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# FDI spillovers and productivity in Vietnamese manufacturing industries - New insights from the unconditional quantile regression

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## Abstract

This research investigates the effects of FDI spillovers on the productivity of domestic firms by relying on unconditional quantile regression. Using panel data of Vietnamese enterprises over the period 2000-2012, we find evidence of positive spillovers for firms at the lower tails and negative spillovers for those at the upper tails of the productivity distribution. Time and the firm's legal status are other factors determining the effect of FDI spillovers. Notably, only low productivity state-own enterprises benefit from positive horizontal spillovers, but in the long run rather than in the short run.

**JEL codes:** F63, O47, O1, F23.

**Key words:** FDI spillovers; Total factor productivity; Domestic firms; Unconditional quantile regression.

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# 1 Introduction

Foreign direct investment (FDI) and productivity have been considered as one of the main forces for economic development. Consequently, many developing countries have adopted policies to attract FDI, hoping domestic firms could benefit from FDI spillovers to enhance their productivity. Besides, despite a rich literature, studying the impact of FDI spillovers on the productivity of domestic firms is always a vital research area. Even so, empirical studies on developing countries using panel data at the firm level fail to provide a conclusive consensus. While horizontal spillovers are almost absent or negative, vertical ones (backward or forward spillovers) are positive in some countries. Given the lack of conclusive evidence, it is vital to revisit FDI spillover effects.

On the other hand, it is noteworthy that the literature mainly estimates the impact of FDI spillovers on the domestic firm's total factor productivity (TFP) at the sample mean. However, since firms are heterogeneous, such an impact would be different at different quantiles of the TFP distribution. Thus, a sole estimation of the sample mean could be inconsistent. Most importantly, this could under or over-evaluate the impact of FDI spillovers, generating misunderstanding and inappropriate policies. Although little research investigates the FDI spillover effects at different points of the productivity distribution (see, for instance, [Girma and Gorg, 2005](#); [Benli, 2016](#)), they primarily rely on conditional quantile regression (CQR), which could generate some econometric issues associated with omitted variables due to the nature of conditional estimation.

The above issues prompt us to reexamine FDI spillover effects in the context of a developing country. We use panel data on Vietnamese manufacturing enterprises between 2000 and 2012. The country is chosen for two reasons. First, it belongs to the most attractive economies for FDI location, together with other developing countries such as China, India, Brazil, and Mexico ([UNCTAD, 2010](#)). A high economic growth perspective and easy access to regional markets are the major attractiveness of the country. Second, since applying the *Doi Moi* law in 1986, the country has implemented many complement policies to open up the economy and attract inward FDI. Given these elements, it is primordial to investigate whether or not Vietnamese firms could benefit from positive FDI spillovers.

We perform a two-step estimation process. In the first step, we apply the [Akerberg et al. \(2015\)](#) (ACF) method to compute the firm's TFP by estimating its production function. In the second step, we estimate the effects of FDI spillovers at different points of the firm's TFP distribution by relying on the unconditional quantile regression (UQR) developed by [Firpo et al. \(2009\)](#). The estimation reveals heterogeneous effects of FDI spillovers across the firm's TFP distribution and ownership. Interestingly, only low-productivity domestic firms benefit from FDI spillovers, while they become harmful for those at the top positions of the TFP distribution.

This paper has two significant contributions to the literature. On the one hand, we advance the understanding of when, why, and where a typical FDI spillover could be positive, nil, or negative in the context of a developing country. Thus, these findings make our study different from previous research. Indeed, unlike other studies, which only provide an average impact of FDI spillovers, we allow for heterogeneous effects by considering the firm productivity's distribution. Most importantly, the possibility

of enjoying positive horizontal spillovers gives a more optimistic picture of FDI in developing countries. Getting such heterogeneous effects is of great importance to drive adequate policies. On the other hand, the UQR applied in our study provides a new methodology to investigate the effect of FDI spillovers. It offers at least two advantages over the common CQR. Indeed, the CQR provides a conditional quantile partial effect (CQPE) that could lead to an over or underestimation at a typical quantile. The UQR considers this issue by estimating the unconditional quantile (marginal) partial effect (UQPE), a weighted average of the CQPE. Most importantly, unlike the CQR, whose partial effect generally depends on covariates, adding any control variables does not affect that of the UQR. Consequently, the UQR generally gives robust quantile partial effects and partly corrects econometric issues associated with omitted variables.

The rest of the paper is organized as follows. Section 2 provides a state of art about the impacts of FDI spillovers on the productivity of domestic firms. Section 3 presents the data and methodological approach before reporting empirical findings in Section 4. Section 5 summarizes the results and concludes.

## 2 FDI spillovers and domestic firm productivity

By entering a host country, multinational enterprises (MNEs) may have some ‘spillover’ effects on domestic firms. Spillover, commonly defined as a transfer of new technology, marketing techniques, or other knowledge, can be generated in the same industry (horizontal spillovers), downstream industries (forward spillovers), or upstream industries (backward spillovers). Generally, local firms may benefit from FDI spillovers through four channels: imitation (demonstration), labor turnover, export, or vertical (backward or forward) linkages (Crespo and Fontoura, 2007).<sup>1</sup>

There is a high number of research examining horizontal spillovers with mixed evidence. Most studies of developing countries reveal a negative or nil effect. For instance, Haddad and Harrison (1993) observe a negative impact of horizontal spillovers on the productivity of Moroccan manufacturing firms from 1985-1989. Meanwhile, MNEs negatively affect Venezuelan firms in the same industry between 1976 and 1989 (Aitken and Harrison, 1999). The negative or nil effect of horizontal spillovers is also found in other developing countries such as the Czech Republic (Djankov and Hoekman, 2000); Bulgaria, Romania, and Poland (Konings, 2001); China (Hu and Jefferson, 2002; Lu et al., 2017); or 17 transition countries (Gorodnichenko et al., 2014). By contrast, horizontal spillovers are rather positive in developed countries such as Ireland (Ruane and Ugur, 2005), the UK (Haskel et al., 2007), the US (Keller and Yeaple, 2009), or a group of eight advanced European countries (Fons-Rosen et al., 2021).<sup>2</sup>

Unlike horizontal spillovers, positive vertical ones are more likely to occur. Indeed, an MNE may create relationships with some local suppliers and thus has a real incentive to improve their productivity through technology transfer (Lin and Saggi, 2007; Blalock and Gertler, 2008). While positive spillovers through backward linkages

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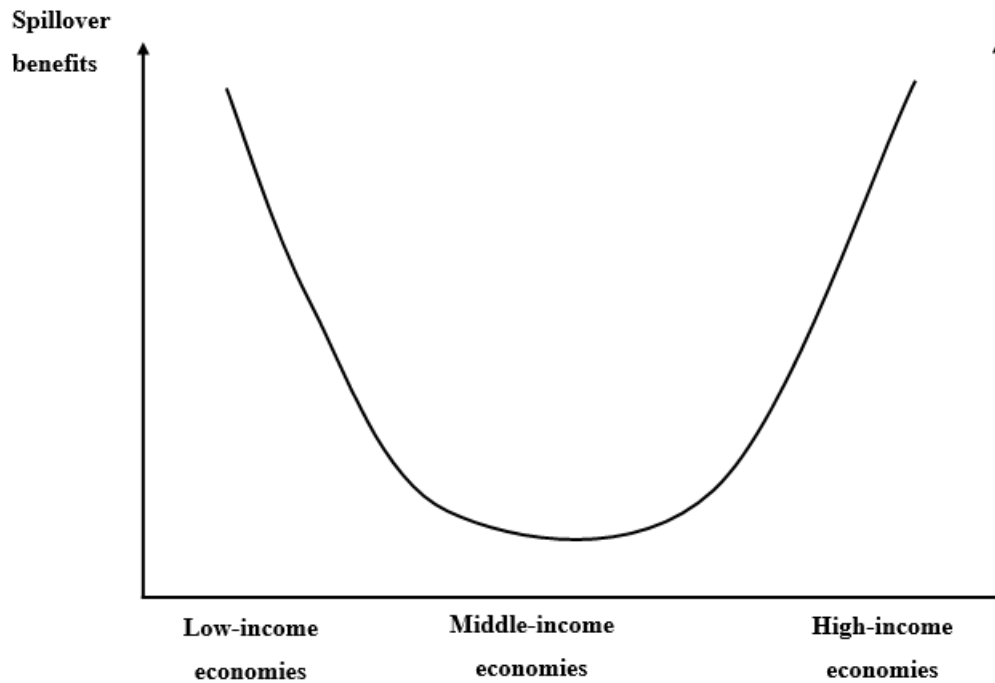
<sup>1</sup>Please refer to Crespo and Fontoura (2007) for a literature review or Meyer and Sinani (2009); Irsova and Havranek (2013) for a meta-analysis of FDI spillovers.

<sup>2</sup>These countries are Belgium, Finland, France, Germany, Italy, Norway, Spain, and Sweden.

were recognized long ago (since the work of [Rodriguez-Clare, 1996](#) and [Markusen and Venables, 1999](#)), empirical studies of vertical spillovers have only recently developed. The overwhelming finding is that vertical spillovers almost benefit domestic firms, regardless of the development level of host countries. For example, [Javorcik \(2004\)](#) finds positive backward spillovers in Lithuania; [Lu et al. \(2017\)](#) observe positive vertical spillover effect in China; or [Barrios et al. \(2011\)](#) find positive backward spillovers in Ireland. Meanwhile, [Gorodnichenko et al. \(2014\)](#) reveal positive backward spillovers in 17 emerging market economies.

Many factors occur to condition the effect of FDI spillovers. The absorptive capacity of domestic firms has a primary role ([Girma and Gorg, 2005](#); [Meyer and Sinani, 2009](#)). Accordingly, a common explanation of negative horizontal spillovers in developing countries is the low absorptive capacity of local firms ([Crespo and Fontoura, 2007](#); [Meyer and Sinani, 2009](#); [Damijan et al., 2013](#)). Human capital and technological capacity are frequent measures of absorptive capacity and have been broadly used in the literature (see, for example, [Haskel et al., 2007](#); [Keller and Yeaple, 2009](#); [Gorodnichenko et al., 2014](#), among others). Institutions, trade openness, time, and geographical distance between MNEs and domestic firms could be other factors determining FDI spillovers ([Damijan et al., 2013](#); [Merlevede et al., 2014](#); [Gorodnichenko et al., 2014](#)). More generally, according to [Meyer and Sinani \(2009\)](#), we can rely on the economic development level of the host country to explain the effect of FDI spillovers, as displayed in Figure 1 below.

Figure 1: FDI spillovers and economic development



Source: [Meyer and Sinani \(2009\)](#).

Overall, the FDI spillover effect depends on the interaction between the demon-

stration, motivation, and competition effects. At low levels of economic development, domestic firms can benefit from standard technology that MNEs do not intend to prevent from diffusion. Besides, they operate in different market segments than their local counterparts. Thus, the demonstration/imitation effect is strong, while the competition effect is weak. Consequently, although domestic firms have a low incentive to improve their absorptive capacity, FDI spillovers are positive in those economies. The early development state in Mexico (e.g., during the 1970s) likely supports this situation (Blomstrom and Persson, 1983; Blomstrom, 1986). When host countries reach some medium levels of economic development, domestic firms are more likely to compete with MNEs. The latter protect their technology more, resulting in a weak demonstration effect and high competition. Besides, the absorptive capacity of domestic firms is low due to a weak incentive or investment. Hence, FDI spillovers become nil or even harmful. It is the case of developing countries mentioned above (e.g., Morocco in Haddad and Harrison, 1993; Venezuela in Aitken and Harrison 1999; 17 transition countries in Gorodnichenko et al. 2014). Last, in developed countries, MNEs directly compete with local firms in the same or similar market segments. However, the former, which have developed their competitiveness through investments in human capital or new technology, can still gain from the competition. FDI spillovers are no longer harmful but beneficial. Some developed countries such as the U.K., the U.S. or some advanced European countries (Haskel et al., 2007; Keller and Yeaple, 2009; Fons-Rosen et al., 2021) have exhibited such a situation.

To sum up, there is a rich literature that provides mixed evidence of the impact of FDI spillovers on the productivity of domestic firms. However, empirical studies mainly give an average impact by estimating the productivity at the sample mean. Since domestic firms are heterogeneous and would absorb spillovers differently, investigating FDI spillovers at different points of the productivity distribution could be more suitable than the sole sample mean estimation. Little research examines the effects of FDI spillovers at different points of the productivity distribution by relying on CQR. For instance, Girma and Gorg (2005) find evidence of some heterogeneous results across sectors and quantiles for U.K. firms. Moreover, the authors observe a u-sharp relationship between productivity growth and FDI spillovers interacting with the firm’s absorptive capacity. Similarly, Benli (2016) also states different effects of FDI spillovers throughout the firm’s TFP distribution in Turkey.

## 3 Data and Methodology

### 3.1 Estimate strategies: A two-step estimation

This subsection builds a general framework to investigate the impacts of FDI spillovers on TFP. We process a two-step estimation where the first step is to compute the firm’s dynamic TFP by estimating the firm production function, and the second step is to estimate how covariates affect it at different quantiles. More precisely, FDI spillovers and other control variables are introduced as additional factors in explaining the productivity of domestic firms. Such an estimation strategy is commonly applied in many studies on the topic of FDI spillovers (see, for example, Damijan et al. 2013; Merlevede et al. 2014; Lu et al. 2017; Fons-Rosen et al. 2021, among others). Last, we

explain how to adjust the standard errors in a two-step estimation process.

### 3.1.1 Step 1: Computing the firm's TFP

To compute the firm's TFP, one needs to estimate the parameters associated with its production function. Consider a added-value Cobb-Douglas production function (in log) of firm  $i$  in time  $t$  as:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \varepsilon_{it} \quad (1)$$

where index  $it$  refers to firm  $i$  in year  $t$ . Besides,  $y$  is the log of output,  $k$ , the log of capital,  $l$ , the log of labor,  $\omega$ , a productivity shock, and  $\varepsilon$ , an independent and identically distributed error.

While the firm managers usually observe  $\omega$ , it is an unobserved econometric variable. Consequently, general models such as pooled OLS or fixed-effects become inconsistent in estimating Equation (1) since they omit the potential productivity shock  $\omega$ . To address this issue, [Olley and Pakes \(1996\)](#) (OP in short) and [Levinsohn and Petrin \(2003\)](#) (LP in short) propose a dynamic production estimate. Nevertheless, these estimators present functional dependence problems as labor has no dynamic implications and is determined at  $t$  ([Akerberg et al., 2015](#)). Besides, the OP and LP methods could no longer be efficient because of serial correlation and heterogeneity ([Wooldridge, 2009](#)). To tackle the limits of OP and LP estimators, [Wooldridge \(2009\)](#) propose a GMM approach, while [Akerberg et al. \(2015\)](#) develop an alternative estimator.<sup>3</sup>

This research relies on the ACF method to estimate the firm production function and then compute its TFP.<sup>4</sup> Accordingly, we have the following assumptions:

- The firm information set at  $t$  ( $I_{it}$ ) includes current and past productivity shocks but not the future ones and  $E[\varepsilon_{it} | I_{it}] = 0$ .
- The firm capital accumulation is determined by:

$$k_{it} = \kappa(k_{it-1}, i_{it-1})$$

where investment decision  $i_{it-1}$  is chosen in  $t - 1$ .

- Labor input  $l_{it}$  has potential dynamic implications and is chosen at  $t$ ,  $t - 1$ , or  $t - b$ , with  $b \in (0, 1)$ .
- The firm's intermediate input demand is:

$$m_{it} = f_t(k_{it}, l_{it}, \omega_{it}).$$

- $f_t(k_{it}, l_{it}, \omega_{it})$  is strictly increasing in  $\omega_{it}$ .

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<sup>3</sup>Please refers to [Wooldridge \(2009\)](#) (p. 112-113) and [Akerberg et al. \(2015\)](#) (p. 2431) for advantages of the associated method over the OP and LP estimators.

<sup>4</sup>As a robustness verification, the GMM estimator developed by [Wooldridge \(2009\)](#) is also performed.

Consequently, we can represent  $\omega_{it}$  as an invert intermediate input demand  $\omega_{it} = f_t^{-1}(k_{it}, l_{it}, m_{it})$ , and rewrite Equation (1) as:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + f_t^{-1}(k_{it}, l_{it}, m_{it}) + \varepsilon_{it} = \phi(k_{it}, l_{it}, m_{it}) + \varepsilon_{it} \quad (2)$$

where  $\phi(k_{it}, l_{it}, m_{it}) := \beta_0 + \beta_k k_{it} + \beta_l l_{it} + f_t^{-1}(k_{it}, l_{it}, m_{it})$ .

Equation (2) can be estimated in two stages. The first stage is to estimate and  $\hat{\phi}(k_{it}, l_{it}, m_{it})$  of  $\phi(k_{it}, l_{it}, m_{it})$  by using the moment condition:

$$E[\varepsilon_{it} | I_{it}] = E[y_{it} - \phi(k_{it}, l_{it}, m_{it}) | I_{it}] = 0 \quad (3)$$

Besides, under the above assumptions, the productivity shock  $\omega_{it}$  can be decomposed into  $\varsigma_{it}$  and  $g(\omega_{it-1})$  as:

$$\omega_{it} = E[\omega_{it} | I_{it-1}] + \varsigma_{it} = E[\omega_{it} | \omega_{it-1}] + \varsigma_{it} = g(\omega_{it-1}) + \varsigma_{it}.$$

Therefore, all production function's parameters  $(\beta_k, \beta_l)$  can be estimated at the second stage, using the following moment condition:

$$\begin{aligned} E[\varsigma_{it} + \varepsilon_{it} | I_{it-1}] &= E[y_{it} - \beta_0 - \beta_l l_{it} - \beta_k k_{it} \\ &\quad - g(\phi_{t-1}(k_{it-1}, l_{it-1}, m_{it-1}) - \beta_0 - \beta_k k_{it-1} - \beta_l l_{it-1}) | I_{it-1}] = 0 \end{aligned} \quad (4)$$

where  $\phi_{t-1}$  is replaced by its estimated value from the first stage.

Once the firm production function's parameters are estimated, its TFP (in log) can be computed as:

$$TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} \quad (5)$$

### 3.1.2 Step 2: Estimating the FDI spillovers' impact at different points of the TFP distribution

To investigate how FDI spillovers affect domestic firms at different TFP distribution quantiles, we rely on the UQR developed by [Firpo et al. \(2009\)](#). This method performs a *recentered influence function* of the unconditional quantile of the outcome variable on the covariates.

By definition, the unconditional (marginal) distribution of the dependent variable  $Y$  can be expressed as:

$$F_Y(y) = \int F_{Y|X}(y|X=x) dF_X(x)$$

where  $X$  is a set of covariates, and the RIF:

$$\begin{aligned} RIF(y; v, F_Y) &= v(F_Y) + \int IF(s; v, F_Y) \cdot d\Delta_y(s) \\ &= v(F_Y) + IF(y; v, F_Y). \end{aligned}$$

Consequently, as shown in Corollary 1 ([Firpo et al., 2009](#)), the vector  $\alpha(v)$  of partial effects of small location shifts in the distribution of a continuous covariate  $X$  on  $v(F_Y)$  can be written as:

$$\alpha(v) = \int \frac{dE[RIF(Y; v)|X=x]}{dx} \cdot dF(x). \quad (6)$$



Turning to the case of quantiles, the RIF at the  $\tau$ -th quantile,  $q_\tau$  ( $q_\tau = v_\tau(F_Y) = \inf_q \{q : F_Y(q) \geq \tau\}$ ), can be expressed as:

$$\begin{aligned} RIF(y; q_\tau) &= q_\tau + IF(y; q_\tau) \\ &= q_\tau + \frac{\tau - \mathbb{1}\{y \leq q_\tau\}}{f_Y(q_\tau)} \\ &= c_{1,\tau} \cdot \mathbb{1}\{y \leq q_\tau\} + c_{2,\tau} \end{aligned} \quad (7)$$

where  $c_{1,\tau} = \frac{1}{f_Y(q_\tau)}$ ,  $c_{2,\tau} = q_\tau - c_{1,\tau}(1 - \tau)$ , and  $f_Y(q_\tau)$  is the density of  $Y$  evaluated at  $q_\tau$ . Thus

$$E[RIF(Y; q_\tau) | X = x] = c_{1,\tau} \cdot \Pr[(Y > q_\tau) | X = x] + c_{2,\tau}.$$

Using Equation (6), the unconditional partial effect, denoted by  $\alpha(\tau)$ , at the  $\tau$ th quantile is computed as:

$$\alpha(\tau) = \frac{\partial v_\tau(F_{Y,t,G_Y^*})}{\partial t} \Big|_{t=0} = c_{1,\tau} \cdot \int \frac{d\Pr[(Y > q_\tau) | X = x]}{dx} \cdot dF_X(x). \quad (8)$$

Accordingly, the estimation of  $UQPE(\tau)$  using RIF regressions includes three components:

- (i) the quantile  $q_\tau$ , whose the estimator can be expressed as:

$$\hat{q}_\tau = \underset{q}{\operatorname{argmin}} \sum_{i=1}^N (\tau - \mathbb{1}\{Y_i - q \leq 0\}) \cdot (Y_i - q).$$

- (ii) the density of the unconditional distribution of  $Y$  involving in the constant,  $c_{1,\tau} = \frac{1}{f_Y(q_\tau)}$ . The density  $f_Y(q_\tau)$  is estimated by using the kernel density estimator

$$\hat{f}(\hat{q}_\tau) = \frac{1}{N \cdot b} \cdot \sum_{i=1}^N \mathcal{K}_Y \left( \frac{Y_i - \hat{q}_\tau}{b} \right)$$

where  $\mathcal{K}_Y(z)$  is a kernel function and  $b$  is a positive scalar bandwidth.<sup>5</sup>

- (iii) the average marginal effect  $E \left( \frac{d\Pr[(Y > q_\tau) | X = x]}{dx} \right)$ , which can be estimated either with an OLS, logit, or nonparametric estimator.

From the work of [Firpo et al. \(2009\)](#), [Borgen \(2016\)](#) provides some extensions to consider a large number of fixed effects and cluster-bootstrapped standard errors.

### 3.1.3 Correcting standard errors in a two-step estimation

Notice that using a two-step estimation always raises a question related to the computation of standard errors in the second step. They are usually known as ‘incorrect.’ Different methods are developed to tackle such an issue as computing the asymptotic covariance ([Murphy and Topel, 1985](#)), using nested samples ([Karaca-Mandic and Train, 2003](#)), or bootstrapping ([Wooldridge, 2015](#)). The latter is particularly useful when other methods are analytically unavailable. In this research, standard errors of the second step estimation are obtained by 200 bootstrap replications.

<sup>5</sup>As in [Firpo et al. \(2009\)](#), the Gaussian kernel is used for the estimation.

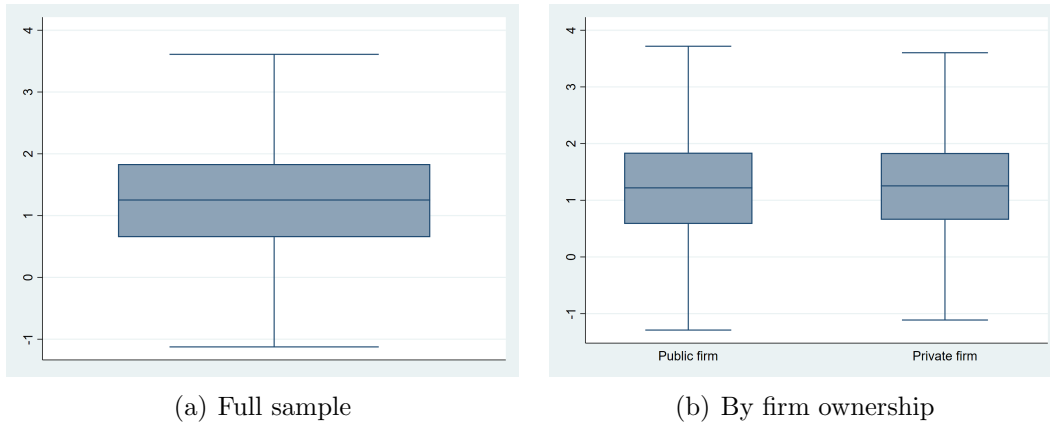
## 3.2 Data and econometric specification

### 3.2.1 Data

The data used in this research are from the Enterprises Annual Survey conducted by the General Statistics Office from 2000-2012. These surveys cover state-owned enterprises (SOEs) and non-SOEs (private and foreign firms). The data set contains different variables, including the firm's main characteristics, such as its identification number (tax code), geographical location, industrial affiliation, and ownership (SOEs, private, or foreign firms). The data set also provides the firm's operational and financial information as sales, materials, employment, fixed assets, investment, export and import value, and different duties or taxes. Since this research attempts to determine the effect of FDI spillovers on domestic firms' productivity, we follow [Lu et al. \(2017\)](#) by excluding from the regression sample all foreign firms. Besides, we are only interested in the manufacturing sectors. After deleting firms with missing fundamental values and those in agriculture and services, we get a sample of 286,216 observations (of which 5.1% are SOEs and 94.9% are private). The number of domestic firms increased from 4,731 in 2000 to 32,897 in 2012. Meanwhile, the share of SOEs continuously decreased from 17.5% to 2.1%.

Figure 2 below represents the distribution of the domestic firm's TFP, the dependent variable.<sup>6</sup> Overall, we state a high concentration around the median value. Indeed, 50% of the sample firms have a TFP (in log) ranging between 0.65 and 1.83 (Figure 2a). Besides, the firm's TFP is highly dispersed below the lower and above the upper quartile. The picture remains the same while considering the firm ownership, although public firms are slightly more dispersed than their private counterparts (Figure 2b).

Figure 2: TFP distribution (in log) of Vietnamese domestic firms



### 3.2.2 Econometric specification

To investigate how FDI spillovers affect the firm performance, we rely on the standard Equation in the literature (see, for instance, [Aitken and Harrison 1999](#); [Javorcik 2004](#);

<sup>6</sup>Please refers to Section 3.1 for the computation of the firm's TFP.

or [Lu et al. 2017](#)) as follows:

$$y_{fit} = \mu_f + \alpha_t + FDI\_spillovers'_{it}\beta + X'_{fit}\gamma + \varepsilon_{fit} \quad (9)$$

where index  $f, i, t$  refers to the firm, two-digit industry, and year;  $y_{fit}$  measures the firm  $f$ 's performance (e.g., TFP) of industry  $i$  in year  $t$ ;  $\mu_f, \alpha_t$  respectively capture the firm and year fixed effects;  $X_{fit}$  is a vector of the firm's time-varying characteristics including its export-import value (in log and at constant price) and share of female workers; and  $\varepsilon_{fit}$  is the error term.

$FDI\_spillovers_{it}$  is our interest regressors, including three kinds of spillovers, i.e., horizontal, forward, and backward. These variables are computed by using the standard measure in the literature.

$$Horizontal\_spillovers_{it} = \frac{\sum_{f \in \Omega_{it}} FDI\_share_{fit} \times Output_{fit}}{\sum_{f \in \Omega_{it}} Output_{fit}} \quad (10)$$

$$Backward\_spillovers_{it} = \sum_{j \text{ if } j \neq i} \delta_{ij} \times Horizontal\_spillovers_{jt} \quad (11)$$

$$Forward\_spillovers_{it} = \sum_{h \text{ if } h \neq i} \theta_{ih} \times Horizontal\_spillovers_{ht} \quad (12)$$

where  $FDI\_share_{fit}$  captures the foreign equity share of firm  $f$  of industry  $i$  in year  $t$ ;  $Output_{fit}$  measures the output of firm  $f$  of industry  $i$  in year  $t$ ;  $\Omega_{it}$  is the set of firms in industry  $i$  in year  $t$ ;  $\delta_{ij}$  is the ratio of industry  $i$ 's output supplied to industry  $j$ ; and  $\theta_{ih}$  is the ratio of inputs purchased by industry  $i$  from industry  $h$ . Both  $\delta_{ij}, \theta_{ih}$  are taken from Vietnam's 2007 Input-Output Table.<sup>7</sup> Notice that backward spillovers could be interpreted as a total foreign demand in the downstream industries. In contrast, forward spillovers could be viewed as a total foreign supply in the upstream industries.<sup>8</sup>

We perform a two-step estimation as described in Subsection 3.1. The first step is to compute the firm's TFP using the ACF method. Second, we estimate Equation (9) at different points of the TFP distribution by relying on the UQR. For comparison purposes, we also provide an estimation of Equation (9) at the sample mean by applying a fixed-effects (FE) estimator. Besides, according to [Merlevede et al. \(2014\)](#); [Nguyen-Huu and Pham \(2021\)](#), it could take time such that domestic firms could benefit from FDI spillovers. To consider this issue, we re-estimate Equation (9), but with a 1-year lag of FDI spillovers.

## 4 Results

### 4.1 FDI spillovers and TFP

Table 1 and Figures 3-5 report the estimations of FDI spillover impacts on the productivity of domestic firms. Columns 1-6 indicate those without the lag of FDI spillovers.

<sup>7</sup> $\delta_{ij}$  is computed by excluding products used for final consumption or imported intermediate products.

<sup>8</sup>Please refer to Table 5 in the Appendix section for the definition, measurement, and some descriptive statistics of variables used in this research.

Thus, they can be interpreted as a short-run impact. On the other hand, to investigate the role of timing, FDI spillovers are lagged 1-year, and the estimated results is reported in columns 7-12. We can consider them as a long-run effect of FDI spillovers. In each case, we perform a FE estimator and then the UQR at different quantiles of the firm's TFP distribution.

Table 1: FDI spillovers and TFP of domestic firms

Specification	Without lag of FDI spillovers					With 1-year lag of FDI spillovers						
	(1) FE	(2) Q10	(3) Q25	(4) Q50	(5) Q75	(6) Q90	(7) FE	(8) Q10	(9) Q25	(10) Q50	(11) Q75	(12) Q90
<i>Panel A: Full sample</i>												
<b>FDI spillovers</b>												
Horizontal spillovers	-0.069** (0.024)	-0.032 (0.062)	-0.070+ (0.037)	0.011 (0.030)	0.032 (0.031)	-0.091* (0.041)	-0.001 (0.026)	0.082 (0.068)	-0.018 (0.038)	-0.034 (0.028)	-0.047 (0.030)	0.024 (0.042)
Forward spillovers	-1.243+ (0.728)	1.261 (1.742)	1.523 (1.039)	2.659** (0.870)	-2.793*** (0.809)	-11.981*** (1.082)	-0.320 (0.693)	-0.256 (1.601)	1.467 (0.989)	-0.632 (0.799)	0.571 (0.793)	-2.309+ (1.197)
Backward spillovers	-0.280* (0.122)	1.109*** (0.329)	0.728*** (0.199)	-0.707*** (0.162)	-1.296*** (0.204)	-1.585*** (0.253)	0.093 (0.155)	1.690*** (0.308)	1.271*** (0.217)	0.020 (0.172)	-0.887*** (0.204)	-1.814*** (0.248)
<b>Firm time-varying characteristics</b>												
Share of female workers	-0.000* (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.001** (0.000)	-0.001*** (0.000)	-0.001** (0.000)	-0.001 (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.001* (0.000)	-0.001** (0.000)
Export value	0.005** (0.002)	-0.000 (0.004)	0.010*** (0.002)	0.016*** (0.002)	0.009*** (0.003)	-0.015*** (0.004)	0.007*** (0.002)	0.003 (0.004)	0.015*** (0.002)	0.016*** (0.003)	0.006* (0.003)	-0.014*** (0.004)
Import value	0.000 (0.002)	-0.018*** (0.004)	-0.009*** (0.002)	0.002 (0.003)	0.012*** (0.003)	0.018*** (0.004)	0.004+ (0.002)	-0.008* (0.004)	-0.002 (0.003)	0.006* (0.003)	0.011*** (0.003)	0.016*** (0.004)
Constant	0.598*** (0.015)	-0.638*** (0.042)	-0.143*** (0.025)	0.473*** (0.021)	1.255*** (0.018)	2.057*** (0.023)	1.837*** (0.014)	-0.327*** (0.048)	-0.004 (0.027)	0.622*** (0.021)	1.349*** (0.019)	2.013*** (0.024)
<b>Firm fixed effects</b>												
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Numbers of firms	83,861	83,861	83,861	83,861	83,861	83,861	57,180	57,180	57,180	57,180	57,180	57,180
Observations	286,216	286,216	286,216	286,216	286,216	286,216	202,502	202,502	202,502	202,502	202,502	202,502
R-squared	0.176	0.028	0.095	0.174	0.155	0.084	0.157	0.020	0.085	0.161	0.147	0.089
<i>Panel B: SOEs</i>												
<b>FDI spillovers</b>												
Horizontal spillovers	-0.193* (0.086)	0.033 (0.229)	-0.064 (0.126)	-0.003 (0.102)	-0.196* (0.095)	-0.423*** (0.127)	0.240** (0.084)	0.967*** (0.220)	0.266+ (0.148)	0.217* (0.108)	-0.261* (0.106)	-0.268* (0.114)
Forward spillovers	0.386 (0.300)	2.631*** (0.646)	2.936*** (0.374)	-0.036 (0.389)	-0.938* (0.393)	-1.855** (0.614)	-1.293 (2.313)	-3.320 (6.212)	-2.512 (3.143)	7.239* (3.149)	-6.979* (3.200)	-11.009* (4.389)
Backward spillovers	0.386 (0.300)	2.631*** (0.646)	2.936*** (0.374)	-0.036 (0.389)	-0.938* (0.393)	-1.855** (0.614)	0.488+ (0.287)	3.458*** (0.584)	2.968*** (0.477)	-0.056 (0.388)	-0.725+ (0.415)	-2.338*** (0.559)
<b>Firm time-varying characteristics</b>												
Share of female workers	-0.001 (0.001)	0.002 (0.002)	0.001 (0.002)	-0.001 (0.001)	-0.002+ (0.001)	-0.003+ (0.002)	-0.001 (0.001)	0.003 (0.003)	-0.000 (0.002)	-0.001 (0.001)	-0.002 (0.001)	-0.003+ (0.002)
Export value	0.004 (0.005)	0.013 (0.009)	0.022*** (0.005)	0.030*** (0.006)	0.001 (0.008)	-0.055*** (0.010)	0.002 (0.005)	0.012 (0.009)	0.025*** (0.006)	0.030*** (0.006)	-0.009 (0.008)	-0.054*** (0.012)

continued next page

Table 1: FDI spillovers and TFP of domestic firms (continued)

Specification	Without lag of FDI spillovers						With 1-year lag of FDI spillovers					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
FE		Q10	Q25	Q50	Q75	Q90	FE	Q10	Q25	Q50	Q75	Q90
Import value	0.006 (0.005)	-0.013+ (0.007)	-0.024*** (0.005)	-0.009 (0.006)	0.025** (0.008)	0.055*** (0.011)	0.006 (0.005)	-0.019* (0.009)	-0.026*** (0.005)	-0.008 (0.006)	0.027*** (0.008)	0.061*** (0.012)
Constant	0.902*** (0.065)	-0.275+ (0.158)	0.094 (0.088)	0.714*** (0.079)	1.584*** (0.069)	2.327*** (0.088)	1.811*** (0.067)	-0.200 (0.285)	0.936+ (0.502)	1.900** (0.580)	3.047*** (0.667)	3.597*** (0.536)
<b>Firm fixed effects</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Year fixed effects</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Numbers of firms	2,781	2,781	2,781	2,781	2,781	2,781	2,225	2,225	2,225	2,225	2,225	2,225
Observations	14,552	14,552	14,552	14,552	14,552	14,552	11,942	11,942	11,942	11,942	11,942	11,942
R-squared	0.281	0.021	0.102	0.245	0.279	0.156 0.279	0.030	0.125	0.267	0.256	0.141	
<i>Panel C: Domestic private firms</i>												
<b>FDI spillovers</b>												
Horizontal spillovers	-0.068* (0.026)	-0.061 (0.061)	-0.080* (0.038)	0.001 (0.029)	0.047 (0.032)	-0.062 (0.042)	-0.021 (0.027)	-0.007 (0.078)	-0.055 (0.039)	-0.052+ (0.030)	-0.026 (0.033)	0.059 (0.041)
Forward spillovers	-0.942 (0.655)	2.594 (2.160)	2.248* (1.060)	3.125*** (0.948)	-2.654** (0.851)	-12.968*** (1.232)	-0.230 (0.745)	0.362 (1.565)	1.879+ (1.010)	-1.064 (0.830)	0.536 (0.980)	-2.083+ (1.128)
Backward spillovers	-0.436** (0.152)	0.251 (0.331)	0.218 (0.221)	-0.798*** (0.196)	-1.141*** (0.216)	-1.121*** (0.284)	0.103 (0.174)	1.005** (0.359)	0.844*** (0.210)	0.122 (0.220)	-0.626** (0.231)	-1.203*** (0.305)
<b>Firm time-varying characteristics</b>												
Share of female workers	-0.000* (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	-0.001** (0.000)	-0.000* (0.000)	-0.001+ (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000+ (0.000)	-0.001** (0.000)
Export value	0.004* (0.002)	-0.002 (0.004)	0.007** (0.003)	0.015*** (0.002)	0.009** (0.003)	-0.013*** (0.004)	0.007** (0.002)	-0.000 (0.005)	0.012*** (0.003)	0.015*** (0.002)	0.007* (0.003)	-0.011** (0.004)
Import value	-0.000 (0.002)	-0.012** (0.004)	-0.001 (0.003)	0.008** (0.003)	0.004 (0.003)	0.002 (0.005)	0.002 (0.002)	-0.001 (0.005)	0.006+ (0.003)	0.010*** (0.003)	0.004 (0.003)	0.000 (0.004)
Constant	0.587*** (0.017)	-0.677*** (0.042)	-0.139*** (0.028)	0.477*** (0.021)	1.252*** (0.019)	2.050*** (0.024)	1.835*** (0.015)	-0.300*** (0.058)	0.045 (0.027)	0.634*** (0.021)	1.343*** (0.019)	1.993*** (0.026)
<b>Firm fixed effects</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Year fixed effects</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Numbers of firms	81,897	81,897	81,897	81,897	81,897	81,897	55,606	55,606	55,606	55,606	55,606	55,606
Observations	271,664	271,664	271,664	271,664	271,664	271,664	190,560	190,560	190,560	190,560	190,560	190,560
R-squared	0.169	0.028	0.093	0.168	0.148	0.081	0.147	0.019	0.080	0.152	0.138	0.086

Robust standard errors in parentheses. Significant: \*\*\* p<0.001, \*\* p<0.01, \* p<0.05, + p<0.1

Considering the full sample case, the estimated results are shown in Panel A of Table 1 and Figure 3. In the short-run, FDI spillovers have an average negative impact on the TFP of domestic firms. Indeed, the FE estimator reports a negative and significant effect of horizontal spillovers, albeit the related magnitude is small. Accordingly, if the FDI output-weight share of an industry increases by 10%, the domestic firms' TFP drops, on average, by  $0.1 \times 0.069 = 0.0069$ , or 0.69% of the sample mean. Meanwhile, forward and backward spillovers are also negative, but to a greater extent. If the foreign demand in the downstream industries increases by 10%, the average domestic firms' TFP in the related supporting industry declines by 2.8%. As for the impact of forward spillovers, the incidence is, on average, a 12.4% decrease in the domestic firms' TFP.

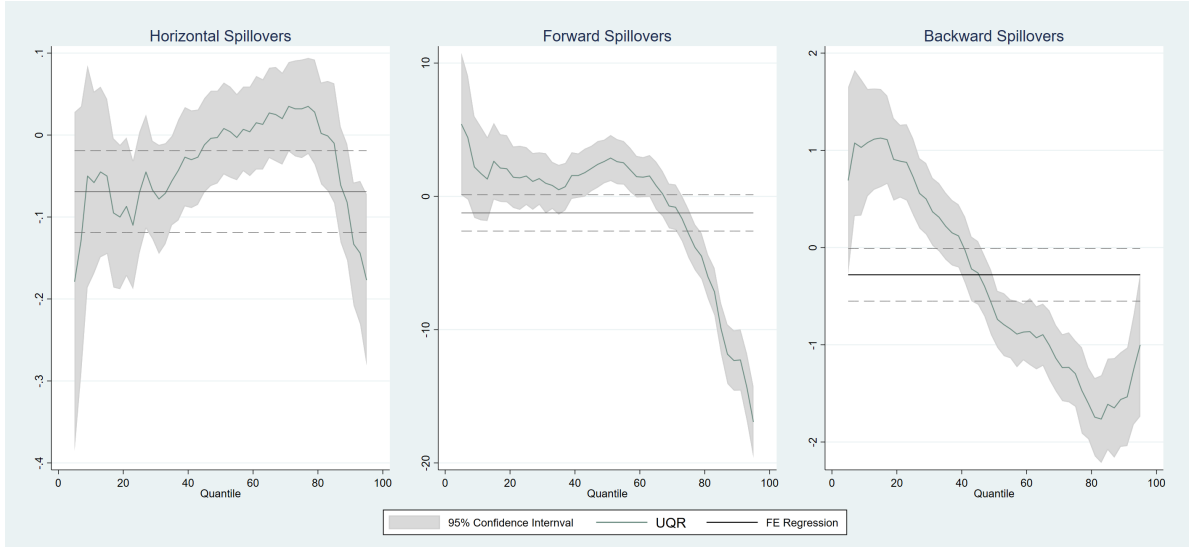
The negative impact of horizontal spillovers in this study is consistent with the bulk of empirical evidence raised in the literature in the case of developing countries. It joins, for instance, the work of Haddad and Harrison (1993) for Morocco, Aitken and Harrison (1999) for Venezuela, Djankov and Hoekman (2000) for the Czech Republic, or Lu et al. (2017) for China. Accordingly, MNEs also generate negative horizontal spillovers on the productivity of domestic firms in these countries. By contrast, such a finding differs from some studies on developed countries such as Ireland (Ruane and Ugur, 2005), the UK (Haskel et al., 2007), or the US (Keller and Yeaple, 2009) where horizontal FDI spillovers are positive. Very interestingly, the negative impact (at the sample mean) of vertical spillovers, either backward or forward linkages, makes our paper different from the literature where such spillovers are almost positive as in Lithuania (Javorcik, 2004), China (Lu et al., 2017), or 17 transition countries (Gorodnichenko et al., 2014).

Notice that the above findings no longer hold once we consider the firm position at the TFP distribution, as displayed in columns 2-6 of Table 1 and Figure 3(a). Backward spillovers are, in the short-run, beneficial for domestic firms at the lower tails (e.g., 10th or 25th percentiles) before becoming harmful at the middle and top tails (e.g., 50th, 75th, and 90th percentiles). Also, only domestic firms around the median benefit from forward spillovers, while those at the upper quartile suffer adverse effects. The backward and forward effects are even significant at the 0.1% level. Let us consider, for example, domestic firms at the 90th quantile. If the total foreign supply (in the upstream industries) increases by 1%, the TFP of domestic producers (in the related downstream industry) decreases by  $0.01 \times 12 = 0.12$  or equivalently 12%. To a lesser extent, a 1% increase in foreign producers' demand would lead to a 1.6% decline in the TFP of domestic suppliers.

Besides, the estimation likely supports the hypothesis that the FDI spillover effects change over time. The average long-run effect of FDI spillovers is no longer significant, even at the 10% level (column 7 of Table 1). Meanwhile, the UQR also reveals nonsignificant backward and horizontal spillovers across the TFP distribution (columns 8-12 of Table 1 and Figure 3b). By contrast, backward spillovers appear heterogeneous and depend on the firm position at the TFP distribution. The impact is beneficial at the lower tails and no longer significant around the median before being harmful at the top positions of the TFP ladder. Moreover, the positive impact of backward spillovers is almost higher compared to the short run, while the negative impact is weaker in the long run.

Such findings on the role of time in determining FDI spillovers are in line with some

Figure 3: Impact of FDI spillovers on domestic firms' TFP



(a) Short-run impact



(b) Long-run impact

previous evidence ([Zhang et al., 2014](#); [Merlevede et al., 2014](#); or [Zhang et al., 2019](#), among others). For example, [Merlevede et al. \(2014\)](#), using a sample of Romanian manufacturing firms during 1996-2005, find evidence of heterogeneous FDI spillovers over time. Foreign firms that recently entered the host country have no significant impact on the domestic firms' TFP. Differently, foreign firms that have been present for four years or more generate significant positive spillovers, regardless of their nature, i.e., horizontal, backward, or forward. In the same vein, [Zhang et al. \(2014\)](#) find that the foreign firms' entry tenure generates a positive horizontal spillover on the domestic firms' productivity.



## 4.2 FDI spillovers, firm ownership, and TFP

The above analysis of the whole sample gives a first view of the nexus between FDI spillovers and the firm’s TFP. To get more in-depth insights into such a relationship, we perform the same estimations as in Panel A but focus on the firms’ legal status, i.e., SOEs versus domestic private firms (private firms for short).

Panel B of Table 1 and Figure 4 display the estimated results for SOEs. The short-run impacts of FDI spillovers are almost identical to the whole sample case. Positive spillovers, if there are any, only benefit SOEs at the lower tails of the TFP distribution, while those at the top portions suffer negative spillovers. Nonetheless, the extent of horizontal and backward spillovers is greater than those of the general case. For instance, each 10% increase in the foreign output-weight share of a typical industry would drop the TFP of SOEs at the 90th quantile by 4.2%. The incidence is 0.9% in panel A. Besides, some divergent results occur when considering the long-run effects. On average, horizontal spillovers are no longer harmful but beneficial and statistically significant, even at the 1% risk level (cf., column 7 of Table 1). Accordingly, if the last year’s output-weight share of an industry increase by 10%, the current productivity of SOEs will improve, on average, by 2.4%. Nevertheless, as shown in Figure 4(b), such beneficial effects only concern public firms in the first half of the TFP distribution. In contrast, the impacts remain negative and statistically significant for those at the top quantiles.

Regarding Panel C concerning private firms, the estimated results almost follow the same tendency as in Panel A. Accordingly, the short-run impact of FDI spillovers is negative and statistically significant for the highest TFP private firms. However, such an impact becomes weaker (as backward spillovers) or even insignificant (as forward spillovers) one year later. Positive spillovers solely benefit those at the lower tails of the TFP distribution. The main divergence between Panel C and Panel A is that low TFP private firms cannot gain from backward spillovers in the short run but one year later.

## 4.3 Robustness check

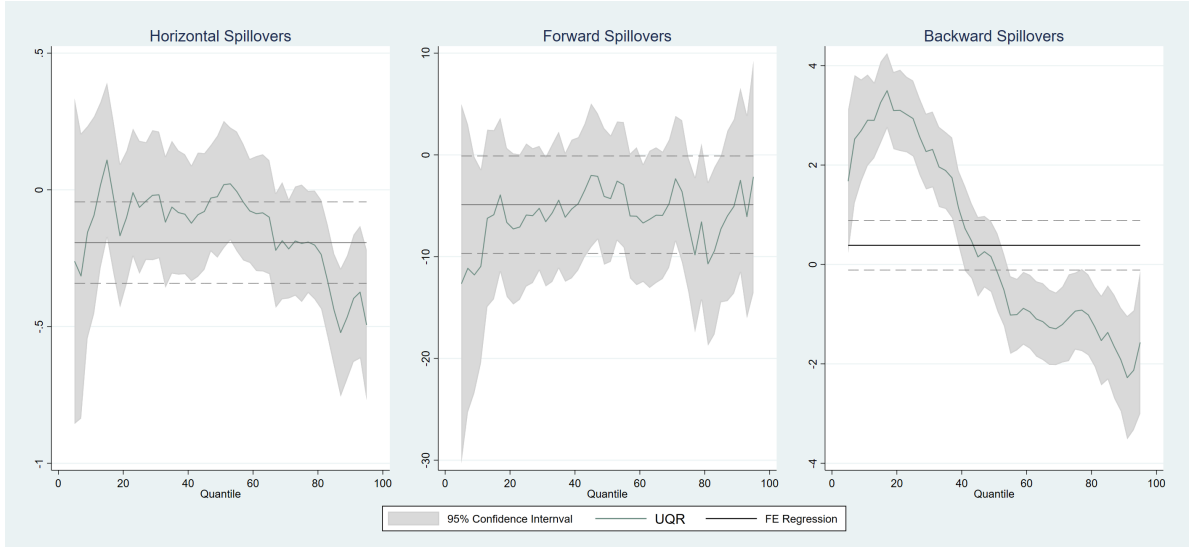
We provide some alternative estimations of Equation (9) as a robustness check. The first alternative is to apply the Wooldridge (2009) method to compute the firm’s TFP. The estimated results support the above findings. MNEs provide positive FDI spillovers to domestic firms with low productivity before becoming harmful to those with high productivity.

The second estimation is to use an alternative measure of FDI spillovers. According to the literature, domestic firms may benefit from a labor turnover from MNEs (Fosfuri et al., 2001; Poole, 2013). We remeasure FDI spillovers by foreign employ-weight shares instead of foreign output-weight shares. Nonetheless, the findings almost remain the same as those reported in Table 1.<sup>9</sup>

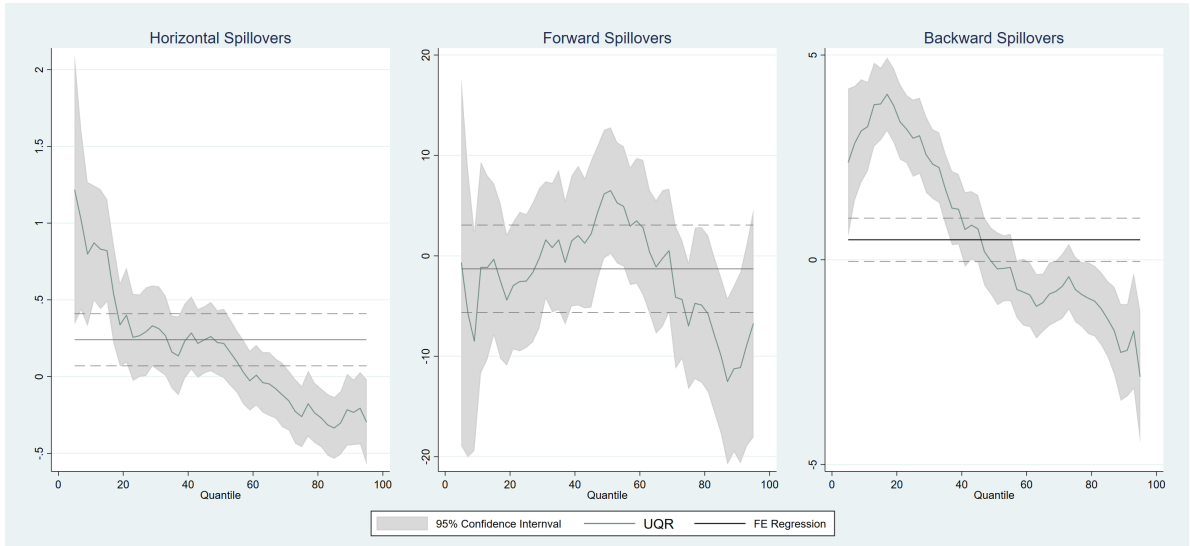
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<sup>9</sup>For a brief purpose, the estimated results are not reported here. They are available upon request.

Figure 4: Impact of FDI spillovers on SOEs' TFP



(a) Short-run impact



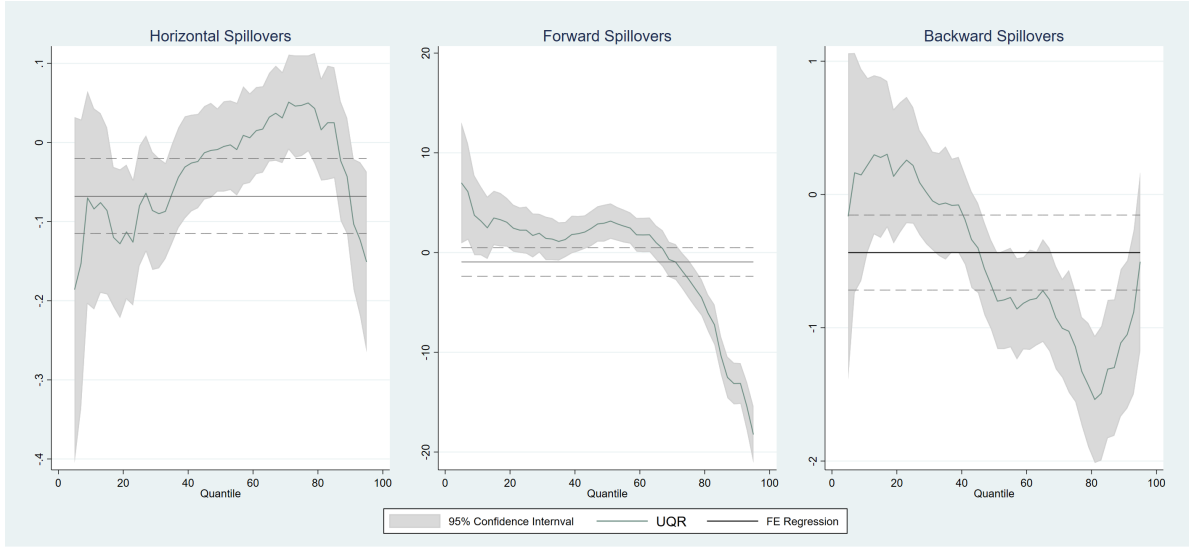
(b) Long-run impact

#### 4.4 Discussion

In sum, over the period 2000 and 2012, we find evidence of heterogeneous FDI spillovers on the TFP of Vietnamese manufacturing firms. The nature and extent of spillovers depend on time, the position of domestic firms at the TFP distribution, and their legal status. FDI spillovers only benefit low-productivity firms and become harmful to those with high productivity. Notably, sole SOEs in the first half of the TFP distribution can gain from horizontal spillovers. Nevertheless, the impact is not significant in the short run, but one year later.

Some reasons can explain the above results. First, domestic firms need time to improve their competitiveness or absorptive capacity (Cohen and Levinthal, 1990;

Figure 5: Impact of FDI spillovers on private firms' TFP



(a) Short-run impact



(b) Long-run impact

Nguyen-Huu and Pham, 2021). That is why positive spillovers are almost stronger, and negative ones are weaker in the long run than in the short run.

Second, downstream and upstream linkages could be potential channels to gain from FDI (Javorcik, 2004). However, in our case, there should be high competition between MNEs and high-performance domestic firms located in different stages of the production chain. By contrast, those MNEs should have an incentive to educate their weak-performance domestic clients and suppliers. Consequently, FDI spillovers benefit domestic firms at the lower tails and harm those at the upper tails of the TFP distribution.

More generally, according to the FDI spillovers literature (e.g., Aitken and Harrison, 1999; Crespo and Fontoura, 2007; Lu et al., 2017, among others), whether

domestic firms can benefit from FDI spillovers depends on the interaction of two opposite effects: agglomeration and competition. An agglomeration effect refers to gains from spatial proximity to MNEs as labor turnovers (recruiting former workers) or knowledge spillovers (imitating their technologies, products, or management practices). Nevertheless, domestic firms could lose their market shares to their multinational counterparts due to a competition effect. High-performance domestic firms are likely in the same or similar market segments as MNEs, consequently driving strong competition. Meanwhile, MNEs protect their knowledge more, generating a weak agglomeration effect. By contrast, low-performance domestic firms face weak competition and strong agglomeration effects. Accordingly, FDI spillovers are positive for Vietnamese manufacturing firms at the bottom before becoming harmful to those at the top positions of the TFP distribution.

## 5 Conclusion

It is difficult to identify the effect of FDI spillovers on domestic firms (Lu et al., 2017). Accordingly, the literature has no conclusive consensus on FDI spillovers. This research contributes to the literature by relying on the UQR developed by Firpo et al. (2009), which allows us to suggest more adequate policy implications for firms at different quantiles of the TFP distribution. We find evidence of heterogeneous FDI spillovers according to the firm position at the TFP distribution, legal status, and time. Overall, FDI spillovers only benefit low-productivity firms and become harmful to high-productivity counterparts. Moreover, positive impacts are stronger and negative ones are weaker in the long run than in the short run.

The findings of this research could provide some policy implications. Since FDI spillovers are almost harmful to Vietnamese manufacturing firms at the upper tails of the TFP distribution, some measures should be in their favor. To this end, policies encouraging foreign firms to increase their local content requirements could be a solution. On the other hand, low quality is one of the main reasons preventing foreign firms from using local inputs. Hence, policies inciting high TFP domestic suppliers to enhance the quality of their products would be helpful. Furthermore, the government could give some public actions to help domestic firms, especially private ones, improve their competitiveness. For example, the government might provide some loans with low-interest rates if firms use them to invest in new technology or human resources. Such policies could become more primordial since more than 90% of them have small and medium sizes and a weak financial capacity. Notice that although the above policy suggestions would primarily benefit firms suffering negative spillovers, they could also be helpful for others to improve their competitiveness and consequently gain more from FDI spillovers.

This research has some limits that are open for further research. First, although the UQR method could provide robustly estimated coefficients, we may not exclude the endogeneity issue. Indeed, the FDI decision could be endogenous, leading to a potential endogeneity of FDI spillovers. While some techniques allow us to correct endogeneity in CQR models, as, for example, using a control function (Lee, 2007), handling such an issue in a UQR using panel data is not straightforward and needs

a new econometric framework development. Second, since time likely plays a role in determining FDI spillovers, it is interesting to investigate how they change over time more appropriately. To this end, a combination of the UQR method and the computation of FDI spillovers developed by [Merlevede et al. \(2014\)](#) could be suitable.

## Data Availability Statement

The data used in this research is available upon request.

## Disclosure Statement

No potential competing interest was reported by the author.

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## Appendix

Table 2: Descriptive statistics

Variables	Definition	Obs.	Mean	Std. Dev.
<b>Dependent variable</b>				
Firm’s TFP	The firm’s TFP computed by relying on the <a href="#">Akerberg et al. (2015)</a> method as described in Subsection 3.1 above.	286,216	1.203	0.992
<b>Sector variables: FDI spillovers</b>				
Horizontal spillovers	Horizontal FDI impact on the firm’s TFP. This variable is computed by using Equation (10).	299	0.42	0.27
Backward spillovers	Backward FDI impact on the firm’s TFP. This variable is computed by using Equation (11).	299	0.013	0.038
Forward spillovers	Forward FDI impact on the firm’s TFP. This variable is computed by using Equation (12).	299	0.003	0.005
<b>Firm time-variant characteristics</b>				
Share of female workers (%)	The share of female workers over the firm’s total employees	286,216	36.02	23.81
Export value (in log)	The firm’s export value (at constant price)	286,216	0.20	1.18
Import value (in log)	The firm’s import value (at constant price)	286,216	0.16	1.05