Informality and Firm Productivity in Myanmar

HANNA BERKEL & FINN TARP
Department of Economics, University of Copenhagen, Copenhagen, Denmark

ABSTRACT Using a unique panel survey of enterprises, we examine the relationship between four categories of formalization and firm productivity. We carry out one- and two-step productivity estimations whose robustness we check with matching and doubly robust estimators. The only formalization category that appears to be significantly associated with productivity is tax formalization, i.e. a firm’s decision to pay taxes. This positive association only holds for firms that were already more productive and bigger before formalizing than other informal firms. The reason for the insignificance of the remaining three categories is likely to be the insignificant association between formalization and potential benefits of formalization, such as more access to credit, employees, and investments. High taxes and fees linked to formalization seem to outweigh the few to non-existent intermediate benefits of formalization.

KEYWORDS: Informality; firms; formalization; Myanmar; productivity

1. Introduction

From 2015 until February 2021, Myanmar was opening up to the world and its economy was globally among the fastest-growing (Beck et al., 2020). Yet, most enterprises in Myanmar do not register their activities. That is, they are informal, and informality is estimated to represent more than half of Myanmar’s GDP (Medina & Schneider, 2018). Informal enterprises generally have lower performance and employ fewer workers than their formal counterparts. Accordingly, a standard policy recommendation to help informal enterprises catch up, is that they should formalize (GIZ, ILO, & BMZ, 2014). A key argument is that formalization will help in gaining access to benefits they do not have under informality, like bank loans or the internet. However, empirically, the consequences of formalization are not fully understood and they are often found to be insignificant for enterprise performance (Benhassine, McKenzie, Poulilquen, & Santini, 2018; Bruhn & McKenzie, 2013). This study aims to uncover the potential formalization consequences in Myanmar using new data and up-to-date analytical methods.

Correspondence Address: Hanna Berkel, Department of Economics, University of Copenhagen, Øster Farimagsgade 5, Building 26, Level 2, Office 26-2-22, 1353 Copenhagen, Denmark. Email: hmb@econ.ku.dk

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As there is no universally accepted informality definition, researchers adopt varying concepts. Some assume firms are formal when they pay taxes, others argue a business license is sufficient. This reflects that many enterprises are neither fully formal nor fully informal. Instead, they operate on a continuum between formality and informality, complying with some though not all regulations (Medvedev & Oviedo Silva, 2015; Williams & Shahid, 2016). Consequently, a specific formality indicator may only be relevant for particular enterprises, depending on which formality criteria they meet (Benjamin & Mbaye, 2012). To address the challenge of multiple definitions, we create four indicators to examine which formality category is beneficial for Myanmar enterprises and why.

We use a nationally representative panel dataset of manufacturing enterprises including two survey rounds from 2017 and 2019. We compare firms that formalized in 2017–19 with firms that remained informal according to the respective formality category. To estimate the association between formalization and potential outcomes, we run one and two-step productivity estimations, carrying out the Ackerberg, Caves, and Frazer (ACF, 2006) correction to the Levinsohn and Petrin (2003) methodology. With matching techniques and doubly robust estimators (Sant’Anna & Zhao, 2020) we check the results’ robustness. In the formalization literature, we are the first to run productivity estimations and examine how productivity is associated with formalization.

Our four indicators are, first, local formalization captures whether a firm registered with its municipality or township office. Second, national formalization shows if a firm signed up with one or more national authorities, for example, the Directorate of Investment and Company Administration (DICA). Third, tax formalization reveals whether a firm started to pay corporate income taxes, value-added taxes, or both. Fourth, social security formalization indicates if a firm began to pay one or more social security benefits to its employees.

We find that tax formalisers belong to the only formalization category significantly more productive than its informal counterparts. This association only holds for bigger enterprises, i.e. tax formalisers with fewer than five employees are not more productive. This is in line with previous studies showing that formalization is only relevant for informal enterprises that are similar to formal enterprises even before formalizing (Benhassine et al., 2018; Campos, Goldstein, & McKenzie, 2018). Further, tax formalisers are associated with attracting more permanent employees, and we suggest this mechanism is why they are more productive than always-informal firms.

We find no statistically significant relation between local, national, and social security formalization, on the one hand, and productivity, on the other. Arguably, many potential formalization benefits are weak or absent in Myanmar because a dictatorship used to repress private-sector institutions. To substantiate this claim we examine potential benefits of formalization including more access to credit, employees, and customers, and find the benefits to be few and non-existing in practice. We conclude that high taxes and fees associated with formalization outweigh these potential benefits.

To improve on the present situation policy-makers will need to make sure the potential formalization benefits become a reality. A sole focus on formalization is unlikely to benefit enterprises and ignores the constraints the smallest firms face.

2. Firm informality and formalization

‘A bewildering range of (often implicit) definitions are used to discuss the formal and informal’ (Guha-Khasnobis, Kanbur & Ostrom, 2006, p. 4). Broadly, the informal economy consists of ‘all economic activities that are – in law or in practice – not covered (or insufficiently covered) by formal employment arrangements’ (ILO, 2007, p. 1). Accordingly, informality involves unincorporated firms that do not register or only partly register with the authorities, and workers, who are unregulated or unprotected by law.
In the Asia-Pacific region, almost 80 per cent of entrepreneurs operate informally (ILO, 2018). Medina and Schneider (2018) estimate Myanmar’s informal economy to account for 51 per cent of GDP. Yet, no precise estimate of the number of informal firms in Myanmar exists (Stokke, Vakulchuk, & Øverland, 2018).

Most informality studies rely on one formality indicator, despite the reality of informal firms being complex. Some firms obtain licenses from local governments but do not pay taxes (De Castro, Khavul, & Bruton, 2014). Others pay taxes, yet do not register for social insurance. Incomplete law compliance rather seems to be the norm than the exception (Medvedev & Oviedo Silva, 2015; Williams & Shahid, 2016).

Entrepreneurs select among different categories of registration, depending on their assessment of costs and benefits. Accordingly, as formalization is reversible, they evaluate each formality category and become more informal when a higher level is too costly (Diaz, Chacaltana, Rigolini, & Ruiz, 2018). Consequently, while one indicator captures some features of informality it may lead to biases when used alone. A combination of indicators is likely to arrive at more nuanced findings (Benjamin & Mbaye, 2012).

The formalization literature distinguishes between observational and experimental studies. The former exploits survey data and examine performance consequences for formalizing enterprises. These studies’ results are optimistic as they tend to find a positive association between formalization and firm performance (Boly, 2018; Demenet, Razafindrakoto, & Roubaud, 2016; Rand & Torm, 2012; Sharma, 2014). A recent publication by McCaig and Nanowski (2019), however, is the first to control for differential trends before formalization and shows that formalization is not positively associated with profits. The authors argue that previous studies did not include unobserved, time-variant factors that influence both the decision to formalize and firm outcomes.

RCTs are less optimistic. In Sri Lanka, registration is only beneficial for firms most similar to formal enterprises (de Mel, McKenzie, & Woodruff, 2012), and formalization does not improve firm outcomes in Benin (Benhassine et al., 2018). In Malawi, firms only benefit when formalization involves assistance and a bank information session (Campos et al., 2018). Thus, formalization needs to be coupled with specific benefits to make firms prosper.

3. Data and formality indicators

3.1. Data

In 2017 and 2019, the Myanmar Central Statistical Organization (CSO) of the Ministry of Planning, Finance, and Industry, implemented two survey rounds of the Myanmar Enterprise Monitoring System (MEMS). The Danish government provided financial support, while the United Nations University World Institute for Development Economics Research (UNU-WIDER) and the University of Copenhagen cooperated on a technical level. The project’s aim was to create a novel database of manufacturing MSMEs.

The balanced dataset includes 2,133 enterprises that are representative of about 70,000 private manufacturing MSMEs at the state/region level. The first survey round used a stratified, two-stage area sampling approach. Within each state/region, townships were randomly picked by using probability proportional to size. The number of sampled townships was proportional to the number of townships in the state/region. The interviewed MSMEs were taken from municipal lists and the selection probability depended on the number of registered firms in each township relative to the total number of registered firms in the state/region. Registration at the municipal level is a legal requirement for all manufacturing enterprises, and as firms have to renew their registration annually, we expect the municipal lists to provide an up-to-date picture of firms.

To include fully informal firms, we applied snowballing techniques. Enumerators identified firms not included in the sampling frame but visually operating in a township. Within each
township, we added 25 per cent of informal firms proportional to the number of interviews with registered firms. We identified 533 unregistered firms in 2017. Of these, 253 enterprises continued unregistered in 2019 and the remaining 280 had registered or closed. Due to the non-random selection, the fully informal firms are not representative of Myanmar’s informal sector. However, they are more established and productive informal enterprises.

We expand our focus beyond these fully informal firms and mostly examine enterprises that had already registered with a state authority by 2017 but decided to register with higher levels until 2019. Our analysis of registration consequences above the municipal level (i.e. national, tax, and SS formalization) is therefore as likely to be represented as practically feasible.

Our firms operate in 35 townships in Myanmar’s 15 regions and states (Hansen et al., 2020). Two-thirds are micro-sized, i.e. they employ fewer than five workers, followed by 37 per cent of small firms with five to 50 workers (37 per cent) and five per cent of medium enterprises with 50–300 employees. The biggest aggregated industries are food, beverages, and tobacco (39 per cent), textiles, apparel and leather (14 per cent), and metal (9 per cent). The dataset contains all necessary information for production function estimations and includes characteristics of the owner/manager and the firm like gender, age, education, management experience, and foundation year. We deflated the financial data by the Consumer Price Index and winsorised to avoid biases caused by outliers. Further dataset details are available in the MEMS Descriptive Reports and a Working Paper (Berkel et al., 2018; Falco, Hansen, Rand, Tarp, & Trifkovic, 2021; Hansen et al., 2020).

The nine per cent attrition rate is low and comparable to other countries. In 2017, we interviewed 2,394 enterprises, of which 261 had closed or refused participation by 2019. To understand if firm death affected the sample’s representativeness, we run BGLW tests in Table S1 of the Supplementary Material (Becketti, Gould, Lillard, & Welch, 1988). We regress the baseline TFP value on our control variables gender, business practices, high school degree, sector, and state dummies. Thereby, we compare the regression results for the survivor with the exit sample. Almost all coefficients are statistically indifferent. We only detect a statistically significant difference between exits and survivors in the states Kachin and Yangon. Overall, we find very few attrition effects on the coefficients such that our results’ representativeness is unlikely to be biased.

3.2. Business registration and formality indicators

In Myanmar, the legal situation of registration is fluid. Various authorities are responsible for business registration at the local and federal levels such that it is common to hold multiple permits. The responsible authorities do not coordinate effectively, so enterprises have to deal with several agencies. While firms have to register with the municipality, it is not legally binding to register with national institutions. However, firms can only acquire benefits like a bank loan or more high-powered electricity when signing up above the local level (Berkel et al., 2018; OECD, 2013).

Table 1 shows that our total sample includes firms that were always formal, formalisers, informalisers, and always-informal firms according to each formality category. In our analysis, we compare formalisers with always-informal firms by formality category.

The first indicator, local formalization, captures whether firms registered with their municipality or township office in 2017–19. About five per cent of the sample had not registered at the local level in 2017 but had formalized by 2019. At the same time, 13 per cent of the firms were always-informal as they never registered with a local office or any other authority. We restrict the treatment (local formalisers) and control group (always locally informal firms) to enterprises not registered with any government authorities at higher levels, i.e. they were neither registered with any national authority nor did they pay taxes in 2017. This restriction facilitates the comparability of the treatment and control groups. For example, a firm that never
| Independent variables       | Description                                                                                                                                                                                                 | Formalizer | Always-informal | Always formal | Informalizer |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------|---------------|--------------|
| Local formalizer           | Dummy indicating if firm registered with at least one of the following local authorities in 2017–19: Township/City Development Committee, Department of Development Affairs, Municipal office. Restricted to firms not registered with any national authority and not paying taxes in 2017. | 108 (0.051) | 274 (0.128)     | 245 (0.115)   | 53 (0.002)   |
| National formalizer        | Dummy indicating if firm registered with at least one of the following national authorities between 2017 and 2019: Directorate of Investment and Company Administration (DICA), Directorate of Industrial Supervision and Inspection (DISI), General Administration Department (GAD), Forest Department (FD), Food and Drug Administration (FDA), MyCo, other authority. Restricted to firms that did not pay taxes in 2017. | 182 (0.085) | 498 (0.233)     | 562 (0.263)   | 117 (0.055)  |
| Tax formalizer             | Dummy indicating if firm started to pay one or more of the following taxes in 2017–19: corporate income tax, value-added tax.                                                                                   | 435 (0.204) | 924 (0.433)     | 546 (0.256)   | 228 (0.107)  |
| Social security formalizer | Dummy indicating if firm started to pay one or more of the following benefits to employees in 2017–19: sick leave with pay, maternity leave with pay, annual (casual) leave with pay, compensation in case of work-related accidents or professional illness, severance pay for laid off workers, national holiday leave, contributions to social security board. Restricted to firms that did paid taxes in 2017. | 123 (0.058) | 280 (0.131)     | 224 (0.105)   | 147 (0.069)  |

**Note.** Frequencies, shares of whole sample reported in parenthesis.  
*Source:* Authors’ calculations based on MEMS data.
registered with any government office and then registers at the local level is likely to be different from a firm that had always paid taxes and then signs up at the local level.

While registration with national-level agencies is not mandatory, it may be vital for operational reasons (Berkel et al., 2018). Registration with at least one national government office, i.e. national formalization, is our second indicator. About nine per cent of firms are national formalisers, i.e. they were not registered at the national level in 2017 but had decided to register by 2019. About 23 per cent were always nationally informal, i.e. they never registered at any national authority. To ensure comparability, the national formalization indicator is restricted to enterprises not paying taxes in 2017.

Our third indicator, whether a firm started paying taxes, is widely deployed by previous studies (Campos et al., 2018; McKenzie & Sakho, 2010). Around 20 per cent of the Myanmar firms were tax formalisers, i.e. they started paying corporate income tax or value-added tax, or both. Some 43 per cent did not pay any taxes but might have been formal at the local and national levels.

The fourth indicator reflects worker status because a firm is only fully formal if its staff is formal. Labour contracts are a standard indicator of formal employment. However, employment contracts are uncommon in Myanmar – only three per cent of the sample provide these. Instead, we create an indicator reporting if a firm pays any type of social benefits to its staff, i.e. social security (SS) formalization (Henley, Arbsheibani, & Carneiro, 2009). We restrict the indicator to firms that paid taxes before formalizing their workers because worker formalization often requires a firm to pay taxes and fulfill other legal requirements. Further, this restriction implies we have two comparable groups, i.e. tax-paying firms that formalized their workers and tax-paying firms with informal workers. While six per cent are SS formalisers, 13 per cent never paid any SS benefits despite being tax-payers in 2017.

It is common for firms to change status from formal to informal, as is also the case in other countries (Berkel, 2018; De Castro et al., 2014). Depending on the formality category, 0.2–11 per cent informalized between the two years. Informalization mostly happens because enterprises have to renew permits, such as the municipal registration every year. They simply do not renew their permits and therefore informalize. It is also possible to stop paying taxes because the government does not have sufficient monitoring capacity to follow up on all cases. Other firms might classify as informalisers because they are exempt from taxes under a certain threshold. However, this is only the case for a minority. Among the firms that stopped paying taxes, only eight per cent earned less than MMK 10 million, which is the threshold not to be exceeded for three consecutive years to be exempted from corporate income tax (Kaizen, 2021).

3.3. Descriptive statistics

In the following, we compare formalisers with always-informal firms by indicator. Table 2 shows the performance of both formalisers and always-informal firms regarding value-added, gross income, capital, labour, and intermediate inputs increased between 2017 and 2019. Formalizers’ performance was significantly higher in both years than in always-informal firms. This implies that formalisers were already performing significantly better before formalizing than their informal counterparts. The performance level increased with the formality indicator, meaning local formalisers performed lowest, followed by national, tax, and social security formalisers. Formalisers of all four indicators have higher educational levels, a smaller share of female owners or managers, and use more business practices than always-informal enterprises.

Formalisers of a certain category are also more likely to be formal in other formality categories than always-informal firms. For example, 89 per cent of tax formalisers also registered at the local level in 2019, while this was only the case for 52 per cent of the firms never paying taxes. Some 36 per cent of local formalisers also formalized at the national level, whereas only
Table 2. Summary statistics – formalizers vs. never formal firms

|                  | Year | Total  | Local formalizer | Always local informal | National formalizer | Always national informal | Tax formalizer | Always tax informal | Soc. Sec. formalizer | Always soc. sec. informal |
|------------------|------|--------|------------------|-----------------------|---------------------|--------------------------|---------------|--------------------|----------------------|------------------------|
| (Log) VA         | 2017 | 16.371 | 15.862           | 15.388 ***           | 16.029              | 15.460 ***               | 16.404        | 15.696 ***         | 17.411               | 16.564 ***              |
|                  | 2019 | 16.603 | 16.164           | 15.725 ***           | 16.233              | 15.804 ***               | 16.762        | 15.941 ***         | 17.450               | 16.687 ***              |
| (Log) gross outcome | 2017 | 17.485 | 16.907           | 16.390***            | 17.046              | 16.491 ***               | 17.494        | 16.742 ***         | 18.652               | 17.866 ***              |
|                  | 2019 | 17.766 | 17.251           | 16.782 ***           | 17.436              | 16.820 ***               | 17.832        | 17.067 ***         | 18.723               | 17.988 ***              |
| (Log) capital    | 2017 | 17.452 | 16.132           | 15.744***            | 16.503              | 16.060 *                 | 17.461        | 16.588 ***         | 18.752               | 17.966 ***              |
|                  | 2019 | 17.816 | 17.282           | 16.530 ***           | 17.553              | 16.647 ***               | 18.022        | 17.049 ***         | 18.931               | 17.997 ***              |
| (Log) intermediates | 2017 | 2.908  | 2.325            | 1.827**              | 2.385               | 1.971***                 | 2.843         | 2.175***           | 4.056                | 3.410 ***               |
|                  | 2019 | 3.243  | 2.712            | 2.273**              | 2.956               | 2.275***                 | 3.202         | 2.562***           | 4.297                | 3.536 ***               |
| Employees        | 2017 | 10.338 | 4.472            | 3.142**              | 6.011               | 3.414***                 | 9.076         | 5.404***           | 11.813               | 6.079 ***               |
|                  | 2019 | 11.952 | 5.611            | 3.741***             | 7.753               | 3.900***                 | 11.283        | 6.034***           | 15.195               | 6.804 ***               |
| Female owner/manager | 2017 | 0.296  | 0.269            | 0.405**              | 0.286               | 0.365*                   | 0.244         | 0.314***           | 0.317                | 0.271 ***               |
|                  | 2019 | 0.323  | 0.278            | 0.471***             | 0.286               | 0.428***                 | 0.276         | 0.356***           | 0.366                | 0.279 **                |
| High school or above | 2017 | 0.481  | 0.370            | 0.263**              | 0.407               | 0.263***                 | 0.526         | 0.321***           | 0.699                | 0.543 ***               |
|                  | 2019 | 0.459  | 0.398            | 0.219**              | 0.363               | 0.267**                  | 0.483         | 0.306***           | 0.667                | 0.518 **                |
| Risk attitude    | 2017 | 5.689  | 5.352            | 5.423                | 5.286               | 5.470                    | 5.699         | 5.499              | 6.114                | 5.964 ***               |
|                  | 2019 | 5.652  | 5.148            | 5.463                | 5.445               | 5.337                    | 5.908         | 5.405***           | 5.358                | 5.443                  |
| Electricity access | 2017 | 0.873  | 0.861            | 0.836                | 0.835               | 0.839                    | 0.846         | 0.843              | 0.959                | 0.939 **                |
|                  | 2019 | 0.894  | 0.833            | 0.836                | 0.835               | 0.827                    | 0.864         | 0.868              | 0.967                | 0.907 **                |
| Business practices | 2017 | 6.162  | 4.602            | 4.726                | 5.637               | 4.803***                 | 6.207         | 5.069***           | 7.130                | 6.304 ***               |
|                  | 2019 | 5.330  | 4.824            | 3.332***             | 3.912               | 3.843                    | 5.575         | 3.736***           | 7.650                | 5.225 ***               |
| Local registration | 2017 | 0.693  | 0.000            | 0.000                | 0.549               | 0.398***                 | 0.795         | 0.497***           | 0.894                | 0.846                  |
|                  | 2019 | 0.723  | 1.000            | 0.000***             | 0.681               | 0.460***                 | 0.887         | 0.517***           | 0.927                | 0.871                  |
| National registration | 2017 | 0.617  | 0.000            | 0.000                | 0.000               | 0.000                    | 0.674         | 0.418***           | 0.780                | 0.764                  |
|                  | 2019 | 0.644  | 0.361            | 0.157***             | 1.000               | 0.000***                 | 0.743         | 0.456***           | 0.756                | 0.771                  |
| Paying taxes     | 2017 | 0.363  | 0.000            | 0.000                | 0.000               | 0.000                    | 0.000         | 1.000              | 1.000                | 1.000                  |
|                  | 2019 | 0.460  | 0.361            | 0.047***             | 0.368               | 0.151***                 | 1.000         | 0.000***           | 0.748                | 0.639 **                |
| Providing soc. sec. | 2017 | 0.369  | 0.204            | 0.230                | 0.253               | 0.209                    | 0.363         | 0.279***           | 0.000                | 0.000                  |
|                  | 2019 | 0.322  | 0.231            | 0.106***             | 0.264               | 0.155***                 | 0.361         | 0.198***           | 1.000                | 0.000***               |
| Observations     | 2017 | 2,133  | 108              | 274                  | 182                 | 498                      | 435           | 924                | 123                  | 280                    |
|                  | 2019 | 2,133  | 108              | 274                  | 182                 | 498                      | 435           | 924                | 123                  | 280                    |

Notes: Mean estimates by year, stars represent significance levels for t-tests between formalizers and always-informal firms according to the formality indicator. ‘Formalizers’ became formal between 2017 and 2019. *Significance at a 10 per cent level, **Significance at a 5 per cent level, ***Significance at a 1 per cent level.

Source: Authors’ calculations based on MEMS data.
16 per cent of the firms remaining informal at the local level signed up with a national authority.

In the Supplementary Material Table S2, depicts the number of formalisers classifying as such along one or more formality indicators. Most enterprises only classify as formalisers along one indicator. For example, 95 per cent of tax formalisers did not formalize in any other category, while two per cent of tax formalisers are national formalisers too. Local formalisers are most likely to be formalisers in other categories, as 20 per cent of them are also national formalisers, 20 per cent tax formalisers, and 16 per cent are both national and tax formalisers.

There is a small but limited overlap between the indicators, which means they do distinguish different groups. The implications for our analysis are 2-fold. First, we look at the formalization consequences for different firms differentiated by the indicators. Second, different formalization categories may lead to different results because starting to pay taxes, for example, may involve benefits different from providing social insurance to workers.

4. Methodology

We set out with a one-step estimation of our main dependent variable, total factor productivity (TFP). We get two TFP estimates; the first is value-added TFP and the second is output TFP. We cannot calculate physical productivity because we do not have sufficient information about work hours. As OLS estimations of the production function are likely to be biased, we use the semi-parametric approach specified by LP (2003) and revised by ACF (2006) to account for the simultaneity of the selection of inputs and outputs. Intermediate inputs serve as a proxy variable for unobserved productivity; capital and labour are inputs. We add control variables, and sector and region/state fixed effects. The formalization indicator is included in this one-step estimation and we examine the correlation between formalization and TFP.

Second, formalisers exhibit characteristics different from those of firms remaining informal (always-informal firms). While we use a variable set to control for these differences (see Appendix Table A.2), the following estimations could still suffer from biases related to unobservable features like firm owner skills. To address this issue of time-invariant unobservable factors, we firstly estimate productivity and, secondly, regress formalization on estimated TFP in a fixed effects (FE) model:

$$Y_{it} = a_i + \beta_1 F_{it} + \beta_2 X_{it} + a_t + i \varepsilon$$  (1)

While $i$ stands for a firm and $t$ for a year, i.e. 2017 or 2019, $Y_{it}$ represents our main outcome, value-added TFP (see Appendix Table A.1 exact measurement). We include firm ($a_i$) and year ($a_t$) FEs. $F$ is the specific formality indicator. $X$ controls for firm and owner characteristics. The regression results reflect a comparison between the mean change in value-added among formalisers and the mean change in value-added among informal enterprises. Possible biases from time-variant unobservable factors could remain, which means our results depict correlations between formalization and productivity rather than the causal formalization effect on productivity.

Our approach relies on a strong parallel trends assumption, i.e. it assumes formalisers and always-informal firms followed the same trends over time before the formalisers became formal. As we do not have more than one point in time before the firms’ formalization, we cannot provide any evidence for parallel trends. To address this problem, we employ matching techniques to establish comparable counterfactuals. Specifically, we compare two matching techniques. The first consists of nearest neighbours (four units). The second technique is a doubly robust (DR) method combining two alternative approaches controlling for confounding factors (Sant’Anna & Zhao, 2020). The DR-method’s first approach relies on outcome regressions (Heckmann, Ichimura, & Todd, 1997), and the second applies inverse probability weighting.
The main idea is to assign larger weights to always-informal firms that had similar characteristics as formalisers before these formalised. The DR estimator renders the parallel trends assumption more convincing, and its advantage is that even if one of the two approaches is incorrectly specified, the estimator remains valid. Nevertheless, we do not estimate causal relationships.

5. Results

We summarize in what follows our results regarding the association of our four formalization categories with TFP. The primary analysis involves one- and two-step productivity estimations whose robustness we check with nearest neighbour matching and doubly robust estimates. To test the results’ robustness further, we run the same analysis with a different sample – the conservative sample (see Appendix and S2 of Supplementary Material).

5.1. Local formalization

We examine the potential consequences of local formalization, i.e. a firm’s decision to register with a municipality or township office. Tables 3 and 4 show one- and two-step productivity estimations and reveal no clear statistically significant association between local formalization and TFP. While the one-step estimations show local formalisers being significantly more

| Formalization | Local formalization | National formalization |
|---------------|---------------------|------------------------|
| VA TFP        | 0.125*** (0.037)    | 0.200 (0.032)          |
| Output TFP    | 0.174 (0.088)       | 0.281*** (0.038)       |
| L             | 0.865*** (0.048)    | 0.843*** (0.025)       |
| K             | 0.080*** (0.035)    | 0.125*** (0.030)       |
| Female        | 0.086* (0.048)      | 0.081*** (0.025)       |
| Business practices | 0.045*** (0.011) | 0.028*** (0.010)       |
| High school or above | -0.078*** (0.023) | 0.032* (0.017)         |
| State dummies | Yes                 | Yes                    |
| Sector dummies| Yes                 | Yes                    |
| Observations  | 764                 | 1,360                  |
| Formalizers   | 108                 | 182                    |
| R2            | 0.39                | 0.40                   |

| Tax formalization | VA TFP  | Output TFP |
|-------------------|---------|------------|
| Formalization     | 0.212*** (0.030) | -0.096*** (0.030) |
| L                 | 0.865*** (0.027) | 0.632*** (0.032)  |
| K                 | 0.129*** (0.031) | 0.229*** (0.056)  |
| Female            | 0.066*** (0.025) | -0.273*** (0.030) |
| Business practices| 0.023*** (0.008) | 0.036** (0.013)   |
| High school or above | 0.124*** (0.026) | 0.120*** (0.027)  |
| State dummies     | Yes      | Yes        |
| Sector dummies    | Yes      | Yes        |
| Observations      | 2,718    | 806        |
| Formalizers       | 435      | 123        |
| R2                | 0.47     | 0.37       |

Notes: Standard errors reported in parenthesis. See Appendix Table A.1 for the dependent variables. *Significance at a 10 per cent level, **Significance at a 5 per cent level, ***Significance at a 1 per cent level.
Source: Authors’ calculations based on MEMS data.
productive than always-informal firms, this association’s significance disappears in the two-step estimations. As the two-step estimators include firm FE, we regard them as more valid than the one-step estimators. The NN and DR estimates confirm the statistical insignificance of the local formalization-TFP relationship (see Table 5). We obtain similar results when restricting our sample to micro firms and when running the same analysis with the conservative sample. Hence, local formalisers do not become significantly more productive than always-informal firms, at least not in the two years examined.

Supplementary Tables S7 and S11 examine intermediate channels through which formality might influence productivity. Local formalisers pay significantly higher taxes and fees than always-informal firms. At the same time, for micro firms and the conservative sample, local formalization is associated with a lower likelihood of making investments. Higher costs and smaller investments are unlikely to raise significantly a firm’s productivity. However, on the positive side, local formalization is associated with more sales to other formal enterprises for both the main sample and micro firms. There are no statistically significant associations between local formalization and any other potential formalization benefits, such as access to credit. Thus, local formalization is associated with high costs and few benefits. The costs may well outweigh the benefits, which could be why local formalization is not associated with higher productivity.

5.2. National formalization

We highlight the association of registration with any national government agency and productivity. National formalisers do not become significantly more productive than always-informal firms. This is so in the main sample’s case (see Tables 3 and 4), micro-enterprises (see Supplementary Tables S4 and S5), and the conservative sample (see Supplementary Tables S8 and S9). The matching and DR estimators do not show any statistical significance either (see Table 5).

Table 4. Formalization and productivity – two-step FE regressions

| Local formalization | National formalization |
|---------------------|------------------------|
| VA TFP              | Output TFP             |
| Formalization       |                       |
|                     | -0.076 (0.083)         |
|                     | -0.036 (0.111)         |
| Female              | -0.062 (0.105)         |
|                     | -0.073 (0.121)         |
| Business practices  | 0.012* (0.007)         |
|                     | 0.016* (0.009)         |
| High school or above| 0.105 (0.088)         |
|                     | 0.192* (0.106)         |
| Observations        | 764                    |
| Formalizers         | 108                    |
| R2                  | 0.07                   |

| VA TFP              | Output TFP             |
| Formalization       |                       |
|                     | 0.109** (0.043)        |
|                     | 0.169*** (0.055)       |
| Female              | -0.060 (0.052)         |
|                     | -0.088 (0.061)         |
| Business practices  | 0.015*** (0.003)       |
|                     | 0.020*** (0.005)       |
| High school or above| 0.045 (0.044)         |
|                     | 0.093* (0.051)         |
| Observations        | 2,718                  |
| Formalizers         | 435                    |
| R2                  | 0.06                   |

| SS formalization    | VA TFP                 |
|                     | Output TFP             |
| Formalization       | 0.173 (0.115)          |
|                     | 0.211 (0.130)          |
| Female              | -0.092 (0.108)         |
|                     | -0.159 (0.120)         |
| Business practices  | 0.001 (0.007)          |
|                     | -0.003 (0.008)         |
| High school or above| 0.227** (0.098)       |
|                     | 0.255** (0.117)        |
| Observations        | 806                    |
| Formalizers         | 123                    |
| R2                  | 0.07                   |

Notes: Firm FE regressions. See Appendix Table A.1 for the dependent variables. *Significance at a 10 per cent level, **Significance at a 5 per cent level, ***Significance at a 1 per cent level.

Source: Authors’ calculations based on MEMS data.
Table 5. Formalization and productivity, matches and DR estimators

|                      | Local formalization | National formalization | Tax formalization | SS formalization |
|----------------------|---------------------|------------------------|-------------------|------------------|
| VA TFP               |                     |                        |                   |                  |
| A: levels specification | -0.039 (0.088)  | -0.031 (0.064)    | 0.128*** (0.046) | -0.008 (0.136)  |
| B: levels specification – full set | 0.019 (0.097)  | -0.011 (0.069)    | 0.105** (0.047)  | -0.009 (0.149)  |
| C: Difference and levels specification | -0.001 (0.097)  | 0.019 (0.069)     | 0.087* (0.047)   | -0.143 (0.156)  |
| Doubly robust        | 0.058 (0.088)     | 0.063 (0.066)     | 0.104** (0.046)  | 0.194* (0.115)  |
| Output TFP           |                     |                        |                   |                  |
| A: levels specification | 0.027 (0.111)  | 0.107 (0.088)     | 0.201*** (0.059) | 0.027 (0.157)   |
| B: levels specification – full set | 0.150 (0.119)  | 0.075 (0.091)     | 0.216*** (0.063) | -0.077 (0.156)  |
| C: Difference and levels specification | 0.076 (0.124)  | 0.084 (0.093)     | 0.174*** (0.063) | -0.165 (0.162)  |
| Doubly robust        | 0.192* (0.116)   | 0.140 (0.085)     | 0.188*** (0.060) | 0.215* (0.130)  |
| Observations         | 382                 | 680                   | 1,359             | 403              |
| Formalizers          | 108                 | 182                   | 435               | 123              |

Notes: Average treatment effect of the treated (ATT) using bias corrected nearest neighbour matching (four matches per observation) in rows 1–3 and doubly robust estimates in row 4. Standard errors reported in parenthesis. Estimations done using the nnmatch and drdid commands in Stata. Matching of A based on: Gender of owner/manager, business practices, high school or above. Matching of B (full set) based on: A + state, sector. Matching of C based on: Initial values of full set of control variables (2017 characteristics) and differences (2017–2019) in the selected variables. Matching variables of DR based on full set (B). *Significance at a 10 per cent level, **Significance at a 5 per cent level, ***Significance at a 1 per cent level.

Source: Authors' calculations based on MEMS data.
We might not find a significant association between national formalization and productivity because national formalization is not associated with any benefits (see Supplementary Table S7). Instead, national formalisers have to pay significantly higher fees and taxes after having formalized than always-informal businesses. Just like local formalization, national formalization seems to be rather costly with limited benefits.

5.3. Tax formalization

An enterprise becomes tax formal when it starts paying corporate income, VA tax, or both. Tax formalization is significantly and positively associated with productivity. The two-step productivity estimates depict that formalisers’ productivity is about 11–17 per cent higher than that of always-informal firms (see Table 4). The NN and DR estimators confirm these results (see Table 5). The association between tax formalization and productivity remains positive, but the magnitude increases to around 22 per cent when using the conservative sample instead (see Supplementary Table S9).

To understand through which channels the positive tax formalization-productivity relationship works, Supplementary Table S7 illustrates tax formalisers employing significantly more workers than always-informal firms. At the same time, tax formalisers are less likely to hire casual workers. This implies that tax formaliser workers have more permanent jobs than those in always-informal firms. Further, tax formalisers pay significantly higher taxes and fees, which is not surprising given that taxes form the formality requirement. We do not identify any other significant intermediate channels of tax formalization, suggesting tax formalization only conveys a few benefits.

The positive relationship discussed does not hold for the smallest firms employing fewer than five workers in both years. Tax formalisers of micro-size do not appear to be significantly more productive than micro-sized firms that remain informal (see Supplementary Tables S4 and S5). The mechanism analysis also shows that for micro firms, tax formalization is mostly associated with high taxes and fees and with few benefits (see Supplementary Tables S7). Hence, we conclude formalization is irrelevant for the smallest enterprises as they never grow large enough to benefit from government services and formal markets (Benhassine et al., 2018; Demenet et al., 2016).

5.4. Social security formalization

An enterprise is only completely formal if its employees are formal. In Myanmar, this happens when a firm starts paying any social security (SS) benefits to its workers. SS benefits can motivate employees or attract more-qualified workers, consequently contributing to improving firm productivity.

We find no consistent significant relationship between SS formalization and productivity. We do detect a few statistically significant estimates but cannot confirm their robustness. Similarly, there is no statistically significant relationship between social SS formalization and potential beneficial or costly intermediate channels. In contrast to the three other formalization indicators, SS formalization does not relate significantly to higher taxes and fees. These results stand in contrast to previous studies showing social insurance leads to higher productivity in Vietnam and lower productivity in China (Huynh, 2021; Zhang, Shi, & Shi, 2021).

5.5. Commonalities

In many countries, formalization is associated with more customers, sales to formal actors, such as the government, and better access to electricity and the internet (Berkel, 2018; Demenet et al., 2016). For Myanmar, we do not find any positive association between formalization and
these benefits. Further, like other research, we confirm that formalization is not significantly associated with better access to credit. International organizations and governments promote access to credit widely as a formalization benefit. This risks misleading firms, as the empirical evidence does not show a significant relationship between the two.

Firms deciding for any level of registration with the Myanmar government pay higher taxes and fees than always-informal firms. These higher costs appear to outweigh the few non-existing formalization benefits. The high costs and few to no benefits are also likely reasons why we do not detect any significant association between productivity and local, national, and SS formalization.

We do find however that tax formalization, a relatively high level of formalization is positively associated with productivity. Tax formalization is a high formalization level because enterprises need to fulfill numerous formal requirements to fall in this category. Firms are likely to need to be locally and nationally formal before becoming tax formal. As firms have to fulfill more requirements for tax formalization, many of those formalizing, are already more productive than always-informal firms and firms formal on lower levels. We believe formalisers’ initial higher performance and other characteristics are the reason that tax formalization is positively associated with productivity; and this is in line with previous studies showing that formalization is only beneficial for informal firms that resemble formal firms before formalizing (Benhassine et al., 2018). Tax formalization is not positively associated with the productivity of micro-enterprises, which reinforces our assessment.

The formalization benefits existing in other countries may be ineffective or absent in Myanmar, which used to repress private enterprises. At the beginning of the 21st century, an informed analyst described Myanmar’s industry as follows: ‘Practically no facilities or institutions exist to provide training, to upgrade technology and to promote overseas markets. There are no financial institutions to help small industries [...]’ (Kyi et al., 2000, p. 60). In this line of reasoning, Danquah and Sen (2021) show Myanmar enterprises rely on informal institutions like social and business networks, which act as substitutes for formal institutions. Finally, considering the recent political developments, it might take time until Myanmar creates institutions that sufficiently support private enterprises.

6. Conclusion

Firm informality is widespread in Myanmar and it will remain so in the future. At the same time, formalization is widely promoted as a key policy measure to enhance firm performance. However, research is inconclusive on the formalization consequences and rather points to insignificant effects. Furthermore, formality can be defined in many ways, and different categories of formalization may lead to different outcomes.

This study uses a unique and nationally representative dataset, and it is the first to study the formalization effects on manufacturing firms in Myanmar. We identified four formality indicators and went on to understand their relevance to the country. Our results reveal that tax payment is the only formalization category that is associated with higher productivity. While tax formalisers pay higher taxes and fees, they also employ more permanent workers than non-paying tax firms. These results do not hold for the smallest enterprises. Further, tax formalisers, on average, belong to the more productive enterprises, even before starting to pay taxes. Thus, it appears that enterprises need to reach a certain level of productivity and size to be able to pay taxes and benefit from tax formalization, in line with results from previous studies.

Lower formalization levels, like the registration with local authorities (local formalization) or national-level offices (national formalization), are not significantly associated with productivity. Further, they come with few intermediate benefits, which are much more prevalent in other countries. Both local and national formalisers pay higher taxes and fees than always-informal enterprises, almost without acquiring any benefits due to their new status.
Even though social security benefits to workers (social security formalization) correlate with productivity in other countries, this does not seem to be the case in Myanmar. Further, SS formalization does not seem to be associated with any mechanisms of formalization, whereas the other three formalization categories relate to at least a few benefits.

While formalization leads to some benefits in other countries, the benefits in Myanmar seem to be fewer and the costs high. Thus, simplistic policy advice suggesting firm formalization is unlikely to be effective, especially in relation to the smallest firms. More holistic approaches are likely to be better at supporting informal livelihoods. For example, the policy could focus on furthering the benefits of formalization that are currently non-existing or weak. Before trying to formalize all firms, policy should target better service provision and facilitate access to formal markets, e.g. make it easier for firms to purchase machinery and obtain credit.

More research on formalization is required. Many programmes worldwide aim to formalize informal enterprises with potentially significant consequences for firms. Yet, formalization outcomes are not as positive as often expected. In addition, there is a need to focus on detecting the causal impact of formalization going beyond the identification of correlations between formalization and firm performance as in the present paper. Further, the literature uses many different informality definitions. Hence, it is difficult, if not impossible, to draw a conclusion about the overall formalization effects on enterprises. Harmonization of the different definitions should be aimed at and include several indicators, keeping in mind that a simplistic focus on formalization is inadequate.

Notes
1. Manufacturing industries follow the Myanmar Standard Industrial Classification.
2. Ibid.
3. The data were collected by CSO in accordance with the formal contracts between CSO and Denmark’s development cooperation (Danida), and CSO and UNU-WIDER, on the one hand, and the Myanmar statistical law and data regulations in force at the time of data collection, on the other hand. Informed consent was obtained from all interviewees by the CSO enumerators at the time of collecting the data in line with international practice, and ethical clearance for the present study was obtained from CSO senior management in the formal programme steering meetings and confirmed in the annual work programme (no approval number available).
4. In the former British Imperial System, the unit of power of electricity was horsepower. Myanmar continues using horsepower and one horsepower equals 746 W. The machines of manufacturing firms might require higher horsepower than a normal household.
5. Ibid.
6. In Stata, we use the following command for the one-step estimation: `prodest lva, free(logl) state(lrk) proxy(lrm) va met(lp) control(F fem MainIndex hs state1 state2-state15 s10-s25 s31) acf opt(mm) reps(50) id(ETPNO) t(year2) fsresiduals(fs_acf_lp)`.

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ORCID
Hanna Berkel http://orcid.org/0000-0003-0650-6566
Finn Tarp http://orcid.org/0000-0002-6247-4370

Data availability statement
The replication data and Stata code are available on request.

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Appendix

A.1. The conservative sample

Most enterprises replied to our questions about registration with different categories of government agencies and on economic accounts. We use this sample of 2,133 firms in the main analysis. However, some interviewees did not provide replies or only gave unclear answers to follow-up questions about their registration status. These follow-up questions asked about the year of registration, the official document or license number the firm owners received and the amount of money they paid upon registration. We decided to drop the firms that only provided incomplete information on their registration status. This more conservative sample includes 1,005 enterprises and we use it as a robustness check of our main analysis.

Table A3 shows that the more conservative sample exhibits lower performance levels but bigger firm size than the main sample. More importantly, the formalizers of the main and conservative samples do not differ significantly. For example, even though local formalizers in the conservative sample have higher performance levels than formalizers in the main sample, the differences are not statistically significant. Similarly, there are few statistically significant differences between the samples for the other three categories of formalizers. We therefore believe that our results do not differ much by sample and, therefore, the conservative sample is valid for a robustness check.

We decided to use the sample with more observations as main sample because it is representative of the Myanmar manufacturing sector.
Table A1. Dependent variables and mechanisms

| Dep. Variables | Description | Pooled | 2017     | 2019     |
|----------------|-------------|--------|----------|----------|
| Total factor productivity (value added) ACF | Estimation result based on the estimation approach by ACF: $Y_{it} = \beta_{1}k_{it} + \beta_{2}l_{it} + \omega_{it} + \epsilon_{it}$ Value added = Revenue from sales – Intermediates and raw material costs – indirect costs | 2.573 (2.573) | 2.485 (1.186) | 2.662 (1.196) |
| Total factor productivity (gross output) ACF | Estimation result based on the estimation approach by ACF: $Y_{it} = \beta_{1}k_{it} + \beta_{2}l_{it} + \omega_{it} + \epsilon_{it}$ Gross output = revenue from sales | 2.375 (0.582) | 2.324 (0.578) | 2.427 (0.582) |

| Mechanisms | Description | Pooled | 2017     | 2019     |
|-------------|-------------|--------|----------|----------|
| Firm size   | A firm’s number of employees | 11.160 (33.360) | 10.338 (31.217) | 11.981 (35.362) |
| Taxes and fees | Logarithm of the firm’s self-reported total fees and taxes | 9.894 (4.793) | 9.713 (4.954) | 10.074 (4.621) |
| Electricity access | Dummy indicating if the firm has access to the public electricity grid | 0.884 (0.884) | 0.873 (0.333) | 0.894 (0.308) |
| Internet    | Dummy indicating if the firm has internet access | 0.050 (0.049) | 0.038 (0.191) | 0.060 (0.238) |
| Loan        | Dummy indicating if the firm has obtained at least one formal loan in the last two years | 0.076 (0.076) | 0.086 (0.281) | 0.066 (0.248) |
| Accounting books | Dummy indicating if the firm maintains formal accounting books in accordance with government guidelines | 0.086 (0.280) | 0.064 (0.245) | 0.108 (0.310) |
| Customers   | Scale variable that increases with the firm’s number of customers for the most important product. It takes the value of 1 if the firm has one customer, 2 for 2–5 customers, 3 for 6–10 customers, 4 for 11–20 customers, 5 for 21–50 customers and 6 for >50 customers | 3.823 (1.633) | 3.794 (1.604) | 3.853 (1.661) |
| Sales to businesses | Dummy indicating if the firm sells >1 per cent of its most important product to other enterprises | 0.021 (0.021) | 0.019 (0.137) | 0.023 (0.151) |
| Invest      | Dummy indicating if the firm has made any investments in the last 2 years | 0.166 (0.372) | 0.224 (0.417) | 0.107 (0.310) |
| Power-driven machinery | Dummy indicating if the firm uses at least one power-driven machine | 0.687 (0.464) | 0.671 (0.470) | 0.703 (0.457) |

Notes: Mean values. Standard deviation in parenthesis.
Source: Authors’ calculations based on MEMS data.
## Table A2. Control variables

| Control variables                  | Description                                                                 | Pooled      | 2017   | 2019   |
|-----------------------------------|-----------------------------------------------------------------------------|-------------|--------|--------|
| Gender of owner/manager           | Dummy which takes the value of 1 if a firm’s owner or manager (depending on who of the two was interviewed) is female. | 0.309 (0.462) | 0.296 (0.457) | 0.323 (0.468) |
| Business practices                | Index of 21 management experience, counting how many of these a firm is applying. See Berkel et al. (2018) and McKenzie and Woodruff (2015) for more details. | 5.746 (5.037) | 6.162 (5.054) | 5.330 (4.987) |
| High school or above              | Dummy takes the value of 1 if a firm’s owner or manager has a high school degree or higher. | 0.470 (0.499) | 0.481 (0.500) | 0.459 (0.498) |
| Total                             |                                                                             | 4,266       | 2,133  | 2,133  |

*Notes:* Mean values. Standard deviation in parenthesis.

*Source:* Authors’ calculations based on MEMS data.
Table A3. Summary statistics – main sample vs. conservative

| Year | Total | Local formalizer | National formalizer | Tax formalizer | Social security formalizer |
|------|-------|------------------|---------------------|----------------|---------------------------|
|      | Main  | Cons             | Main                | Cons          | Main                      | Cons          |
| 2017 | 16.371| 16.291           | 15.862              | 16.151        | 16.404                    | 17.411        |
| 2019 | 16.603| 16.595           | 16.233              | 16.524        | 16.762                    | 17.450        |
|      |       |                  |                     |               |                           | 17.190        |
| (Log) VA | 17.489| 17.362**         | 16.907              | 17.121        | 17.494                    | 18.652        |
| 2017 | 17.766| 17.638           | 17.463              | 17.193        | 17.832                    | 18.273        |
| 2019 | 17.354| 17.123**         | 16.503              | 16.448        | 17.461                    | 18.752        |
|      |       |                  |                     |               |                           | 18.797        |
| (Log) Gross outcome | 2.911| 2.772**         | 2.325               | 2.528         | 2.843                    | 4.056         |
| 2017 | 3.247 | 3.105**          | 2.712               | 2.645         | 3.202                    | 4.297         |
| 2019 | 10.338| 12.314           | 4.472               | 6.194         | 9.076                    | 11.813        |
|      |       |                  |                     |               |                           | 10.229        |
| Female | 0.296 | 0.235            | 0.269               | 0.333         | 0.286                    | 0.494         |
| 2017 | 0.323 | 0.361**          | 0.278               | 0.306         | 0.286                    | 0.494         |
| 2019 | 0.481 | 0.457            | 0.370               | 0.333         | 0.417                    | 0.737         |
| High school | 0.459 | 0.431          | 0.398               | 0.389         | 0.363                    | 0.702         |
| 2017 | 5.689 | 5.767          | 5.352               | 5.306         | 5.286                    | 5.908         |
| 2019 | 5.652 | 5.635          | 5.148               | 5.806         | 5.445                    | 6.114         |
| Risk attitude | 0.678 | 0.879       | 0.861               | 0.861         | 0.835                    | 0.846         |
| 2017 | 0.894 | 0.910          | 0.833               | 0.861         | 0.868                    | 0.864         |
| 2019 | 6.162 | 5.985          | 4.602               | 4.750         | 5.637                    | 6.207         |
| Electric | 5.330 | 5.161          | 4.824               | 4.806         | 3.912                    | 5.757         |
| 2017 | 0.693 | 0.600***        | 0.000               | 0.000         | 0.000                    | 0.000         |
| 2019 | 0.723 | 0.542**         | 1.000               | 1.000         | 0.724                    | 0.887         |
| Local registration | 0.617 | 0.529***        | 0.000               | 0.000         | 0.549                    | 0.795         |
| 2017 | 0.644 | 0.541**         | 0.361               | 0.306         | 1.000                    | 0.743         |
| 2019 | 0.363 | 0.304**         | 0.000               | 0.000         | 0.000                    | 0.756         |
| Paying taxes | 0.460 | 0.372**        | 0.361               | 0.444         | 0.368                    | 0.743         |
| 2017 | 0.369 | 0.415**         | 0.204               | 0.333         | 0.253                    | 0.756         |
| 2019 | 0.322 | 0.359**         | 0.231               | 0.278         | 0.264                    | 0.756         |
| Providing SS | 0.361 | 0.341**        | 0.182               | 0.369         | 0.363                    | 0.361         |
| 2017 | 2.133 | 1.005          | 108                 | 36            | 435                      | 123           |
| 2019 | 2.133 | 1.005          | 108                 | 36            | 435                      | 123           |

Notes: Mean estimates by year, stars represent significance levels for t-tests at a 10 per cent level, *Significance at a 10 per cent level, **Significance at a 5 per cent level, ***Significance at a 1 per cent level.

Source: Authors’ calculations based on MEMS data.