stage estimation is as follows:

$$E[\xi_{it}+\varepsilon_{it} \mid I_{i,t-1}] = E[y_{it}-\beta_0-\beta_k k_{it}-\beta_l l_{it}-\beta_m m_{it}-g(\phi_{t-1}(k_{i,t-1}, i_{i,t-1})-\beta_0-\beta_k k_{i,t-1}) \mid I_{i,t-1}] = 0 \tag{31}$$

This second stage estimation, from which the coefficient on capital can be identified, involves plugging in the first stage estimates of $\hat{\beta}_l$, $\hat{\beta_m}$, and $\hat{\phi}_{t-1}$ into the second moment condition. We follow this two stage OP method in estimating TFP for each firm while adopting the specifications on the functional forms of $\phi_t(k_{it}, i_{it})$ and $g(.)$ in Yu (2015). Our TFP estimation procedure based on the OP method is described in the following subsections 6.1 and 6.2.

A1.1. First step: Estimate the Parameters of the Production Function.

We follow Yu (2015) in adopting OP method while using fourth-order polynomials to approximate $\phi_t(k_{it}, i_{it})$ and $g(.)$. Specifically, in the first stage, we adopt the following functional form for $\phi_t(k_{it}, i_{it})$:

$$\phi_t(k_{it}, i_{it}) = \sum_{h=0}^{4}\sum_{q=0}^{4} \delta_{hq} k_{it}^{h} i_{it}^{q} \tag{32}$$

Thus we regress y_{it} over l_{it}, m_{it} and the terms of $\phi_t(k_{it}, i_{it})$ to obtain estimates of $\hat{\beta}_l$ and $\hat{\beta_m}$ then calculate the residual $\hat{\phi}_t$ which is defined as $\hat{\phi}_t = y_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_l l_{it}$

For the second stage, in order to obtain unbiased estimate of $\hat{\beta}_k$ and correct for self-selection bias induced by firm's exit as discussed in Amiti and Konings (2007), we estimate the probability of a survival indicator on a high-order polynomial in log capital and log investment which is the probability of firm's exit in the year after. We estimate the following specification:

$$\hat{\phi}_t = \beta_k k_{it} + f^{-1}(\phi_{t-1} - \beta_k k_{i,t-1}, p\hat{r}_{i,t-1}) + \epsilon_{it} \tag{33}$$

where the inverse function f^{-1} that expresses ω_{it} is written in terms of $\omega_{i,t-1}$ and $p\hat{r}_{i,t-1}$ that is the fitted value of the probability of firm's exit in the following year from probit regression. This second stage estimation is conducted using nonlinear least squares where the function f^{-1} is approximated by another fourth-order polynomial in ϕ_{t-1}, $k_{i,t-1}$ and $p\hat{r}_{i,t-1}$. Standard errors are calculated using bootstrapping.

A1.2. Second Step: Back Out Firm-Specific Productivity Measure

The OP type of TFP for each firm i in industry j can be calculated after the coefficients of the production function have been estimated:

$$lnTFP_{ijt}^{OP} = y_{it} - \hat{\beta}_m m - \hat{\beta}_k k - \hat{\beta}_l l \tag{34}$$

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A2. Estimation Results - Two-stage TFP Estimation

First stage estimation: regress y_{it} over l_{it}, m_{it} and the terms of the fourth-order polynomial approximating $\phi_t(k_{it}, i_{it})$ to obtain estimates of $\hat{\beta}_l$ and $\hat{\beta_m}$. We report the coefficients of interest in the result tables.

Table 18: First stage TFP estimation - OP method

	y
l	0.602***
	(29.37)
m	0.229***
	(20.40)
Number of observations	2468
R^2	0.807

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Other control variables are included but not reported.

Second stage estimation: plugging in the first stage estimates of $\hat{\beta}_l$, $\hat{\beta_m}$, and $\hat{\phi}_{t-1}$ (residuals from first stage regression) into the second moment condition, using nonlinear least squares to estimate $\hat{\beta}_k$ with function f^{-1} appoximated by a fourth order polynominal in ϕ_{t-1}, $k_{i,t-1}$ and $p\hat{r}_{i,t-1}$. Similar to the first stage estimation, only the coefficient of interest (on capital) is reported in the result table below.

Table 19: Second stage TFP estimation - OP method

	y
k	0.145***
	(6.43)
Number of observations	2007
R^2	0.271

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Other control variables are included but not reported.

APPENDIX B: Proofs

Henceforth we set the wage as the numeraire so that $w_t = 1\ \forall t$. From the optimal vertical R&D condition (21), in equiliubrium it must be that q_{it} declines at the same rate as $A_{it}^{\max}$ grows, so that $q_{iv} = q_{i0}e^{-g_i v}$. As a result, $q_{iv}A_{it}^{\max} = q_{i0}A_{i0}^{\max}e^{g_i(t-v)}$. Also, S in units of the numeraire must be constant over time.

Then, (21) becomes:

$$1 = (1-\tau_i)\,\lambda\left(q_{i0}A_{i0}^{\max}\right)^{\frac{1}{1-\alpha}}\pi\int_0^{\infty}e^{-\left(r+\lambda\bar{n}_{is}+\frac{g_i}{1-\alpha}\right)s}ds$$

or

$$1 = (1-\tau_i)\,\pi\lambda\left[\left(q_{i0}A_{i0}^{\max}\right)^{\frac{1}{1-\alpha}}\right]\frac{1}{r+\lambda n_i+g_i\frac{1}{1-\alpha}} \tag{36}$$

To solve the model we now turn to the agent's preferences. Given the preferences in (9), if an agent has after-tax income S then she will spend $S\omega_i$ on each good i, so $q_{it}c_{it} = S\omega_i$. Total supply of good i is $\int_0^1 y_{it}(v,t)\,f_i(v,t)\,dv$, which depends on the distribution of technology vintages in use. Let us express this distribution in terms of the technology gap $a_i \equiv A_{it}/A_{it}^{\max}$, where $a_i \in (0,1]$. Then we can express supply in terms of the evolving distribution of vintages relative to the frontier. In a steady state, as in Aghion and Howitt (1998), this distribution has the form $f(a) = \frac{1}{a\sigma}a^{\frac{1}{\sigma_i}}$ so that, in steady state, letting $y_{it}(a)$ equal output at a firm with gap a, we have that $L_t c_{it} = \int_0^1 y_{is}(a)\,f(a)\,da$. Then,

$$\begin{aligned}
y_{iv}(a) &= q_{it}A_{iv}x_{it}^{\alpha} \\
&= q_{it}A_{iv}\left(\frac{\alpha^2 q_{it}A_{iv}}{w_t}\right)^{\frac{\alpha}{1-\alpha}} \\
&= q_{it}a_iA_{it}^{\max}\left(\alpha^2 q_{it}a_iA_{it}^{\max}\right)^{\frac{\alpha}{1-\alpha}} \\
&= \left(q_{it}a_iA_{it}^{\max}\right)^{\frac{1}{1-\alpha}}\alpha^{\frac{2\alpha}{1-\alpha}}
\end{aligned}$$

From here we can derive that

$$\begin{aligned}
Lc_{it} &= Q_{it}\int_0^1 y_{ia}(a) f(a)\,da \\
&= Q_{it}\alpha^{\frac{2\alpha}{1-\alpha}}\left(q_{it}A_{it}^{\max}\right)^{\frac{1}{1-\alpha}}\int_0^1 a_i^{\frac{1}{1-\alpha}}\frac{1}{a\sigma}a^{\frac{1}{\sigma}}da \\
&= Q_{it}\alpha^{\frac{2\alpha}{1-\alpha}}\left(q_{it}A_{it}^{\max}\right)^{\frac{1}{1-\alpha}}\frac{1}{\sigma_i}\int_0^1 a_i^{\frac{\alpha}{1-\alpha}+\frac{1}{\sigma}}da \\
&= Q_{it}\alpha^{\frac{2\alpha}{1-\alpha}}\left(q_{it}A_{it}^{\max}\right)^{\frac{1}{1-\alpha}}\frac{1}{\sigma_i}\left[\frac{1}{\frac{1}{1-\alpha}+\frac{1}{\sigma}}a_i^{\frac{1}{1-\alpha}+\frac{1}{\sigma_i}}\right]\int_0^1 \\
&= Q_{it}\alpha^{\frac{2\alpha}{1-\alpha}}\left(q_{it}A_{it}^{\max}\right)^{\frac{1}{1-\alpha}}\left(\frac{1}{\frac{\sigma}{1-\alpha}+1}\right) = L_t S\omega_i
\end{aligned}$$

where the final step sets demand equal to supply. This implies that

$$\left(q_{it}A_{it}^{\max}\right)^{\frac{1}{1-\alpha}} = \alpha^{\frac{-2\alpha}{1-\alpha}}\frac{L_t S_t}{Q_{it}}\omega_i\left(\frac{\sigma}{1-\alpha}+1\right) \tag{37}$$

Combining this with the optimal vertical R&D condition (21), we obtain:

$$1 = \pi(1-\tau_i)\lambda\alpha^{\frac{-2\alpha}{1-\alpha}}\frac{LS}{Q}\omega_i\left(\frac{\sigma}{1-\alpha}+1\right)\frac{1}{r+\lambda n_i+g_i\frac{1}{1-\alpha}} \tag{38}$$

Replacing the expression for g_i, we get

$$r + n_i\left[\lambda+\lambda\sigma\frac{1}{1-\alpha}\right] = \pi(1-\tau_i)\lambda\alpha^{\frac{-2\alpha}{1-\alpha}}\frac{LS}{Q}\omega_i\left(\frac{\sigma}{1-\alpha}+1\right) \tag{39}$$

Rearranging, we obtain equation (24) that characterizes optimal vertical R&D as a function of parameters and S.

Next we turn to horizontal R&D. Rearranging equation (22),

$$h_{it} = \psi'^{-1}\left(\frac{r+\lambda n_i+g_i\frac{1}{1-\alpha}}{\frac{\pi}{1+\frac{\sigma}{1-\alpha}}\left[\left(q_{i0}A_{i0}^{\max}\right)^{\frac{1}{1-\alpha}}\right]}\right)$$

Combining this with (37) and (24), the argument of $\psi'^{-1}(\cdot)$ becomes:

$$\frac{r+\lambda n_i+g_i\frac{1}{1-\alpha}}{\frac{\pi}{1+\frac{\sigma}{1-\alpha}}\left[\left(q_{i0}A_{i0}^{\max}\right)^{\frac{1}{1-\alpha}}\right]}=\lambda\left(1-\tau_i\right)\left[1+\sigma\frac{1}{1-\alpha}\right]$$

From here it follows that inequilibrium $h_{it}=\bar{h}$ does not vary across time nor across industries, so variation in R&D intensity $\bar{\rho}_i$ is driven solely by variation in $\bar{n}_i$. This completes the proof of Proposition 2.

Then, equilibrium uniqueness follows from the equilibrium budget condition, which becomes:

$$\sum_i\frac{Q_{i0}}{L_0}\int_0^1\pi_{ip}\left(a\right)f\left(a\right)da+\sum_i\frac{Q_{i0}}{L_0}\int_0^1\pi_{ir}\left(a\right)f\left(a\right)da+\left(L-\sum_i\bar{n}_i\frac{Q_{i0}}{L_0}-\sum_i\bar{h}\frac{Q_{i0}}{L_0}\right)=S.$$

Expanding, the left hand side is decreasing in S (through $\bar{n}_i$ and the rigth hand side is stricltly increasing, yielding a unique solution and the proof of Proposition 1.

Next, what is the impact of taxes on productivity growth in different industries? Clearly

$$\frac{dg_i}{d\tau}=\lambda\sigma\frac{dn_i^*}{d\tau}\tag{40}$$

so statements about productivity growth hinge on statements about R&D intensity based on (24). For example, since R&D intensity increases in $\frac{\omega_i}{Q_{i0}}$, we can see immediately that $\frac{dg_i}{d\tau}$ will be higher in industries where R&D intensity is higher, so statements about $\frac{\omega_i}{Q_{i0}}$ can be interpreted as statements about industry R&D intensity using the inverse function theorem.

First, the impact of higher taxes on R&D intensity is

$$\frac{d\bar{\rho}_i}{d\tau}=\frac{d\bar{n}_i}{d\tau}=-\frac{\pi\omega_iSL_0}{\alpha^{\frac{2\alpha}{1-\alpha}}Q_{i0}}+\frac{\left(1-\tau_i\right)\pi\omega_iL_0}{\alpha^{\frac{2\alpha}{1-\alpha}}Q_{i0}}\times\frac{dS}{d\tau}\tag{41}$$

This is negative if and only if:

$$\frac{(1-\tau_i)}{S} \times \frac{dS}{d\tau} < 1 \tag{42}$$

Also, comparing across industries,

$$\frac{d\bar{n}_i}{d\frac{\omega_i}{Q_{i0}}} = \frac{(1-\tau_i)\,\pi S L_0}{\alpha^{\frac{2\alpha}{1-\alpha}}} \tag{43}$$

Then

$$\frac{d^2 n_i^*}{d\frac{\omega_i}{Q_{i0}} d\tau} = -\frac{\pi S L_0}{\alpha^{\frac{2\alpha}{1-\alpha}}} + \frac{(1-\tau_i)\,\pi L_0}{\alpha^{\frac{2\alpha}{1-\alpha}}} S' \tag{44}$$

It is easy to show this is negative (so higher taxes particularly hurt productivity growth in the R&D intensive industries) provided condition (42) holds.

We now work to demonstrate (42) holds. Start from the fact that Walras' Law implies all labor must be used up in equilibrium, so that

$$\sum_i \frac{N_{it}}{L_t} + \sum_i \frac{M_{it}}{L_t} + \sum_i Q_{it} \int_{-\infty}^{t} x\,(v,t)\, f_i\,(v,t)\, dv = L_t$$

since

$$x_i\,(v,t) = \left(\frac{\alpha^2 q_{it} A_{iv}}{w_t}\right)^{\frac{1}{1-\alpha}}, \tag{45}$$

this becomes

$$\sum_i \frac{N_{i0}}{L_0} + \sum_i \frac{M_{i0}}{L_0} + \sum_i \frac{Q_{i0}}{L_0} \int_0^1 \left(\frac{\alpha^2 q_{it} A_{iv}}{w_t}\right)^{\frac{1}{1-\alpha}} \frac{1}{a\sigma} a^{\frac{1}{\sigma}} da = L_0$$

$$\sum_i \frac{N_{i0}}{L_0} + \sum_i \frac{M_{i0}}{L_0} + \alpha^{\frac{2\alpha}{1-\alpha}} \sum_i \frac{Q_{i0}}{L_0} \alpha^{\frac{-2\alpha}{1-\alpha}} \frac{L_0 S_0}{Q_{i0}} \omega_i \left(\frac{\sigma}{1-\alpha}+1\right)\left(\frac{1}{\frac{\sigma}{1-\alpha}+1}\right) = L$$

or

$$\sum_i \frac{N_{i0}}{L_0} + \sum_i \frac{M_{i0}}{L_0} + \sum_i S\omega_i = L_0$$

or simply

$$\sum_i \frac{N_{i0}}{L_0} + \sum_i \frac{M_{i0}}{L_0} + S = L_0$$

or

$$\sum_i \frac{Q_{i0}}{L_0}\bar{n}_i + \sum_i \frac{\bar{h}Q_{i0}}{L_0} + S = L_0 \tag{46}$$

The total derivative of (46) with respect to τ becomes:

$$\sum_i \frac{Q_{i0}}{L_0}\frac{dn_i}{d\tau} + \frac{d\psi'^{-1}}{dx}(x)\left[-\lambda\left(1+\sigma\frac{1}{1-\alpha}\right)\right]\sum_i \frac{Q_{i0}}{L_0} + S' = 0 \tag{47}$$

The middle term is positive.[5] If the first one is positive then $\frac{dS}{d\tau} < 0$.

Recall that

$$\frac{dn_{it}}{d\tau} = -\frac{\pi\omega_i S L_0}{\alpha^{\frac{2\alpha}{1-\alpha}}Q_{i0}} + \frac{(1-\tau_i)\,\pi\omega_i L_0}{\alpha^{\frac{2\alpha}{1-\alpha}}Q_{i0}} \times \frac{dS}{d\tau} \tag{48}$$

which is positive iff

$$-S + (1-\tau_i) \times \frac{dS}{d\tau} > 0 \tag{49}$$

which requires $\frac{dS}{d\tau_i} > 0$. So if $\frac{dn_{it}}{d\tau_i} > 0$ then $\frac{dS}{d\tau_i} > 0$ and equation (47) implies that $\frac{dS}{d\tau_i} < 0$. This is a contradiction. Hence, it must be that $\frac{dn_i}{d\tau_i} < 0$. This impies that condition (42) must hold, which in turn implies that $\frac{d^2 n_i^*}{d\frac{\omega_i}{Q_{i0}}d\tau_i} < 0$. This completes the proof of Proposition 3, as industrial support is defined as a *decrease* in τ_i.

[5]Note that ψ is increasing and concave, so ψ' is decreasing, so ψ'^{-1} is decreasing and so $\frac{d\psi'^{-1}}{dx}(x) < 0$).

APPENDIX C: Industrial Policy in East Asia

In the last thirty years of the twentieth century, the stunning growth rate of the East Asian economies took the world by storm. In 1991, East Asia was growing by 6.8 percent and thus became one of the world's best-performing regions (Hobday et al. 1995). However, out of the 23 countries of East Asia, much of the miracle was attributed to the progress made by Japan and the "Four Tigers": Hong Kong, Korea, Singapore, and Taiwan. Throughout the 1970s and 1980s, the GNP growth of Japan and the four dragons rose at two to three times the rates of older industrialized countries. Between 1965 and 1990, these countries increase their real income per capita four-fold (World Bank 1993). Japan jumped from the thirtieth richest country in per capital income in 1962 to eleventh in 1986; Taiwan from eighty-fifth to thirty-eighth; Korea from ninety-ninth to forty-fourth (Wade 1990).

This phenomenon, dubbed "the East Asian economic miracle," attracted immense scholarly interest, instigated heated debates over the nature of economic changes and true propellants of growth. The crux of such fierce contention boils down to how much change could be credited to the market-friendly versus interventionist government measures - two broad prescribed sets of public policies seeming to be at odds with each other.

"Getting the Fundamentals Right," or the Market-Conforming View of the East Asian Miracle

Despite recognizing pervasive and systematic government interventions through various channels, the World Bank report on the East Asian miracle in essence strictly adheres to the tenets of the neoclassical view. They credit the East Asian economies' achievements to "getting the basics right": high rate of private domestic investment, declining population growth rate hand in hand with productivity improvement, a better-educated labour force, and a more effective public administration system (World Bank 1993). These basics imply that government policies are limited to their prescribed neoclassical functions or certain interventions that further facilitate those policy fundamentals. In their analysis, the significant government actions in the thriving industrial sector of these economies turned out to be unproductive and misleading, and therefore not to be recommended to developing countries.

In East Asia's history, there is certainly some evidence in congruence with the World Bank's claims. For example, liberalization programs and more open trade regimes were successfully installed in all five countries under the economic systems based on private property ownership.

Following Japan's extraordinary export drive in the 1950s, the Four Tigers launched their ambitious export-promotion agendas with a set of government policies that changed their economic structures substantially. Take Taiwan and Singapore as examples. Taiwan's phenomenal economic development progress was traced back to the 1960 reform in which dramatic shifts in its economic structure took place. Earlier, the Taiwanese economy in the decade of the 1950s was characterized by "heavy import and foreign-exchange controls and a multiple and overvalued exchange rate system" (Wang 1994). Despite impressive growth up to 6 percent GNP per capita growth per annum in the first half of the decade, output growth slowed down significantly in the later half to a scanty 3.7 percent. Such economic stagnation prompted the government to launch a series of liberalization programs and export promotion initiatives in 1960. Capital market reforms were put in place to bolster larger-scale private investment projects. Moreover, the government concentrated its resources on supplying physical and organizational infrastructure, instituting a second agricultural revolution, including land consolidation and the development of the cultivating firm, to respond to labour shortages (Ranis and Fei 1988).

In 1974, Taiwan moved into organizational reforms by creating a bond market, which was followed by the establishment of an organized money market in 1976. In addition, long-run capital flows were liberalized via "a further reduction of government restrictions on foreign firm operations and positive government encouragement of joint ventures." (ibid., p. 132)

These innovations and policies helped bring about a more flexible financial market, expand the scope of commercial banks' operations, attract more foreign investment, foster trade activities, competitiveness, and industrial production.

Out of the five super-economies, Singapore has its developmental track most heavily imprinted by the presence of transnational corporations (TNCs). Singapore's shift from import-substitution to export-promotion strategy also happened in the 1960s after the country officially gained independence from the British colonial power. One of the ways the Singaporean government improved its export performance was by promoting industrialization and diversifying away from the country's traditional entrept business via cooperation with TNCs. In its efforts to attract the TNCs, Singapore allowed a high level of foreign control, introduced restrictive labour legislation, new investment incentives, and educational plans to provide more technically trained workers. Thanks to such freedom granted to foreign firms, administrative support from the state, a stable macroeconomic environment, political stability, and rapidly improving transportation and communications infrastructure, Singapore welcomed a substantial number of TNCs' entrances in the 1960s and 1970s (Hobday et al. 1995).

Additionally, while Singapore is known for its engagement with TNCs, Hong Kong stands out as an economy as close to a free market model as possible. Only returned to China from British control since 1997, Hong Kong inherited a long-standing economic practice of laissez-faire, or market-oriented policy (Chang 2010), from the British Empire in 1935. The rationale behind this policy, instituted by the Hong Kong Legislative Council, was that there was "little scope in a Colony like Hong Kong, having no natural raw products and a small domestic consumption, for the ambitious schemes of economic reconstruction or national planning which have become the modern fashion" (Haggard 1990). With massive inflows of capital flight and the arrivals of factory owners and investors from mainland China during times of political instability in the 1940s and 1950s, Hong Kong had the resources it needed to establish its initial industrial base. Large trading companies, which focused on leading local firms into the competitive market by providing them with designs and specifications, developed this base further (ibid., p. 163). This Hong Kong example is often used as a neoclassical weapon against advocates of government's strategic measures.

The facts above show how integration into the world economy was present in the economic development track of the East Asian economic miracle.

"Strategic Interventions": The Case for "Targeted" Industrial Policy

At the same time, liberalization programs and the encouragement of foreign investment flows were not the only ways through which the Singaporean and Taiwanese governments promoted their exports. Nor was it the case with export-driven Korea and Japan. "Targeted" industrial policy, or industrial policy in short, which is, according to Chang (2011), "a policy that deliberately favors particular industries over others, against market signals, usually (but not necessarily) to enhance efficiency and promote productivity growth," has been identified by a growing number of development economists as a set of pervasive and systematic government interventions crucial to the East Asian economic miracle. The policy toolset employed in these measures include the establishment of big state-owned corporations, credit rationing, protection via tariffs or subsidies, technological and administrative support, etc.

Industrial policy has been identified as the cause of an important shift in the export patterns of East Asia: the shift away from exports of natural resources and labour-intensive goods, to exports of human capital and technology-intensive goods, among other structural changes to these economies (Fukusaku 1992). This shift was crucial to the accelerating economic performance of the East Asian economies as it allowed them to move into high-technology and high-value trade sectors. The emerging school of thought on this topic has yielded substantial documentation of how industrial policy has been implemented, and how and why it works.

Industrial Policy in Japan, Korea, Taiwan and Singapore

Industrial policy in Japan came about with a heightened role for the government to play in its economy after the Meiji Restoration of 1868, its subsequent recovery of tariff autonomy in 1911, and establishment of state-owned model factories in a variety of industries: remarkably in shipbuilding, mining, textiles, and military industries. Despite selling most of these factories to the private sector at discounted prices later on, the state continued to play its role in these industries' development in the form of subsidy grants and infrastructural development (Chang 2002). For example, the shipbuilding industry received from 50 to 90 percent of all state subsidies before 1924 (ibid.). After creating the nation's first rail line in 1881, the Japanese government had to provide substantial concessions to private investors to keep them engaged in the railways industry (Smith 1955) and give large subsidies to the private sector rail companies during the 1880s and 1890s. Telegraph infrastructure was built by the Japanese state in 1869 and linked all major cities by 1880 while all principal trunk lines were nationalized in 1906 (Macpherson 1995).

Additionally, the Japanese government carried out various policies aimed at facilitating the transfer and absorption of advanced foreign technologies (Chang 2002). The results of such policies can be demonstrated by the decline in the number of foreign technical advisors it hired from 527 in 1875 to 155 by 1885 (Allen 2013). In 1911, Japan introduced tariff reforms to protect infant industries, to make raw materials imports more affordable and to monitor luxury goods (Macpherson 1995). By 1913, Japan was among the most protectionist countries in the world (Chang 2002). In his historical analysis, Chang discovered that such protectionist measures were used in not only Japan but also prevalently in the many developed countries in their earlier stages of development. These measures, he argues, were instrumental in laying the groundwork for the later advancements of their economies in terms of infrastructure and manufactured exports (ibid., pp. 13-68).

Along the same line, Wade (1990) also identifies a range of Japanese state interventions with the specific aim to promote select industrial sectors: redistributive land reform, post-reform ownership ceilings, restrictions on financial institutions, a bank-based financial system able to sustain high debt/ equity ratios, exchange rate controls, protection, direct foreign investment controls, export promotion, and selective government leadership in investment and technology. The policy directive of Japan's Ministry of International Trade and Industry (MITI), a principal institution supervising and managing the country's industrial development, well summarizes the government's adherence to industrial policy practice: "Public policies should be designed, it said, not merely to make the most efficient use existing resources, in the static sense of conventional theory, but to furnish the directional thrust and raise the finance for a set of heavy and chemical industries that had to be created." (ibid., p. 326)

Similarly, Korea and Taiwan, in contrast to the popular perception of these countries as free-trade champions, have employed deliberate industrial policy in their development strategies. According to Chang, Korean exports in the earlier years, for example basic garments and inexpensive electronics - were "all means to earn the hard currencies needed to pay for the advanced technologies and expensive machines that were necessary for the new, more difficult industries, which were protected through tariffs and subsidies" (Chang 2010). Contrary to neoliberal conviction, Korea did not pursue a neo-liberal economic development agenda throughout the 1960s and the 1980s but to develop certain new industries, chosen by the government in collaboration with the private sector, via measures of tariff protection, subsidies, technological and administrative government support, etc (ibid., p. 14).

Moreover, the Korean government implemented a fundamental reshaping of the investment structure with land reform and a publicly owned banking system. The banks, owned by the state until 1980-1983, were a central instrument in the state's market guidance and development of targeted industries by means of credit rationing. For example, in the industries like cement, steel, shipbuilding, machinery, the government prioritized some firms over others to become industry leaders via industrial licensing-cum-subsidized credit allocation.

In the cement industry, the Ssangyong group, a chaebol, or big state-owned corporation, was entitled to occupy almost half of cement-making capacity by the 1980s, and was then issued licenses for capacity expansions. In the steel industry, a newly created state-owned integrated enterprise, the Pohang Iron and Steel Company (POSCO) received very favorable treatment in terms of credit rationing as opposed to older and better-established mills (Amsden 1992).

In spite of nationalization, the Korean banks continue to be under government control and serve the purpose of industrial targeting. Through its monitoring of key parameters such as foreign exchange rates, interest rates, and aggregate demand, the Korean government successfully built an sphere of relative stability for long-term investment decisions and moderated the economy's exposure to international competitive forces in the domestic market (Wade 1990).

In Taiwan, the state played a major role in its industries' technological upgrading and latecomer firms' success. In addition to providing the educational and infrastructural groundwork necessary for industrial development, it orchestrated the industrial and macroeconomic framework of low inflation (Ranis and Schultz 1988) and high savings in order to facilitate latecomer firms' integration into the market. During the 1970s and 1980s, Taiwan's Ministry of Economic Affairs injected further technical support into industry through government-owned R&D institutes and universities. It also selectively invested in a number of firms working in scale-intensive, high-tech upstream sectors like semiconductors (Hobday et al. 1995).

Furthermore, the Taiwanese government has also influenced prices in order to bolster industrialists' profitability and attract more investment. It fixed agricultural prices at a low level throughout the 1950s and 1960s by compensating farmers with low input costs and socializing risks, which drove industrial wages lower and industrial profits higher. The Taiwanese state was also found to use measures like subsidies and duty drawbacks to reduce the costs of export production (Wade 1990).

Similar to Korea, the Taiwanese government used a number of methods to shape the investment pattern. It kept control over foreign exchange, incoming and outgoing direct foreign investment (FDI), and its ownership of the banking system to monitor the sectoral distribution of investment funds (ibid.). Outside their export-processing zones, which easily give the impression that Korea and Taiwan are pioneers of pro-FDI policy, these two countries imposed various restrictions on foreign investors, which enhanced their technological capabilities and absorption and reduce their dependence on foreign firms before the adoption of neo-liberal policies in the 1990s (Chang 2010).

In the case of Singapore, targeted industrial policy started in the early 1970s, after the decade of general favorable policies to attract TNCs of all industries. Attempting to raise the standard of technological investments, the Singaporean government started to focus on more skill-intensive and higher value-added export industries. In 1979 the National Wages Council introduced large increases in wages with a view to speeding up the shift towards technology-intensive manufacturing (Hobday et al. 1995). Additionally, Singapore put in place various policies for education, training, and skills development to meet the demands of the transfer of advanced knowledge and technological upgrading with the establishment of numerous institutes for software training, electronics engineering, advanced mechanical engineering and research (ibid., pp. 141-142).

Hong Kong: An Exception or a Confirmation?

While the experience of Japan, Korea, Singapore and Taiwan has proven a strong case of state-led development, especially via industrial targeting, Hong Kong has acquired success as an adherent of free trade and laissez-faire policy (Chang 2010). Does this represent an aberrant pattern for the East Asian industrial policy story? In fact, Hong Kong's special circumstances set it out as a case not to be considered at the same level with other city or nation states. The special administrative region has never been an independent state but only a "city within a bigger entity": since 1997 it has become the China's financial centre and previously was under the British rule (ibid., p. 29). Its economic growth is "a function of its service role in a wider regional economy, as entrepôt trader, regional headquarters for multinational companies, and refuge for nervous money" (Wade 1990). Given these conditions, it is less critical for Hong Kong to develop an independent industrial base, e.g. heavy and chemical industries, or instigate industrial breakthroughs.

Moreover, Hong Kong possesses no "significant and productivity-depressing agricultural sector," (ibid., 333) and it inherited an organizational and marketing capacity developed over the years by British-linked trading companies, which greatly facilitated the industrialization process.

Notwithstanding such special factors, the Hong Kong government has some unusual instruments and have exercised them in intervening in the economy. Firstly, it owns all the land, from which it collects substantial revenue through selling on leasehold and hence becomes relieved from the burden of collecting taxes. However, Hong Kong also provides subsidized housing to about half of its population, which helps keep the costs of labour down, and hence facilitate production, employment and investment. And finally, since the 1970s, waking up to the reality of slowing exports compared to Taiwan and Singapore, the Hong Kong government embarked on a radical departure from its traditional laissez-faire policy: it set up communications and technology laboratories to help its local electronics industry with training and technology transfer, and hire consultants to look into potential technology with industrial applications (ibid.). These moves have unfailingly echoed the reverberations of the "make the winners" strategy as analyzed in the other East Asian economies.

All in all, the experience of the East Asian super-economies was a rather controversial mixture of market-friendly and interventionist policies, out of which many heated debates have spiraled to no limits. Scholarly understanding is inevitably subject to the interpretation of historical evidence and personal bias, as perspectives diversify along a range of paradigms.

The rationale for the application of targeted industrial policy to latecomer countries' industrialization, however, seems to have gained traction over the years, as it has shaken the most powerful neoliberal institutions to the revision of its own principles. With the current global economic downturn, or the so-called "capitalism's crisis," here and there we have seen the return of states' efforts to influence market paradigms, evidently in the United States' recent plans to consolidate a number of federal agencies, making what is seen as an American version of Japan's MITI, in order to enhance its export prowess through more potent strategic policies (Bartlett 2016).

APPENDIX D: Institutional Background of Industrial Policy in Vietnam

In efforts to promote industrialization and technological upgrading, many developing and newly industrialized countries (NICs), including China and Vietnam, have adopted "industrial policy" in recent decades. Falling a few decades behind the East Asian "miracle" economies, latecomer countries have been faced with an increasingly globalized world that has thrusted the agenda of economic development policy into a convoluted web of complex socio-political and financial interactions, raising doubts over the applicability of "lessons learned" from the forerunners, stoking heated debates over the necessary caveats or targeting methods for industrial policies as relevant to the adopters' specific conditions.

As the prescriptions of industrial policy embody the generation of a visionary economic development plan for science, engineering and technology, there is ample evidence on the pursuit of industrial policy in both OECD and non-OECD countries by way of their adoption of national industrial strategies which come hand in hand with the creation of institutions specifically dedicated to foster such activities as thoroughly documented in Warwick (2013). For example, among OECD countries, the Netherlands established the Ministry of Economic Affairs, Agriculture and Innovation in 2011 in order to promote new strategies to boost the economy's competitiveness and innovativeness in targeted sectors such as high tech, life sciences, chemicals and energy. At the same time, Brazil, China, India, Argentina, Colombia and Vietnam are known as examples of non-OECD countries which have also been actively pursuing industrial policy. Specifically, Vietnam has crafted national strategies with a goal to diversifying its economy and promoting innovative activities to enhance competitiveness.

The transition of Vietnam's focus from import-substitution to export-orientation has been well documented in the literature as one of the breakthrough strategies in the country's renovation efforts called Doi Moi starting in 1986. Vietnam has successfully made substantial strides towards full integration into the global trade networks and supply chains through the establishment of numerous export processing zones and industrial zones to attract multinational companies and international trade partners. Vietnam's industrial competitiveness, however, rests mainly on the synergies developed from the entrance and operations of foreign-owned companies (Perkins and Anh 2010). The country is still facing significant challenges in catching up with developed countries in the level of technology and competitiveness. Without a competitive business environment, market institutions that support productivity growth, and the development of supporting industry and industrial upgrading, Vietnam remains stuck in the role of an assembly platform for global value chains (GVCs), limited to the final stages of production in its major GVCs including textiles and apparel and information and communications technology (ICT) hardware. As the recent waves of FDI inflows into Vietnam are partly associated with a shift in low-wage production from China in what is dubbed China+1 strategy, the country is facing high risks of experiencing rapid in-and-out movements of FDI where activities are low value-added, which draws a picture of a future that is darkened with many uncertainties (Hollweg et al. 2017).

For example, a study of the textile and apparel industry of Vietnam has examined the paradox of SMEs' virtual absence in the export business despite their domination in the domestic market. The study points out major obstacles to SMEs' participation in this export market including these companies' low technology and manufacturing capacities, dependence on imported materials from China, Korea, and Taiwan, lack of horizontal (cooperation among firms in the same production step) and vertical linkages (cooperation among firms across different production steps) in value chains, and lack of effective policy support in a poor business environment (APEC 2016)

In recent years, the Socialist Government of Vietnam (SGoV) has placed a strong emphasis on improving the country's private-sector business-enabling environment, as is clear from a number of development strategy documents. Resolution No. 142/2016/QH13 (April 04, 2016) on the Socio-Economic Development Plan (SEDP) for 2016-2020 period states nine targets for economic development, including 6.5-to-7 percent average GDP growth, getting the composition of industry and services in the economy to reach 85 percent, and increasing TFP's contribution to growth to 30 to 35 percent. With such goals, the SEDP emphasizes the need to improve the efficiency of public investment and the reallocation of the state's financial resources towards the objective to the participation and investment of the non-state sector. The SGoV will prioritize public investment in areas where no other economic actors participate in. Section Two of the SEDP's elaborations of major solutions details the steps to significantly improve the country's investment climate so that Vietnam enters into the top four countries in South East Asia. A first step includes further restructuring of the SOE sector. A second step aims to improve conditions for strong private-sector development, for example, by completing the legal framework and policies for privately owned enterprises to have equal access to resources, especially in terms of credit, land and natural resources. A third step envisions offering greater support to stimulate the development of the small-and-medium-enterprise (SME) sector, household enterprises, and cooperatives. These development objectives go hand in hand with the vision of promoting consumption of domestic products and trade activities, expanding the export market together with building stronger Vietnamese brand names, and actively participating in global value chains.

The same discourse resonates in Resolution No. 23/2016/QH14 (December 05, 2016) containing the SEDP for 2017 and in Decision No. 622/QD-TTg (May 10, 2017) on the formulating the National Action Plan to implement the 2030 Consultation Program for Sustainable Development. Indeed, in recent years, the SGoV has shown its commitment to shift a considerable amount of resources to the private sector, especially targeting the SMEs through a series of policies and programs. Specifically, Decree No. 56/2009/ND-CP (June 30, 2009) on development support to SMEs focuses on the following sectors: agriculture, forestry and fisheries, industry and construction, commerce and services, with priority being given to enterprises with female owners or many female workers. Support policies under this Decree include:

- Establishment of credit funds for SMEs to facilitate improvements in competitiveness, technological upgrading, and product and managerial innovation; and

- Technical support projects to (i) strengthen capacity for financial organizations to extend credit supply to SMEs, (ii) support for product innovation and product and service diversification, (iii) financial consulting, (iv) investment management and other customer services for SME clients; (v) administrative support to SME in filling out loan applications to meet requirements by credit institutions.
- The Decree was followed by Decision 601/QD-TTg (April 17, 2013) to establish SME Development Fund (SMEDF) with a budget of VND 2000 Billion, equivalent to US$ 88M. A five-year SME Development Plan 2011-2015 has been formulated and the SME Promotion Law was passed on June 12, 2017.

Moreover, with Decree No. 19-2017/NQ-CP (February 06, 2017) on the continuation of the implementation of specific tasks and solutions to improve the business environment and improve national competitiveness in 2017 with a view towards 2020, the SGoV has detailed targets to achieve to facilitate a better business-enabling environment such as the shortening of time for businesses to conduct certain procedures, including paying tax and social insurance contributions (not to exceed 168 hours per year); granting of construction permits not to exceed 63 days; maximum of 300 days for resolution of contract-related disputes and handling of bankruptcy procedures not to exceed 30 months, etc. This decree is another demonstration of the high priority SGoV places on the business-enabling environment and the enhancement of national competitiveness with particular attention to the SME sector.

Regarding taxation, the SGoV has a comprehensive framework for the provision of tax incentives to targeted sectors and/or export services or new investment or expansion projects in manufacturing. Specifically, corporate income tax incentives are provided to prioritized sectors such as education, health care, culture, high technology, environmental protection, scientific research and technology, infrastructural development, processing of agricultural and aquatic products, software production and renewable energy. Products or services in investment projects in manufacturing and industrial sectors such as those supporting the development of high technology industries or industries such as garment, textile, footwear, electronic spare parts, automobile assembly or mechanical sectors are also eligible for tax incentives. In addition, value added tax (VAT) exempted or reduced VAT rates are applied to goods processed for exporting and other goods and services related to export activities as well as goods and services related to the provision of essential services as detailed in PricewaterhouseCoopers (2017). There is thus clear evidence that the SGoV has been systematically implementing industrial policy in a wide range of strategic and essential sectors for economic development.

APPENDIX E: Graphs on Distribution of Tax Holiday Variables

Figure 2: **Tax Holiday Distribution**

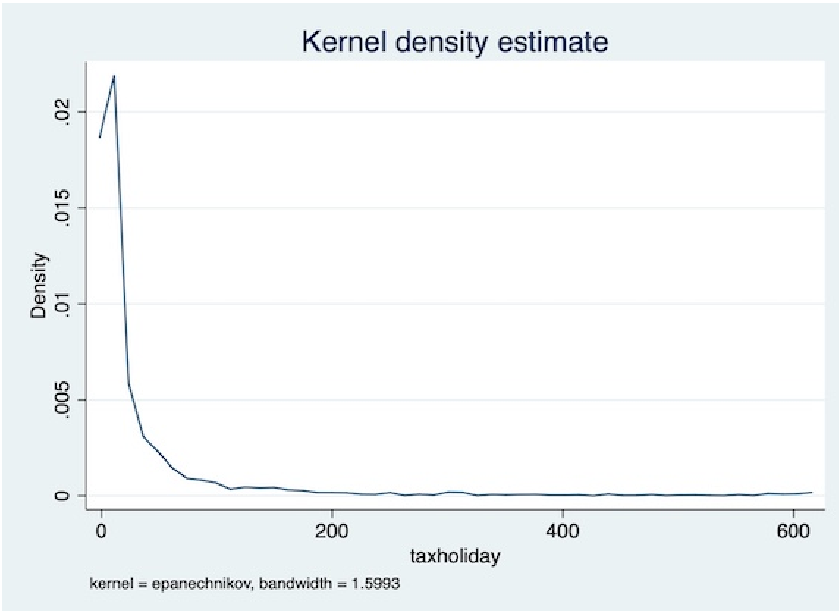
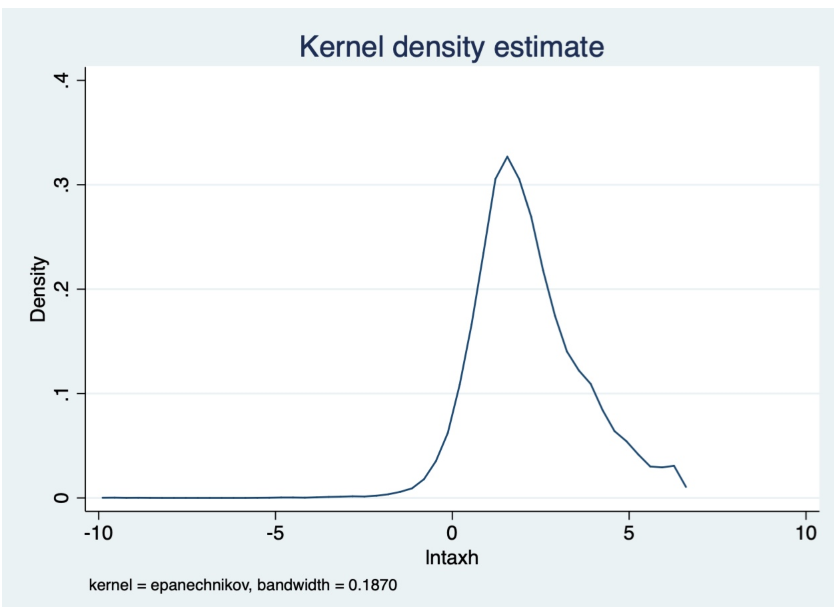


Figure 3: **Distribution of the Log of Tax Holiday**



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