

## *Referee Report:*

# Assessing E-commerce Productivity for Micro French Firms using Propensity Score Matching

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**Summary:** The paper investigates the impact of e-commerce adoption on firms performance for a sample of French micro firms. The authors exploit the TIC-TPE survey on French micro firms for the year 2012 provided by the INSEE. The database contains information about firms' economic and financial performances, the use of ICT capital (*e.g.* use of PC, use of e-commerce, etc.), and the belonging industry. The literature has provided different potential mechanisms that can drive productivity gains following the adoption of an e-commerce platform, but the authors focus on the quantification of the adoption *per se* and take no stance about which mechanism is at stake. To assess the causal impact of adopting the platform, they opt for a semi-parametric matching estimation (*i.e.* propensity score matching or PSM). The main finding of the analysis is the following: firms adopting an e-commerce platform do perform better than the others in terms of total turnover, productivity (measured as turnover over employees in logs), but face higher interest rates of financing.

**Contribution:** The authors identify the lack of micro firm-level analysis of e-commerce as a gap in the literature and they try to fill it. Despite the limitation in terms of research scope due to the database size, answering the research question would provide an insight for micro firms related policies. Nonetheless, much empirical work has been done about the relationship between ICT (e-commerce) and firms' performances, but the authors are silent about whether their results do differ in magnitude with respect to previous ones. Most importantly, the identification strategy and the database used are inadequate with respect to the research question, leading to far-fetched claims about the relationship between e-commerce and productivity. I will clarify the major flaws in the next section.

### **Major Comments:**

1. The identification strategy follows this logic: with a sample characterized by both e-commerce adopting firms and non-adopting ones, linking e-commerce to productivity gains requires to control for the *selection bias*, *i.e.* do most productive firms self-select in e-commerce adoption or is e-commerce driving firms' productivity gains? The idea of PSM is to *randomize* the treatment (*i.e.*

e-commerce adoption), controlling for firms' pre-treatment covariates, to be able to interpret causally the post-treatment outcome difference between the treated and non-treated groups.

What's the main problem in the proposed setup? The entire analysis relies on data for 2012, meaning that you are constructing propensity scores *after* the treatment has happened, violating the *unconfoundedness assumption*. To illustrate the point, let me refer to the PSM theory. In the sample you have, it is not possible to claim that the treatment is random, *i.e.*  $Y_0, Y_1 \perp Z$ . Therefore, you decide to construct a propensity score  $p(X) = \mathbb{P}(Z = 1|X) = \mathbb{E}(Z|X)$ , where  $X$  should be the set of pre-treated covariates. However, in your setup,  $X$  is the set of *post*-treated covariates, meaning that  $p(X)$  is not the probability of being treated, but the probability of actually using the e-commerce platform. Since you're not balancing pre-treated variables using PS, you have that  $Z \not\perp X|p(X)$ , which violates the unconfoundedness assumption, hence in your setup you have:

$$Y_0, Y_1 \not\perp Z|p(X)$$

Intuitively, you are not accounting for past productivity levels, therefore you can't rule out the possibility that firms using e-commerce were already more productive than non adopters before 2012. This inaccuracy makes the whole PSM estimation incorrect. I would recommend to read the paper by Grimes, Ren, and Stevens (2012) on the Journal of Productivity Analysis for a practical example using PSM.

**2.** In the showed tables, you explicitly claim the use of *sector dummies*, which is misleading, since for example, in the descriptive Table 3, there is no regression. It seems that you are matching by propensity score firms that belong to different sectors. This is an huge source of bias for the estimation, because you're considering a firm in the construction industry to share common characteristics with a firm in the information and communication industry. To properly address the issue, you should sub-sample your data and run PSM for each industry separately.

**3.** You claim you are looking at the effect on productivity, but there is no estimate of productivity. By definition, TFP productivity is the residual component of a firm's production function (ex. the  $A$  in the following simple model  $Y = AF(L, K)$ ). It is possible, nonetheless, to assess *labor productivity*, that is by definition constructed as the total value added over employees. Contrarily, turnover over employees is not a clear measure of productivity.

### Minor Comments:

#### Paragraph 1: Introduction

**1.** Use at first *Business-to-Consumer (B2C)* to allow non-experts in the field to be at ease with the terminology.

**2.** If you claim that few studies have investigated the role of e-commerce adoption on micro-firm productivity, than you should cite them. Otherwise, if by your knowledge none has published on the subject, just state it.

#### Paragraph 2: Literature Review

**1.** When you claim that ICT has been identified to produce two productivity effects, can you be more clear about what kind of IC technologies you refer to.

By my knowledge, information technologies and coordination technologies have different impacts on firms' organization of offshoring for example, which is one of the points made by Bloom et al. (2014) in their paper.

2. Matthews et al. (2001), Allcock et al. (2002), and all the subsequent literature on e-commerce that you cite is far from being recent, hence the attention *has already turned* to this topic.

3. Showing data regarding the role of micro firms in Europe in terms of employment would give a better idea of the relevance of the research question. Or even in France compare to SMEs.

4. You cite Falk and Hagsten (2015) in the sub-paragraph related to micro firms, although the former paper doesn't tackle explicitly micro firms. This is misleading for the reader.

5. You mention a study conducted by the (which exactly?) Federation that is not cited in the bibliography. Moreover, if you cite this study, maybe you want to go deeper in showing some evidences about e-commerce and its role for firms' growth in France.

### **Paragraph 3: Data and Descriptive Statistics**

1. Try to be consistent with the database name (TIC-TPE 2012, Information and Communication Technologies Survey for micro firms). You claim that the database has never been exploit, but since 2012 (probably the publication was in 2013/14) there has been time to use it.

2. The sample is composed of 5102, is it representative of the population of micro firms in France?

### **Paragraph 4: Methodology**

1. The matching, in PSM, allows to pair treated and non-treated firms exploiting the *probability of being treated*, not the proximity in terms of covariates!

2. PSM is one of the many strategies one can implement to assess causality. Comparing treated and non-treated groups to make inference about the causal effect of the treatment on the population (ATE) or on the treated (ATT) is, more broadly, part of the *Causal Inference* literature

3. In paragraph 4.1 you discuss matching, not propensity score matching. Nonetheless, if discussing PSM from the theoretical point of view, it's important to introduce its assumptions and how they will play a role in your setup.

4. In the choice of covariates, there's no discussion about whether some are dropped and some others are not, it's important to be transparent about it. Is the choice driven by previous studies?

5. In Table 4, column (1) and (2) are identical, it shouldn't be the case if you are estimating the effect on turnover and labor productivity. It's easier to read the table if you are conservative in the number of digits showed for the point estimates and st. errors, 0.00003 can be simply expressed with 0. Elaborate more on the fit-of-model measures, just saying that R squared is equal to 8.7 % doesn't add anything to the analysis.

7. In Table 5, credit rationing and  $\tau$  should not appear.

8. In Figure 1, there is no need to specify the source.