

Shinozaki, Shigehiro; Miyakawa, Daisuke

**Working Paper**

## Designing a country's small and medium-sized enterprise development index using firm-level data: The case of Thailand

ADB Economics Working Paper Series, No. 785

**Provided in Cooperation with:**

Asian Development Bank (ADB), Manila

*Suggested Citation:* Shinozaki, Shigehiro; Miyakawa, Daisuke (2025) : Designing a country's small and medium-sized enterprise development index using firm-level data: The case of Thailand, ADB Economics Working Paper Series, No. 785, Asian Development Bank (ADB), Manila, <https://doi.org/10.22617/WPS250228-2>

This Version is available at:

<https://hdl.handle.net/10419/322378>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/3.0/igo/>

# DESIGNING A COUNTRY'S SMALL AND MEDIUM-SIZED ENTERPRISE DEVELOPMENT INDEX USING FIRM-LEVEL DATA

THE CASE OF THAILAND

*Shigehiro Shinozaki and Daisuke Miyakawa*

**NO. 785**

June 2025

**ADB ECONOMICS  
WORKING PAPER SERIES**

ADB Economics Working Paper Series

# Designing a Country's Small and Medium-Sized Enterprise Development Index Using Firm-Level Data: The Case of Thailand

Shigehiro Shinozaki and Daisuke Miyakawa

No. 785 | June 2025

The *ADB Economics Working Paper Series* presents research in progress to elicit comments and encourage debate on development issues in Asia and the Pacific. The views expressed are those of the authors and do not necessarily reflect the views and policies of ADB or its Board of Governors or the governments they represent.

Shigehiro Shinozaki ([sshinozaki@adb.org](mailto:sshinozaki@adb.org)) is a senior economist at the Economic Research and Development Impact Department, Asian Development Bank. Daisuke Miyakawa ([damiyak@waseda.jp](mailto:damiyak@waseda.jp)) is a professor at Waseda University and chief economist of UTokyo Economic Consulting Inc.



Creative Commons Attribution 3.0 IGO license (CC BY 3.0 IGO)

© 2025 Asian Development Bank  
6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines  
Tel +63 2 8632 4444; Fax +63 2 8636 2444  
[www.adb.org](http://www.adb.org)

Some rights reserved. Published in 2025.

ISSN 2313-6537 (print), 2313-6545 (PDF)  
Publication Stock No. WPS250228-2  
DOI: <http://dx.doi.org/10.22617/WPS250228-2>

The views expressed in this publication are those of the authors and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent.

ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use. The mention of specific companies or products of manufacturers does not imply that they are endorsed or recommended by ADB in preference to others of a similar nature that are not mentioned.

By making any designation of or reference to a particular territory or geographic area in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

This publication is available under the Creative Commons Attribution 3.0 IGO license (CC BY 3.0 IGO) <https://creativecommons.org/licenses/by/3.0/igo/>. By using the content of this publication, you agree to be bound by the terms of this license. For attribution, translations, adaptations, and permissions, please read the provisions and terms of use at <https://www.adb.org/terms-use#openaccess>.

This CC license does not apply to non-ADB copyright materials in this publication. If the material is attributed to another source, please contact the copyright owner or publisher of that source for permission to reproduce it. ADB cannot be held liable for any claims that arise as a result of your use of the material.

Please contact [pubsmarketing@adb.org](mailto:pubsmarketing@adb.org) if you have questions or comments with respect to content, or if you wish to obtain copyright permission for your intended use that does not fall within these terms, or for permission to use the ADB logo.

Corrigenda to ADB publications may be found at <http://www.adb.org/publications/corrigenda>.

Note:

In this publication, “B” refers to baht.

## **ABSTRACT**

Understanding the business environment and structural issues that limit growth is critical when designing an effective national policy framework for private sector development—especially for micro, small, and medium-sized enterprises (MSMEs). Given the limited MSME data available, this paper employs probabilistic principal component analysis to develop a new way to quantitatively assess what affects MSME development nationally, by using granular firm-level panel data for 49,565 MSMEs in Thailand as a case study. The estimation results found a potential disproportionate effect of MSME policy interventions during and after the coronavirus disease pandemic. Government assistance for MSMEs likely helped Bangkok-based firms ease the negative pandemic effects, especially in manufacturing. However, it did not help local MSMEs—regardless of sector—as their operational performance deteriorated both during and after the pandemic. This underscores the importance of using a focused approach when designing policies for MSME development to facilitate more sustainable, resilient private sector growth.

**Keywords:** SME development, access to finance, financial inclusion, SME policy, probabilistic principal component analysis, Thailand

**JEL codes:** D22, G20, L20, L50

# 1. Introduction

Macro and micro policy implementation should be consistent with assistance measure targets. While highly aggregated variables such as gross domestic product (GDP) and the inflation rate have been used as key measures in guiding policy design, policy makers are now paying more attention to granular data such as firm-level financial statements. This reflects the need to consider the heterogeneous status and characteristics of policy targets—such as micro, small, and medium-sized enterprises (MSMEs)—so policy implementation is more effective and efficient (Gourinchas et al. 2020; Ebeke et al. 2021). In this paper, we empirically measure summarized business activity using granular data to construct firm activity indexes that account for the heterogeneity among policy targets.

MSMEs have a large impact on business activity, job creation, and economic output, helping drive growth across developing Asia and the Pacific. Governments in the region thus use various assistance measures for national MSME development—to promote young and women entrepreneurs, adopt and commercialize technology, expand MSME international market access, develop human capital and worker skills, and boost access to finance. However, constraints on MSME development remain in most countries, raising the question of how governments can design effective policies that better reach MSMEs. Understanding the business environment and structural problems associated with business growth is critical to design an effective national policy framework for MSME development. However, limited MSME data make it difficult to do so.

Given the general usefulness of constructing firm activity indexes, various global organizations such as the Organisation for Economic Co-operation and Development, the Economic Research Institute for ASEAN and East Asia, and the International Trade Centre have already begun the process. They propose a qualitative approach using assessment matrices for performance ratings or median comparisons based on available data to evaluate MSME development conditions (ADB 2022). Despite these efforts, the discretion associated with ways to construct measures, the cost of producing reliable measures, and the difficulty of interpreting results are also considered major issues public organizations must address. Preceding studies such as ADB (2022) and Shinozaki et al. (2024) aim to overcome this difficulty by applying an empirical method—probabilistic principal component analysis (P-PCA)—to country-level annual data, which is immune to discretion and easy to implement, thus allowing for straightforward interpretation.

One caveat to preceding studies is that constructing activity indexes for MSMEs—such as the Small and Medium-Sized Enterprise Development Index (SME-DI)—do not necessarily consider the heterogeneity among policy targets. This drawback reflects the fact that ADB (2022) and Shinozaki et al. (2024) used aggregate data such as country-level macroeconomic variables to construct an SME-DI that covers the entire (or sub) Asian region(s). In this paper, we follow ADB (2022) and Shinozaki et al. (2024) and further apply the P-PCA method to disaggregated data so we can consider the heterogeneous status among policy targets, for example, across various industries and regions in constructing an SME-DI.

Here, we use proprietary firm-level panel data obtained from a private data vender in Thailand (Dun & Bradstreet) to apply the P-PCA method to the granular data. Specifically, we conduct several exercises to further develop the SME-DI. First, we apply the P-PCA method to industry-region-year level disaggregated panel data (constructed from firm-year level granular data specifically on Thailand's MSMEs) to create an index accounting for MSME activities in a single country. This index is further broken down by industry- and/or regional-level indicators as well as indicators explicitly accounting for MSMEs' real and financial activities. Second, using the smaller dataset randomly chosen by the entire granular dataset, we construct industry-region-year level

disaggregated panel data and re-run the P-PCA algorithm. Comparing this result with that based on the entire MSME dataset, we examine whether or not the relatively small amount of data can reproduce an SME-DI consistent with that obtained from the entire dataset. This provides useful information practitioners can easily implement—for example, survey analyses to construct a reliable indicator summarizing MSME activities. Third, we further apply the P-PCA method to firm-level “raw” granular data (MSME data not aggregated by industry-region but used as is) and directly obtain the indicators that account for MSME activities in Thailand. Again, this exercise contributes to our deeper understanding of the value of survey analyses in constructing a reliable indicator summarizing MSME activities.

## **2. Thailand’s MSME Landscape and Policy Support Measures**

Like in other countries, MSMEs play a crucial role in driving Thailand’s economy.<sup>1</sup> Over time, their numbers have consistently increased, even during the coronavirus disease (COVID-19) pandemic that started in early 2020. MSMEs increased in number by 0.9% in 2020 and 1.4% in 2021. As of end-2023, there were 3.2 million MSMEs, accounting for 99.5% of all enterprises (ADB 2024). By sector, the largest share was in wholesale and retail trade (41.8%), followed by other services (including accommodation and food services, 40.4%) and manufacturing (16.0%). MSMEs were spread across the country with 83.6% in the provinces and 16.4% in the capital city Bangkok. As of end-2023, MSMEs employed 12.9 million workers or 70.4% of the total workforce, which has gradually expanded during the post-pandemic recovery.

While GDP growth in Thailand slowed in 2023 (2.0%), MSME output remained relatively robust. Despite the pandemic challenges, GDP rebounded quickly for MSMEs—from a 9.6% decline in 2020 to 4.2% growth in 2021, a V-shaped recovery. As of end-2023, MSME output was B6.3 trillion, accounting for 35.2% of GDP, up 3.6% from 2022. Among MSMEs, other services contributed most (41.2%), followed by manufacturing (30.0%) and wholesale and retail trade (21.8%) (ADB 2024).

MSME exports also rebounded quickly from the pandemic impact, growing by a remarkable 22.0% in 2021 after a 17.1% drop in 2020. By 2023, MSME export value reached B1.3 trillion or 13.4% of total export value. MSME exports grew by a robust 24.3% from 2022. Major export destinations included other Southeast Asian countries, the People’s Republic of China (PRC), the United States, and the European Union, which together accounted for nearly 80% of total MSME export value. Nearly all major MSME export markets expanded primarily due to their own economic recovery (Office of Small and Medium Enterprises Promotion [OSMEP] 2022). In 2021, export volumes of gems and jewelry, wood, agricultural produce, iron and steel, and plastic products grew fastest. By contrast, MSME exports such as sugar, automobile parts, and rubber products declined in volume. MSME imports also expanded, reaching B1.4 trillion in 2023, accounting for 14.0% of total import value, a 16.2% increase from 2022 (ADB 2024).

The government’s quick policy actions supporting MSMEs and workers during the pandemic likely contributed to the lower pandemic impact on businesses in Thailand. For debt financing, the central bank (Bank of Thailand) provided several liquidity support measures for banks to finance MSMEs hurt by the pandemic. These included capital buffers for banks, deferred principal payments, reduced interest rates, and new soft loans/credit lines for MSMEs. The government

---

<sup>1</sup> In Thailand, MSMEs are defined as either (i) manufacturing or (ii) services and trading, using the number of employees and revenue as criteria (ADB 2024). For manufacturing (including agriculture), an MSME is defined as a firm with up to 200 employees or annual revenue of less than B500 million. For services and trading, an MSME can have up to 100 employees or annual revenue below B300 million.

used value added tax (VAT) refunds for domestic entrepreneurs and reduced social security contributions and withholding taxes for businesses. It also provided B5,000 monthly handouts for self-employed and laid-off workers, and partial (50%) salary payouts for those displaced. To help lower business costs, water and electricity payments were suspended (ADB 2020).

Given the importance of MSMEs in the Thailand economy, the government developed a medium-term strategy to promote MSMEs. The current SME Promotion Plan 2023–2027 aims to create a strong and progressive environment to make MSMEs more competitive. It has three strategic pillars: (i) inclusive development across all MSME sectors, (ii) identify market opportunities, and (iii) create a supportive MSMEs ecosystem that improves access to finance, technology, innovation, skills development, big data, the legal framework, and policy information (ADB 2024).

### 3. Empirical Approaches

This study uses the P-PCA empirical approach. As detailed in ADB (2022) and Shinozaki et al. (2024), the idea behind the P-PCA method is basically same as standard principal component analysis (PCA), which extracts common factors shared by multiple time series data. One unique feature of the P-PCA method is its robustness against missing records, which is likely the case in developing countries. This iteration of the PCA calculation and interpolation processes gives us the principal components (and factor loadings) based on the data suffering from missing records. The detailed P-PCA model is explained in Appendix 1.<sup>2</sup>

The ADB (2022) and Shinozaki et al. (2024) main analysis takes out a limited number of common factors shared by, for example, multiple time-series macroeconomic data accounting for the entire (or sub) Asian region(s). Unlike previous studies, we focus on a single country (Thailand) as a case study, and follow four analytical steps. First, we use granular MSME panel data (aggregating time-series industry-region level granular firm data) to take out the common factors as a baseline analysis. Second, we break down the analysis by industry and region, and use that nexus to take out the common factors. Third, the same procedures are used to analyze the trend of real or financial activities of firms. And fourth, we conduct small sample exercises to see to what extent the dynamics of the extracted principal components are influenced by sample size.

### 4. Data

The firm-level panel data used here come from a private data vender in Thailand (Dun & Bradstreet). The data consist of annual frequency firm-level information over the periods from 2016 to 2023.<sup>3</sup> In this firm-level data, we have firm-year unbalanced panel data for 11 variables, consisting of those associated with firms' real and financial activities (Table 1). The original data cover 52,086 firms with no missing data on employment and total 370,676 samples for 2016–2023. From these, we extract MSMEs that fit the criteria of firms in manufacturing or agriculture with up to 200 employees and those in services and other industries with up to 100 employees—49,565 MSMEs with a total of 353,373 samples for 2016–2023, equivalent to 95% of total firm samples.<sup>4</sup> This MSME dataset is analyzed in this study.

---

<sup>2</sup> The Appendix is available at <http://dx.doi.org/10.22617/WPS250228-2>.

<sup>3</sup> Throughout this paper, we call a firm's financial statement data stored in the original database ending in year YYYY as the year = YYYY. For example, if a firm's financial statement accounts for the accounting period from January 2023 to December 2023, we call this data as year = 2023.

<sup>4</sup> A firm is classified as an MSME if it meets the criteria for at least 1 year during the data period. This classification is fit to the employment threshold of the national MSME definition in Thailand (see footnote 1).

The industry classification of the data refers to nine categories based on the standard industrial classification system: (i) agricultural, forestry, and fishing; (ii) mining; (iii) construction; (iv) manufacturing; (v) transportation; (vi) wholesale; (vii) retail; (viii) financial services; and (ix) other services.<sup>5</sup> The regional classification of the data refers to Bangkok (capital city) and six official regions: Central (except Bangkok), Eastern, North, Northeast, Southern, and Western Thailand. To construct the input data for the P-PCA method, we aggregate each variable in each year using these industry and region classifications.

For the small sample exercises, we randomly choose a set of data from the entire MSME dataset. This provides us an experimental environment where we use information on the limited number of surveyed firms to compute the SME-DI. Where the number of randomly chosen firms is limited, we apply the P-PCA directly to those selected firm-level panel data to obtain the SME-DI based on the pseudo survey data.<sup>6</sup> In other words, we estimate the factors moving behind those firm-level data series and a large number of factor loadings for each firm-variable pair.

**Table 1: MSME Data in Thailand**

<b>A. Variables Used</b>			
<b>ID</b>	<b>Variable name</b>	<b>Definition</b>	<b>Real/Financial</b>
1	sls_revn_amt	Sales revenue	Real
2	emp_cnt	Number of employees	Real
3	grs_pft_or_lss_amt	Gross profit/loss	Real
4	bef_tax_net_pft_amt	Net profit before taxes	Real
5	tot_aset_amt	Total assets	Real
6	wrkg_capl_amt	Working capital	Real
7	tot_liab_amt	Total liabilities	Financial
8	trd_dbtr_amt	Trade debtors	Financial
9	bnk_loan_od_amt	Bank loans outstanding/overdraft	Financial
10	trd_cr_amt	Trade credit	Financial
11	tot_curr_liab_amt	Total current liabilities	Financial

*Continued on the next page*

<sup>5</sup> In this industry classification, for example, “Wholesale” is treated as a distinct industry classification from “Retail” while these two industries are often placed in one category. Given that the data contain a sufficient number of observations for these two industry classifications and that we prefer a larger number of industries to determine the number of semi-aggregate time series data used in applying the P-PCA, we treat “Wholesale” as a distinct industry classification from “Retail.”

<sup>6</sup> The application of the P-PCA method to the entire data of firm-year level granular data requires a certain level of computing power, which we do not have for this paper. Refining the computing process would be one of the most important ways to obtain SME-DI in the future from the raw data (i.e., firm-year level data).

## B. Summary Statistics

Category	Variable	Definition	num firms	mean	max	min	median	sum	std
ALL	bnk_loan_od_amt	Bank loans/overdraft	49,565	5,251,036	4.82E+10	-1.3E+07	0	1.31E+12	1.78E+08
ALL	emp_cnt	Number of employees	49,565	16.15884	5,000	1	7	5,655,271	30.85476
ALL	grs_pft_or_iss_amt	Gross profit/loss	49,565	10,739,036	5.14E+10	-5.8E+08	1,872,761	2.11E+12	2.14E+08
ALL	bef_tax_net_pft_amt	Net profit before taxes	49,565	2,920,279	1.6E+11	-4.4E+10	212,282	6.61E+11	5.07E+08
ALL	sls_revnt_amt	Sales revenue	49,565	1.86E+10	6.24E+14	-576,716	8,317,713	4.03E+15	2.17E+12
ALL	tot_aset_amt	Total assets	49,565	56,223,192	2.77E+11	-1.6E+07	6,582,331	1.4E+13	1.35E+09
ALL	tot_curr_liab_amt	Total current liabilities	49,565	21,684,718	2.86E+11	-292,953	498,964	5.41E+12	9.14E+08
ALL	tot_liab_amt	Total liabilities	49,565	32,137,141	2.86E+11	-325,407	1,142,306	8.02E+12	9.95E+08
ALL	trd_cr_amt	Trade credit	49,565	8,865,528	2.85E+11	0	51,631	2.21E+12	6.2E+08
ALL	trd_dbtr_amt	Trade debtors	49,565	8,094,800	4.25E+10	-1.1E+08	60,997	2.02E+12	1.82E+08
ALL	wrkg_capl_amt	Working capital	49,565	5,838,590	5.74E+10	-2.4E+11	1,300,392	1.46E+12	7.14E+08

MSME = micro, small, and medium-sized enterprise.

Note: These are the summary statistics of the 353,373 firms-year observations accounting for 49,565 unique firms. All firms are MSMEs for which the number of employees is not missing.

Source: Authors' calculations.

## 5. Estimation Results

### 5.1. Industry-Region-Year Level Disaggregate Data

As a first set of results, we present the SME-DI based on the industry-region-year level data constructed from firm-year level granular data.

#### ***Baseline results of the SME-DI based on all MSME panel data***

There are three main factors gleaned from the data that explain 87% of the data variation (Figure 1).<sup>7</sup> Over the periods of our analysis, the first factor (Comp 1) moved from a low level to high level, the second factor (Comp 2) exhibited a U-shape transition with bottom in 2020, and the third factor (Comp 3) takes relatively complicated dynamics with a peak in 2020.

To interpret the dynamics of each factor, the distribution of the estimated “impacts” of each variable on the three factors is summarized (Table 2). As mentioned, we use industry-region-year level data as the inputs for this baseline estimation. Thus, as a result of applying the P-PCA, we obtain the same number of estimated factor loadings as that of industry-region pair (i.e., 9 industries and 7 regions = 63 pairs). For each pair, the impacts are computed as the multiplication of the sign of the factor loading of each factor and share of the variation of each variable to that of the variation of the corresponding factor. The last of the three panels shows the mean of the impacts corresponding to each variable and the star (\*) accounting for whether the mean is statistically away from zero under 90% statistical significance.

From Table 2A, we see the first factor is negatively correlated with sales and profits. Given the fact that the first factor moved from a low to high level around the year 2020, this suggests that MSME performance measured by the outputs (sales revenue and two profitability variables measured by gross and net profits) saw a significant downturn over the course of the COVID-19 pandemic. Meanwhile, the first factor is positively correlated with bank loans outstanding, working

<sup>7</sup> The contribution of each estimated principal component (PC) is 59% for PC1, an additional 19% for PC2, and a further 9% for PC3, for a total of 87% explained.

capital amounts, and trade debtors. It can be interpreted that MSMEs in Thailand piled up their borrowing for strengthening working capital under the deteriorating operational environment with increased customers who have yet to pay for the goods/services sold (trade debtors). This is attributed to increasing their total assets even during the pandemic (positively correlated as well).

Somewhat interestingly, the first factor is also positively correlated with employment. Among the relations between employment and the estimated three factors, only this first factor is significantly positively correlated with employment. This implies MSMEs facing deteriorating performance in sales and profits increased borrowing and employment. As mentioned, one of the benefits of applying the P-PCA method to disaggregated data is to identify heterogeneous status among policy targets—MSMEs in this context. This empirical implication says that MSMEs facing deteriorated performance in a significant number of industries might be strongly affected by government support so as to not only maintain their workforce but also strengthen it. Given the government's several emergency support measures for MSMEs and workers during the pandemic, this estimation likely justifies the positive effects of policy interventions for MSMEs to survive the crisis. One additional feature associated with the dynamics of this first factor is that it started to decline somewhat in 2023, which also suggests that strong governmental support already began to fade.

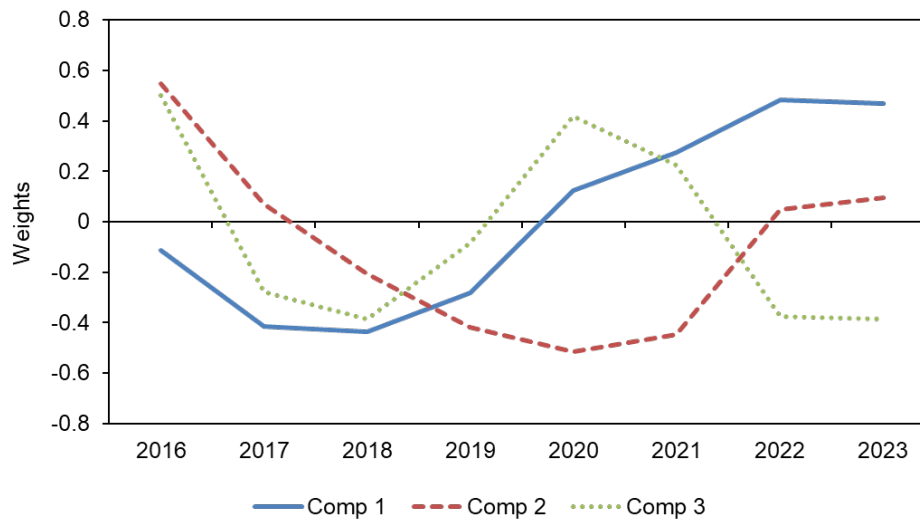
From Table 2B, we found that the second factor is also negatively correlated with firm profitability, but shows the “inverse” negative correlation of bank borrowing and various balance sheet items (total assets, liabilities, trade credit, and trade debtors). Given that the second factor steadily declined up to 2020 (firms performed better, borrowing increased, and firm size measured by the balance sheet items became larger) and increased from 2021 (firms performed worse, borrowing decreased, and firm size measured by the balance sheet items became smaller), we can infer that the pandemic had a significant negative impact on the profitability, borrowing, and size of their balance sheets. These are the heterogeneous firm conditions from the firm group described in the first factor. In the second factor firm group, “employment” does not show any significant association with the trend curve. This estimation suggests that MSMEs in some selected industries faced declining performance and borrowing difficulties during the pandemic. Given that the second factor has not shown any decline in recent years, at least through the lens of the P-PCA method, profitability for some MSMEs in Thailand remain in the recovery process.

From Table 2C, the third factor is negatively correlated with most financial-side variables (liabilities, working capital, trade credit, and trade debtors) while not showing any association with real-side variables (employment, sales revenue, and profits). Thus, we can infer that MSMEs in some industries only experienced negative impacts on their financial side in the form of increased burden on their balance sheets. Notably, the third factor shows relatively high frequency of cyclicity. These results suggest that the third factor mainly accounts for the (inverse of) financial conditions of the firms in some industries, which tends to show volatility, while the real side of those firms evolves more steadily.

Overall, the baseline results suggest that MSME sales and profits largely deteriorated during the pandemic while they were likely able to obtain bank credit for working capital and secure their workforce using emergency government assistance. Meanwhile, some groups of MSMEs hurt by the pandemic had problems obtaining working capital financing, as they likely failed to access government assistance measures. Also, some other MSME groups likely found their balance sheets deteriorating during the pandemic. In sum, Thailand's MSMEs faced a higher burden of financial variables over the course of the pandemic, while their performance and employment conditions show significant heterogeneity, depending on industry. Government emergency support for MSMEs likely eased the negative impact of the pandemic on MSME operations. But

we should understand more detailed heterogeneity among MSME activities by industry- and region-level breakdown to better target MSME segments for effective policy implementation.

**Figure 1: SME-DI based on Total MSME Data**



MSME = micro, small, and medium-sized enterprise; SME-DI = Small and Medium-Sized Enterprise Development Index.

Source: Authors' calculations.

**Table 2: Factor Loadings based on Probabilistic Principal Component Analysis—Total Micro, Small, and Medium-sized Enterprise Data**

**A. Relation Between the First Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0029	0.0014	0.0058	0.0043	0.0000	0.0014	0.0043	0.0043	0.0072	0.0043	0.0000
(-0.9, -0.8)	0.0029	0.0058	0.0058	0.0072	0.0043	0.0000	0.0000	0.0029	0.0029	0.0000	0.0014
(-0.8, -0.7)	0.0029	0.0000	0.0144	0.0058	0.0043	0.0014	0.0043	0.0014	0.0058	0.0043	0.0000
(-0.7, -0.6)	0.0014	0.0029	0.0101	0.0115	0.0043	0.0029	0.0087	0.0058	0.0043	0.0043	0.0058
(-0.6, -0.5)	0.0014	0.0029	0.0087	0.0029	0.0014	0.0029	0.0000	0.0014	0.0043	0.0000	0.0029
(-0.5, -0.4)	0.0029	0.0029	0.0087	0.0029	0.0058	0.0000	0.0014	0.0043	0.0029	0.0014	0.0029
(-0.4, -0.3)	0.0014	0.0043	0.0058	0.0072	0.0072	0.0029	0.0029	0.0029	0.0029	0.0043	0.0000
(-0.3, -0.2)	0.0043	0.0043	0.0072	0.0058	0.0303	0.0029	0.0043	0.0014	0.0043	0.0043	0.0014
(-0.2, -0.1)	0.0058	0.0029	0.0072	0.0058	0.0101	0.0058	0.0029	0.0058	0.0000	0.0043	0.0058
(-0.1, -2.22e-16)	0.0043	0.0000	0.0000	0.0029	0.0014	0.0029	0.0058	0.0072	0.0014	0.0000	0.0014
(-2.22e-16, 0.1)	0.0029	0.0029	0.0029	0.0029	0.0014	0.0014	0.0072	0.0087	0.0014	0.0072	0.0029
(0.1, 0.2)	0.0058	0.0058	0.0043	0.0014	0.0014	0.0014	0.0072	0.0043	0.0072	0.0029	0.0058
(0.2, 0.3)	0.0058	0.0014	0.0014	0.0029	0.0000	0.0043	0.0058	0.0087	0.0043	0.0029	0.0014
(0.3, 0.4)	0.0043	0.0029	0.0029	0.0072	0.0029	0.0087	0.0058	0.0029	0.0087	0.0058	0.0058
(0.4, 0.5)	0.0072	0.0043	0.0029	0.0029	0.0014	0.0058	0.0029	0.0029	0.0014	0.0087	0.0101
(0.5, 0.6)	0.0043	0.0029	0.0000	0.0058	0.0072	0.0058	0.0072	0.0043	0.0087	0.0014	0.0087
(0.6, 0.7)	0.0130	0.0130	0.0014	0.0029	0.0029	0.0144	0.0072	0.0058	0.0087	0.0087	0.0043
(0.7, 0.8)	0.0029	0.0130	0.0000	0.0058	0.0000	0.0101	0.0029	0.0058	0.0058	0.0087	0.0072
(0.8, 0.9)	0.0072	0.0101	0.0014	0.0014	0.0014	0.0130	0.0087	0.0072	0.0058	0.0101	0.0130
(0.9, 1.0)	0.0072	0.0072	0.0000	0.0014	0.0029	0.0029	0.0014	0.0029	0.0029	0.0072	0.0101
mean	0.221*	0.28*	-0.39*	-0.142*	-0.144*	0.354*	0.104	0.097	0.066	0.236*	0.357*

*Continued on the next page*

## B. Relation Between the Second Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0014	0.0000	0.0000	0.0000	0.0000	0.0029	0.0043	0.0043	0.0000	0.0014	0.0000
(-0.9, -0.8)	0.0072	0.0000	0.0072	0.0000	0.0087	0.0014	0.0130	0.0087	0.0072	0.0058	0.0000
(-0.8, -0.7)	0.0087	0.0014	0.0115	0.0029	0.0029	0.0058	0.0058	0.0072	0.0029	0.0072	0.0000
(-0.7, -0.6)	0.0087	0.0000	0.0115	0.0087	0.0087	0.0144	0.0058	0.0130	0.0058	0.0014	0.0072
(-0.6, -0.5)	0.0072	0.0058	0.0173	0.0029	0.0014	0.0144	0.0101	0.0115	0.0072	0.0058	0.0043
(-0.5, -0.4)	0.0130	0.0058	0.0029	0.0087	0.0058	0.0130	0.0058	0.0014	0.0144	0.0130	0.0101
(-0.4, -0.3)	0.0043	0.0043	0.0058	0.0058	0.0058	0.0072	0.0058	0.0087	0.0029	0.0072	0.0043
(-0.3, -0.2)	0.0043	0.0101	0.0159	0.0072	0.0014	0.0058	0.0043	0.0072	0.0043	0.0058	0.0087
(-0.2, -0.1)	0.0101	0.0043	0.0043	0.0072	0.0014	0.0000	0.0058	0.0072	0.0101	0.0014	0.0029
(-0.1, -2.22e-16)	0.0058	0.0087	0.0014	0.0072	0.0029	0.0058	0.0058	0.0029	0.0043	0.0072	0.0000
(-2.22e-16, 0.1)	0.0014	0.0101	0.0000	0.0087	0.0072	0.0087	0.0014	0.0000	0.0029	0.0058	0.0058
(0.1, 0.2)	0.0043	0.0087	0.0029	0.0029	0.0043	0.0029	0.0087	0.0029	0.0072	0.0087	0.0072
(0.2, 0.3)	0.0029	0.0043	0.0014	0.0101	0.0072	0.0029	0.0043	0.0087	0.0014	0.0087	0.0087
(0.3, 0.4)	0.0000	0.0087	0.0029	0.0014	0.0014	0.0000	0.0000	0.0014	0.0072	0.0029	0.0058
(0.4, 0.5)	0.0029	0.0043	0.0029	0.0058	0.0014	0.0000	0.0029	0.0000	0.0014	0.0014	0.0072
(0.5, 0.6)	0.0029	0.0043	0.0014	0.0029	0.0014	0.0014	0.0029	0.0014	0.0072	0.0014	0.0087
(0.6, 0.7)	0.0014	0.0029	0.0000	0.0029	0.0014	0.0000	0.0014	0.0014	0.0014	0.0014	0.0043
(0.7, 0.8)	0.0043	0.0043	0.0014	0.0029	0.0014	0.0014	0.0014	0.0014	0.0014	0.0000	0.0014
(0.8, 0.9)	0.0000	0.0029	0.0000	0.0029	0.0260	0.0029	0.0014	0.0014	0.0014	0.0043	0.0029
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014
mean	-0.274*	0.065	-0.38*	-0.04	0.074	-0.329*	-0.294*	-0.351*	-0.156*	-0.177*	0.053

## C. Relation Between the Third Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014
(-0.9, -0.8)	0.0000	0.0000	0.0014	0.0014	0.0014	0.0029	0.0029	0.0014	0.0000	0.0014	0.0029
(-0.8, -0.7)	0.0000	0.0014	0.0029	0.0014	0.0014	0.0014	0.0014	0.0072	0.0029	0.0014	0.0014
(-0.7, -0.6)	0.0014	0.0000	0.0029	0.0014	0.0029	0.0058	0.0043	0.0058	0.0029	0.0058	0.0101
(-0.6, -0.5)	0.0043	0.0087	0.0058	0.0029	0.0087	0.0159	0.0101	0.0072	0.0058	0.0058	0.0058
(-0.5, -0.4)	0.0072	0.0043	0.0014	0.0058	0.0029	0.0115	0.0101	0.0072	0.0115	0.0072	0.0115
(-0.4, -0.3)	0.0058	0.0072	0.0043	0.0087	0.0072	0.0101	0.0072	0.0115	0.0101	0.0072	0.0043
(-0.3, -0.2)	0.0072	0.0072	0.0144	0.0072	0.0058	0.0115	0.0087	0.0130	0.0072	0.0130	0.0058
(-0.2, -0.1)	0.0115	0.0087	0.0072	0.0043	0.0043	0.0087	0.0072	0.0115	0.0188	0.0072	0.0115
(-0.1, -2.22e-16)	0.0029	0.0087	0.0058	0.0087	0.0014	0.0043	0.0115	0.0058	0.0072	0.0043	0.0043
(-2.22e-16, 0.1)	0.0101	0.0087	0.0058	0.0072	0.0014	0.0043	0.0043	0.0014	0.0087	0.0130	0.0072
(0.1, 0.2)	0.0130	0.0029	0.0130	0.0072	0.0072	0.0043	0.0072	0.0043	0.0014	0.0115	0.0072
(0.2, 0.3)	0.0115	0.0072	0.0058	0.0029	0.0043	0.0029	0.0029	0.0043	0.0000	0.0043	0.0072
(0.3, 0.4)	0.0101	0.0043	0.0043	0.0101	0.0014	0.0029	0.0043	0.0029	0.0058	0.0014	0.0014
(0.4, 0.5)	0.0029	0.0115	0.0101	0.0072	0.0130	0.0029	0.0043	0.0029	0.0087	0.0029	0.0058
(0.5, 0.6)	0.0014	0.0029	0.0029	0.0072	0.0231	0.0014	0.0029	0.0029	0.0000	0.0043	0.0029
(0.6, 0.7)	0.0014	0.0043	0.0014	0.0014	0.0043	0.0000	0.0014	0.0014	0.0000	0.0000	0.0000
(0.7, 0.8)	0.0000	0.0014	0.0014	0.0029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.8, 0.9)	0.0000	0.0014	0.0000	0.0029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	-0.002	0.022	-0.027	0.054	0.093	-0.272*	-0.166*	-0.224*	-0.158*	-0.134*	-0.185*

Source: Authors' calculation.

## ***Industry- and region-level breakdown of the SME-DI***

We further estimated the industry- and/or region-level indicators by selected industry and region. First, to construct the industry- (regional-) level indicators, we make subsamples of the MSME data that account for a specific industry (region), and aggregate the firm-level data included in the subsample by using the industry (region) information to obtain industry-year (region-year) panel data for each variable and specific industry (region). We can then plug these into the P-PCA to extract the factors driving the time-series variation of the aggregated industry-level (region-level) variables.

### **a. MSMEs in wholesale trade**

Figure 2 depicts the top three factors for industry-level indicators, in this case wholesale trade. In this estimation, three factors explain 94% of the data variation.<sup>8</sup> Table 3 summarizes the distribution of the estimated impacts of each variable on three factors for wholesale trade.

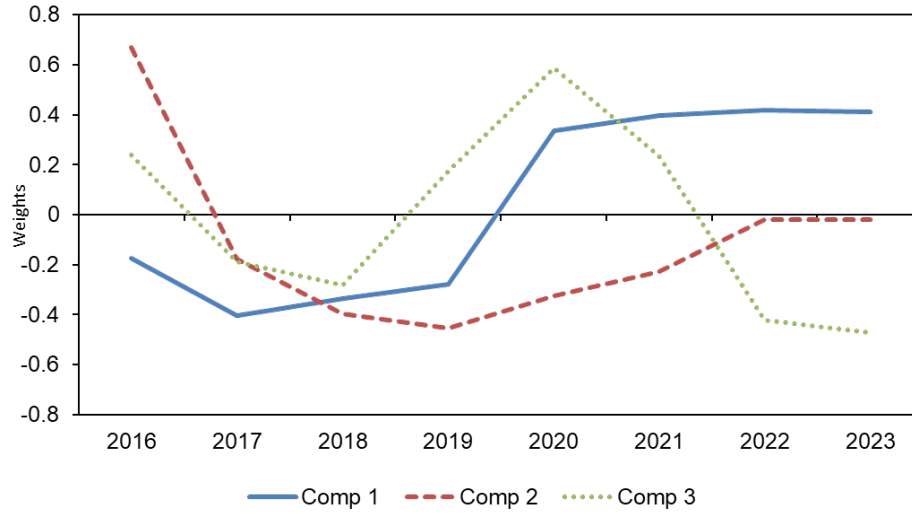
The first and the third factors have the opposite association with gross profit and working capital. Specifically, the first (third) factor has the negative (positive) association with gross profit while the positive (negative) association with working capital. As the dynamics of those factors up to 2020 mostly coincided, this suggests heterogeneity in terms of gross profit and working capital among regions. In other words, the first and third factors suggest that wholesale MSMEs in some regions improved profitability with smaller working capital, while those in some other regions showed the completely opposite pattern. The dynamics of the first and third factors after 2020, which are consistent with each other, show that most firms faced lower profitability with larger working capital. This trend continued into 2023.

The second factor has the negative association with most variables including profitability, asset size, and borrowing. Real and financial activities of wholesale MSMEs improved in the pre-pandemic period but likely deteriorated during the pandemic and afterward with limited access to bank credit. This estimation suggests that government assistance measures did not reach wholesale trade MSMEs in some regions.

---

<sup>8</sup> The contribution of each estimated principal component (PC) is 76% for PC1, an additional 14% for PC2, and a further 4% for PC3, for a total of 94% explained.

**Figure 2: SME-DI for Wholesale Trade**



SME-DI = Small and Medium-Sized Enterprise Development Index.  
Source: Authors' calculations.

**Table 3: Factor Loadings based on Probabilistic Principal Component Analysis—  
Wholesale Trade**

**A. Relation Between the First Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0130	0.0000	0.0130	0.0130	0.0000	0.0130	0.0130	0.0130	0.0130	0.0130	0.0000
(-0.9, -0.8)	0.0000	0.0000	0.0260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.8, -0.7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.7, -0.6)	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.6, -0.5)	0.0000	0.0000	0.0260	0.0130	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000
(-0.5, -0.4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000
(-0.4, -0.3)	0.0000	0.0130	0.0130	0.0000	0.0649	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.3, -0.2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0130	0.0000	0.0000
(-0.2, -0.1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.1, -2.22e-16)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000
(-2.22e-16, 0.1)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0260	0.0000	0.0000
(0.1, 0.2)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000
(0.2, 0.3)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130
(0.3, 0.4)	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000
(0.4, 0.5)	0.0000	0.0000	0.0130	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.5, 0.6)	0.0130	0.0000	0.0000	0.0260	0.0130	0.0000	0.0000	0.0130	0.0000	0.0130	0.0000
(0.6, 0.7)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0130
(0.7, 0.8)	0.0260	0.0130	0.0000	0.0000	0.0130	0.0000	0.0260	0.0130	0.0000	0.0000	0.0260
(0.8, 0.9)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0390	0.0130	0.0260	0.0000	0.0260	0.0000
(0.9, 1.0)	0.0260	0.0130	0.0000	0.0130	0.0000	0.0260	0.0130	0.0130	0.0130	0.0260	0.0390
mean	0.47	0.453*	-0.524*	0.031	-0.065	0.583*	0.292	0.383	-0.116	0.502	0.753*

*Continued on the next page*

## B. Relation Between the Second Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000
(-0.9, -0.8)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0260	0.0000	0.0000
(-0.8, -0.7)	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0260	0.0000	0.0130	0.0000
(-0.7, -0.6)	0.0260	0.0130	0.0130	0.0000	0.0130	0.0000	0.0260	0.0000	0.0130	0.0000	0.0000
(-0.6, -0.5)	0.0130	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0130	0.0130	0.0000
(-0.5, -0.4)	0.0000	0.0000	0.0519	0.0130	0.0000	0.0000	0.0130	0.0260	0.0000	0.0130	0.0000
(-0.4, -0.3)	0.0000	0.0000	0.0130	0.0130	0.0000	0.0130	0.0130	0.0000	0.0000	0.0000	0.0130
(-0.3, -0.2)	0.0130	0.0260	0.0000	0.0000	0.0000	0.0260	0.0130	0.0130	0.0000	0.0130	0.0000
(-0.2, -0.1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0260	0.0000	0.0130	0.0130	0.0000	0.0130
(-0.1, -2.22e-16)	0.0130	0.0000	0.0130	0.0260	0.0000	0.0130	0.0130	0.0130	0.0130	0.0130	0.0000
(-2.22e-16, 0.1)	0.0130	0.0000	0.0000	0.0130	0.0000	0.0130	0.0000	0.0000	0.0000	0.0260	0.0000
(0.1, 0.2)	0.0130	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130
(0.2, 0.3)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0390
(0.3, 0.4)	0.0000	0.0260	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.4, 0.5)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.5, 0.6)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.6, 0.7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130
(0.7, 0.8)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.8, 0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0649	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	-0.285*	0.032	-0.401*	-0.156	0.45	-0.143*	-0.455*	-0.402*	-0.555*	-0.269*	0.154

## C. Relation Between the Third Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.9, -0.8)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.8, -0.7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.7, -0.6)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130
(-0.6, -0.5)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0130
(-0.5, -0.4)	0.0000	0.0130	0.0000	0.0000	0.0000	0.0130	0.0130	0.0000	0.0130	0.0000	0.0130
(-0.4, -0.3)	0.0000	0.0260	0.0000	0.0260	0.0000	0.0260	0.0000	0.0130	0.0000	0.0000	0.0000
(-0.3, -0.2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0130
(-0.2, -0.1)	0.0130	0.0130	0.0000	0.0130	0.0000	0.0130	0.0260	0.0260	0.0260	0.0260	0.0260
(-0.1, -2.22e-16)	0.0130	0.0000	0.0260	0.0130	0.0000	0.0130	0.0130	0.0000	0.0000	0.0260	0.0000
(-2.22e-16, 0.1)	0.0260	0.0130	0.0000	0.0000	0.0260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.1, 0.2)	0.0000	0.0000	0.0000	0.0260	0.0000	0.0130	0.0130	0.0390	0.0260	0.0260	0.0000
(0.2, 0.3)	0.0130	0.0000	0.0000	0.0000	0.0649	0.0000	0.0000	0.0000	0.0130	0.0000	0.0130
(0.3, 0.4)	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000
(0.4, 0.5)	0.0130	0.0000	0.0130	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000	0.0130	0.0000
(0.5, 0.6)	0.0000	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0130	0.0000	0.0000
(0.6, 0.7)	0.0130	0.0000	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.7, 0.8)	0.0000	0.0000	0.0130	0.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.8, 0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	0.171	-0.365*	0.378*	0.017	0.183*	-0.196*	0.035	-0.108	0.04	0.061	-0.299*

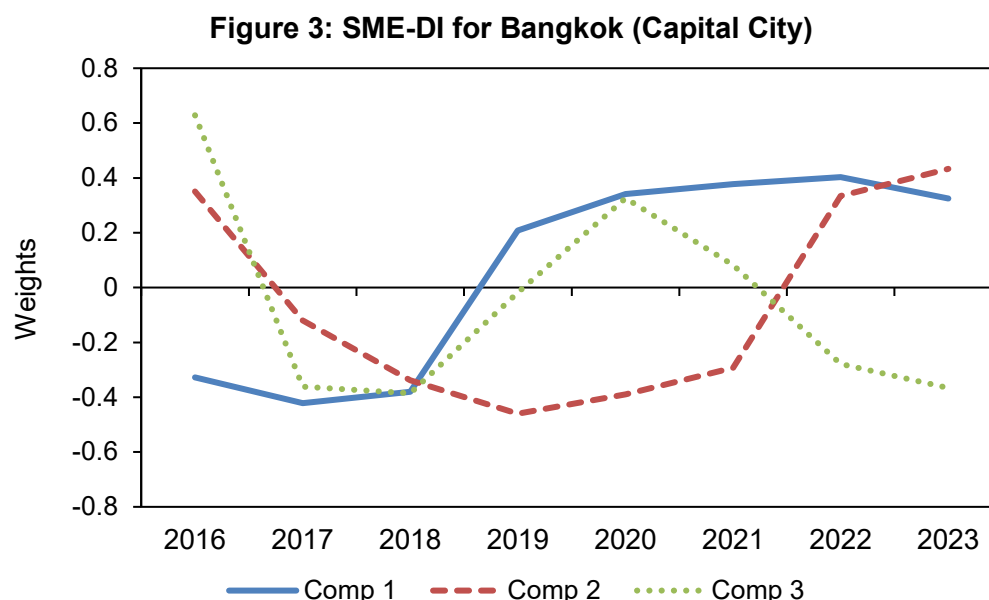
Source: Authors' calculations.

## b. MSMEs operating in Bangkok (Capital City)

Figure 3 depicts the top three factors in the case of regional-level indicators such as for the capital city, Bangkok. In this estimation, three factors explain 88% of the data variation.<sup>9</sup> Table 4 summarizes the distribution of the estimated impacts of each variable on three factors for the case of Bangkok.

The associations between the three factors and the variables in the case of Bangkok suggest several things. The first factor implies that over the course of the COVID-19 pandemic, many MSMEs operating in Bangkok had a higher debt burden under lower profitability and sales revenue. The second factor suggests that profit shows a “hump” shape over time. This group of MSMEs likely faced profit losses during and after the pandemic. The third factor is negatively correlated with most financial-side variables while showing a positive correlation with sales revenue (no association with other real-side variables of employment and profits). MSMEs located in Bangkok were hurt financially in some industries not well covered by sales revenue.

This estimation suggests that Bangkok-based MSMEs hurt by the pandemic by sales and profit were likely to obtain more bank credit. Government assistance measures during the pandemic might have been disproportionately allocated to capital city-based MSMEs in some industries.



SME-DI = Small and Medium-Sized Enterprise Development Index.  
Source: Authors' calculations.

<sup>9</sup> The contribution of each estimated principal component (PC) is 65% for PC1, an additional 16% for PC2, and a further 7% for PC3, for a total of 88% explained.

**Table 4: Factor Loadings based on Probabilistic Principal Component Analysis—  
Bangkok (Capital City)**

**A. Relation Between the First Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0101	0.0000	0.0101	0.0000	0.0101	0.0101	0.0101	0.0101	0.0000	0.0000
(-0.9, -0.8)	0.0000	0.0101	0.0101	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101
(-0.8, -0.7)	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.7, -0.6)	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.6, -0.5)	0.0000	0.0000	0.0000	0.0000	0.0404	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.5, -0.4)	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101	0.0000
(-0.4, -0.3)	0.0000	0.0000	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.3, -0.2)	0.0101	0.0101	0.0202	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000
(-0.2, -0.1)	0.0000	0.0000	0.0303	0.0202	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101
(-0.1, -2.22e-16)	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000
(-2.22e-16, 0.1)	0.0101	0.0000	0.0101	0.0000	0.0101	0.0000	0.0202	0.0000	0.0000	0.0000	0.0000
(0.1, 0.2)	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000
(0.2, 0.3)	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0101	0.0101	0.0000	0.0000	0.0101
(0.3, 0.4)	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101	0.0101	0.0101	0.0101
(0.4, 0.5)	0.0202	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0202	0.0000	0.0202
(0.5, 0.6)	0.0000	0.0000	0.0000	0.0202	0.0000	0.0202	0.0202	0.0202	0.0101	0.0101	0.0000
(0.6, 0.7)	0.0202	0.0000	0.0000	0.0101	0.0101	0.0101	0.0000	0.0202	0.0000	0.0101	0.0000
(0.7, 0.8)	0.0101	0.0101	0.0000	0.0101	0.0000	0.0101	0.0202	0.0202	0.0101	0.0202	0.0101
(0.8, 0.9)	0.0000	0.0404	0.0000	0.0000	0.0000	0.0303	0.0000	0.0000	0.0000	0.0000	0.0202
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	0.306*	0.28	-0.197*	-0.034	-0.317*	0.51*	0.242	0.399*	0.096	0.192	0.318

**B. Relation Between the Second Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0000	0.0303	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.9, -0.8)	0.0000	0.0000	0.0202	0.0000	0.0101	0.0101	0.0202	0.0000	0.0101	0.0000	0.0101
(-0.8, -0.7)	0.0101	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0202	0.0303	0.0000
(-0.7, -0.6)	0.0101	0.0000	0.0101	0.0000	0.0101	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000
(-0.6, -0.5)	0.0000	0.0000	0.0101	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.5, -0.4)	0.0000	0.0101	0.0000	0.0101	0.0000	0.0000	0.0101	0.0101	0.0000	0.0101	0.0000
(-0.4, -0.3)	0.0101	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101	0.0000
(-0.3, -0.2)	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000
(-0.2, -0.1)	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000
(-0.1, -2.22e-16)	0.0101	0.0101	0.0101	0.0101	0.0000	0.0000	0.0101	0.0000	0.0101	0.0000	0.0202
(-2.22e-16, 0.1)	0.0101	0.0202	0.0000	0.0000	0.0000	0.0404	0.0202	0.0000	0.0000	0.0000	0.0000
(0.1, 0.2)	0.0000	0.0303	0.0000	0.0000	0.0000	0.0202	0.0101	0.0202	0.0000	0.0101	0.0101
(0.2, 0.3)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0101	0.0101	0.0202	0.0101
(0.3, 0.4)	0.0202	0.0000	0.0000	0.0202	0.0101	0.0101	0.0202	0.0000	0.0000	0.0000	0.0101
(0.4, 0.5)	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0202	0.0101	0.0000
(0.5, 0.6)	0.0000	0.0101	0.0000	0.0101	0.0505	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.6, 0.7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101
(0.7, 0.8)	0.0202	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000	0.0000
(0.8, 0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0202
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	0.038	0.07	-0.71*	-0.043	0.117	0.026	-0.14	-0.189	-0.083	-0.208	0.219

*Continued on the next page*

### C. Relation Between the Third Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.9, -0.8)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.8, -0.7)	0.0101	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(-0.7, -0.6)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0101	0.0101	0.0101	0.0000	0.0000
(-0.6, -0.5)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0303	0.0000	0.0303	0.0000
(-0.5, -0.4)	0.0000	0.0000	0.0101	0.0000	0.0000	0.0101	0.0202	0.0101	0.0202	0.0000	0.0000
(-0.4, -0.3)	0.0101	0.0000	0.0202	0.0000	0.0000	0.0202	0.0202	0.0000	0.0000	0.0101	0.0303
(-0.3, -0.2)	0.0202	0.0000	0.0101	0.0202	0.0000	0.0000	0.0000	0.0101	0.0101	0.0000	0.0101
(-0.2, -0.1)	0.0000	0.0101	0.0101	0.0101	0.0101	0.0101	0.0000	0.0303	0.0202	0.0000	0.0101
(-0.1, -2.22e-16)	0.0202	0.0101	0.0101	0.0101	0.0101	0.0202	0.0101	0.0000	0.0000	0.0101	0.0202
(-2.22e-16, 0.1)	0.0101	0.0000	0.0000	0.0101	0.0000	0.0101	0.0101	0.0000	0.0101	0.0202	0.0101
(0.1, 0.2)	0.0000	0.0000	0.0202	0.0000	0.0101	0.0101	0.0101	0.0000	0.0101	0.0101	0.0000
(0.2, 0.3)	0.0000	0.0202	0.0000	0.0202	0.0101	0.0000	0.0000	0.0000	0.0101	0.0000	0.0101
(0.3, 0.4)	0.0101	0.0303	0.0101	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.4, 0.5)	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0101	0.0000
(0.5, 0.6)	0.0000	0.0000	0.0000	0.0101	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.6, 0.7)	0.0000	0.0000	0.0000	0.0000	0.0404	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.7, 0.8)	0.0000	0.0101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.8, 0.9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(0.9, 1.0)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
mean	-0.099	0.148	-0.102	0.083	0.373*	-0.206*	-0.291*	-0.374*	-0.184*	-0.156	-0.138*

Source: Authors' calculations.

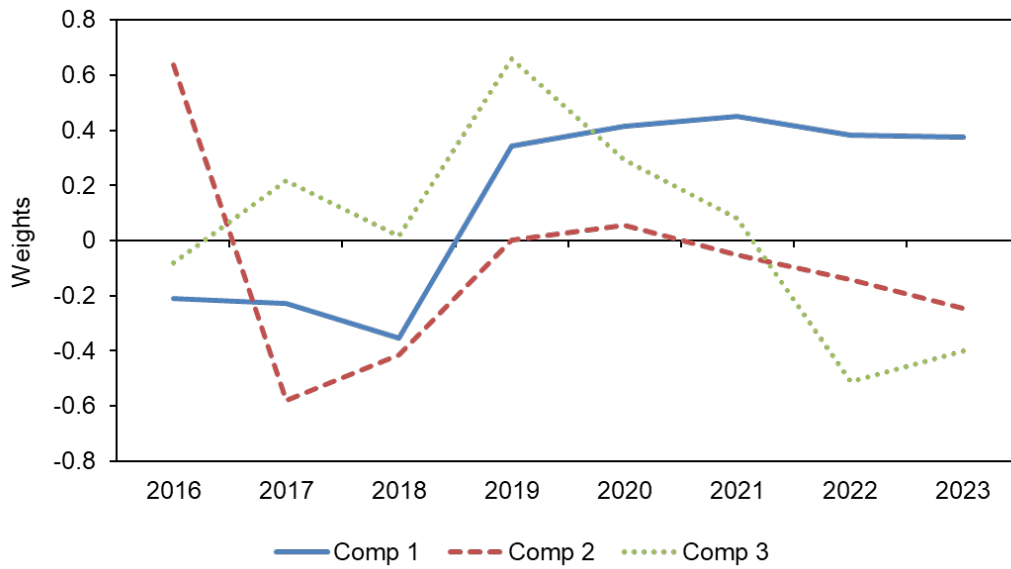
### c. Manufacturing firms by region

Here we investigate how the method we use can highlight the heterogeneity among MSMEs through the industry-region nexus. Figure 4 depicts three factors obtained from the data accounting for manufacturing firms operating in Bangkok, while Figure 5 depicts those in manufacturing outside Bangkok (local areas).<sup>10</sup> It should be noted that in this exercise we input the raw firm level data of MSMEs into the model instead of the aggregate MSME data series (Appendix 2A).

We can immediately identify that the first factors in each figure—which account for the largest variation of the data among the three factors—show different dynamics. Using the first factors from Figures 4 and 5 as an example, we can depict the firm's activities in those two cases. From the associations between the first factor in Figure 4 and each variable, we found that a large number of capital city-based manufacturing MSMEs likely reduced their employment with larger borrowing while not necessarily seeing sales revenue and profit deteriorate during and post pandemic, although the estimates were not statistically significant (Appendix 2A1). From the associations between the first factor in Figure 5 and each variable, we found that many local manufacturing MSMEs (non-capital city-based firms) experienced lower profits from the pandemic onset until 2022. Their profits likely improved in 2023 (Appendix 2A2).

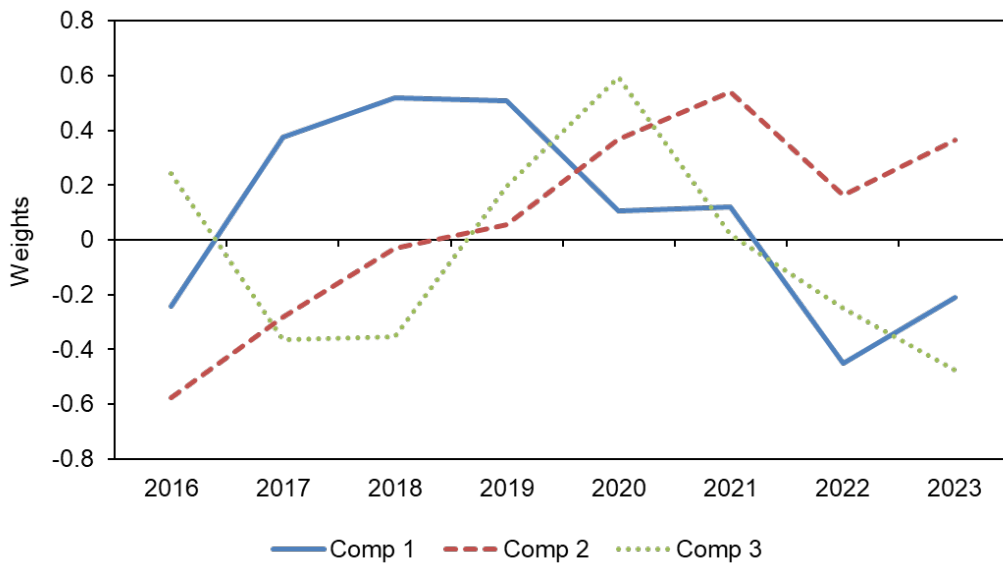
<sup>10</sup> The contribution of each estimated principal component (PC) for Figure 4 is 72% for PC1, an additional 14% for PC2, and a further 5% for PC3, for a total of 91% explained. For Figure 5, it is 53% for PC1, an additional 20% for PC2, and a further 11% for PC3, for a total of 84% explained.

**Figure 4: Manufacturing—Bangkok**



Source: Authors' calculations.

**Figure 5: Manufacturing—Outside Bangkok**



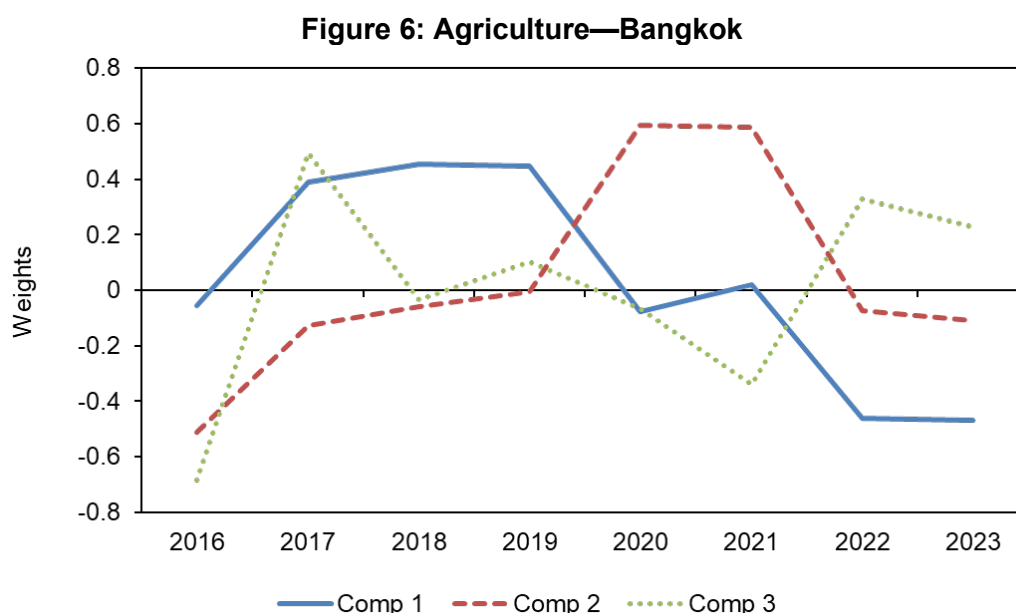
Source: Authors' calculations.

This estimation suggests that manufacturing MSMEs based in Bangkok cost cuts through layoffs and successfully obtained bank credit during the pandemic, attributed to the lower impact of the pandemic on their sales revenue and profits. Emergency government assistance measures likely facilitated their access to bank credit. By contrast, local manufacturing MSMEs likely saw profits fall during the pandemic, as they were not well covered by government financial assistance (though they improved in 2023).

#### d. Agribusinesses by region

A similar exercise was conducted on agricultural MSMEs by region. The first factors were obtained from the data accounting for agribusiness firms operating in Bangkok and agribusiness MSMEs outside the capital (Figures 6 and 7) (Appendix 2B).<sup>11</sup>

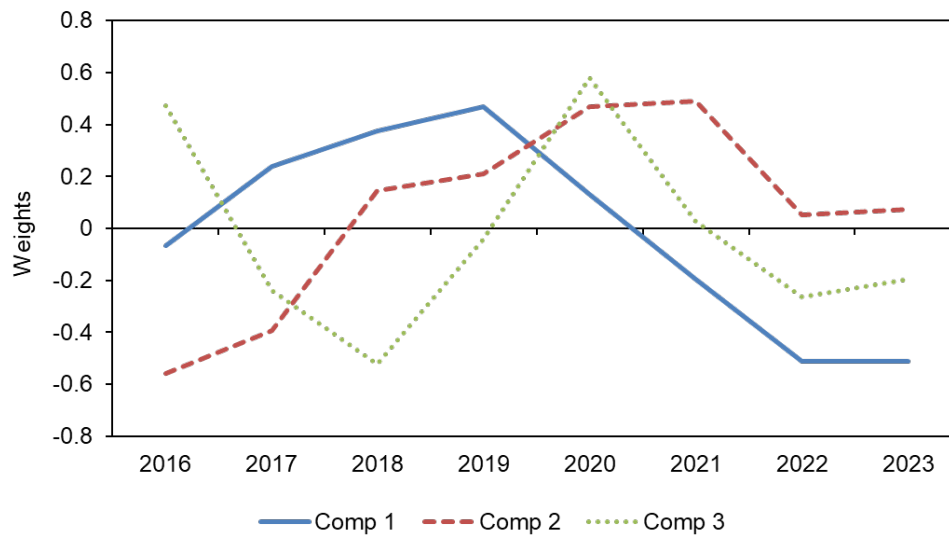
The estimates simply show that profitability deteriorated amid the COVID-19 pandemic. Capital city-based agricultural MSMEs likely deteriorated in sales revenue and gross profit with no effective support from any improved working capital conditions during the pandemic, although estimates were not statistically significant (Appendix 2B1). Similarly, local agricultural MSMEs consistently saw their profits deteriorate over the course of the pandemic, accelerated by a constant slowdown in access to bank credit, even as working capital conditions improved (estimates strongly significant) (Appendix 2B2).



Source: Authors' calculations.

<sup>11</sup> The contribution of each estimated principal component (PC) for Figure 6 is 69% for PC1, an additional 19% for PC2, and a further 4% for PC3, for a total of 92% explained. For Figure 7, it is 59% for PC1, an additional 16% for PC2, and a further 11% for PC3, for a total of 86% explained.

**Figure 7: Agriculture—Outside Bangkok**



Source: Authors' calculations.

### ***Real and financial breakdown of the SME-DI***

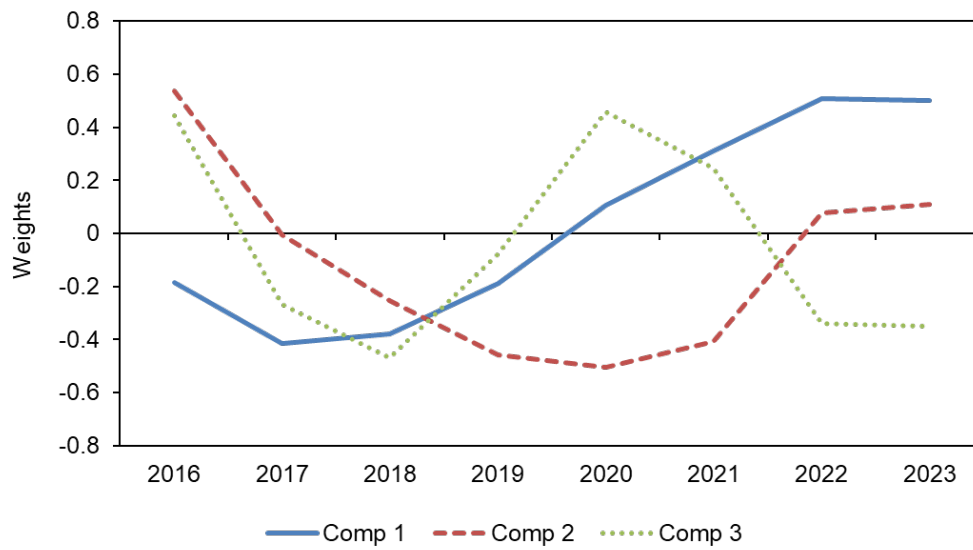
In our baseline analysis, we simultaneously used all variables—categorized as both real and financial. One possible, useful exercise is to use the data accounted for by the real and financial variables separately so we can see the extent to which the baseline result is driven by each type of variable.

The top three factors based on the data can be shown separately as real or financial variables (Figures 8 and 9). In both estimations, those three factors explain 87% of the data variation.<sup>12</sup> A table on factor loadings is attached (Appendix 2C).

The most important fact is that the dynamics of the factors in the two panels are similar. More precisely, the first factors in the two figures are increasing while the second factors are in u-shape. The third factors exhibit a more complicated trend in both the real and financial cases. Findings from these separate exercises by real and financial variables are consistent with the baseline results using all variables (see Table 2). For example, the first factor in real variables shows that MSME sales revenues and profits deteriorated during the pandemic while they likely strengthened working capital and the workforce (Appendix 2C1). The financial variables show that MSME borrowing from banks likely increased with more customers not yet paying for their products and services (Appendix 2C2). Although it is natural to see these links between variables over episodes such as the pandemic, this approach would be potentially useful to see whether or not real and financial variables account for MSME business dynamics, and how they do so.

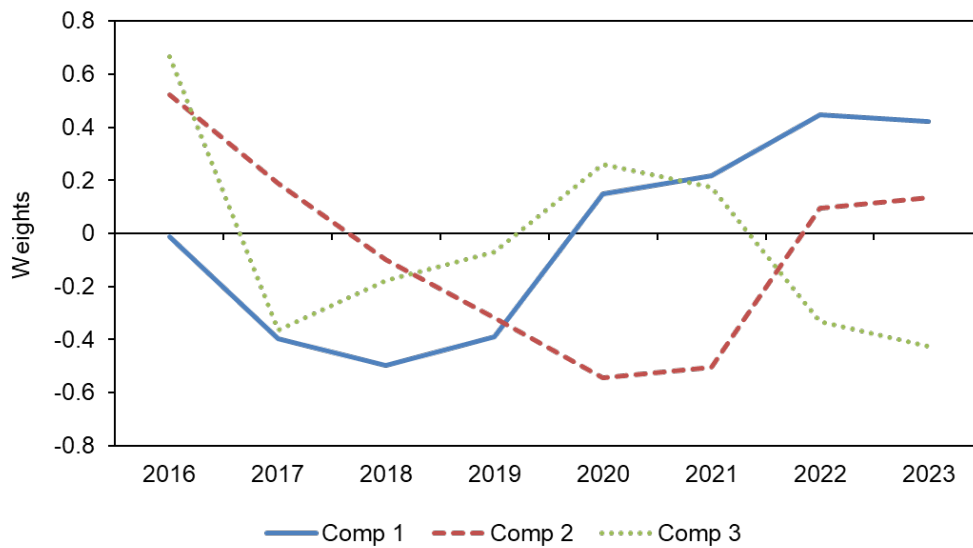
<sup>12</sup> The contribution of each estimated principal component (PC) for Figure 8 is 58% for PC1, an additional 19% for PC2, and a further 10% for PC3, for a total of 87% explained. For Figure 9, it is 62% for PC1, an additional 18% for PC2, and a further 7% for PC3, for a total of 87% explained.

**Figure 8: SME-DI on Real Variables**



SME-DI = Small and Medium-Sized Enterprise Development Index.  
Source: Authors' calculations.

**Figure 9: SME-DI on Financial Variables**



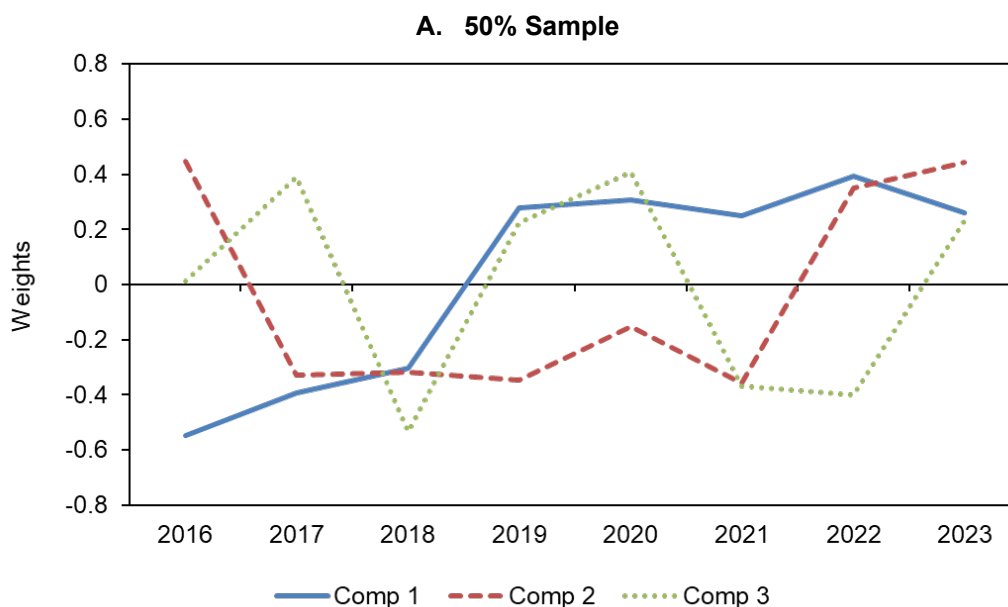
SME-DI = Small and Medium-Sized Enterprise Development Index.  
Source: Authors' calculations.

## Small sample exercises

As mentioned, by using the pseudo dataset randomly chosen from all granular MSME data and re-running the P-PCA algorithm, we can see the extent to which the relatively small number of data can produce a SME-DI consistent with that using the entire MSME dataset. This experiment is useful for practitioners conducting, for example, survey analyses to construct a reliable indicator summarizing MSME activities. By doing so, we constructed two sets of SME-DI. Panel A (Panel B) of Figure 10 depicts an SME-DI based on the randomly chosen subsample that accounts for 50% (10%) of the entire MSME data.<sup>13</sup> A factor loadings table is attached (Appendix 2D).

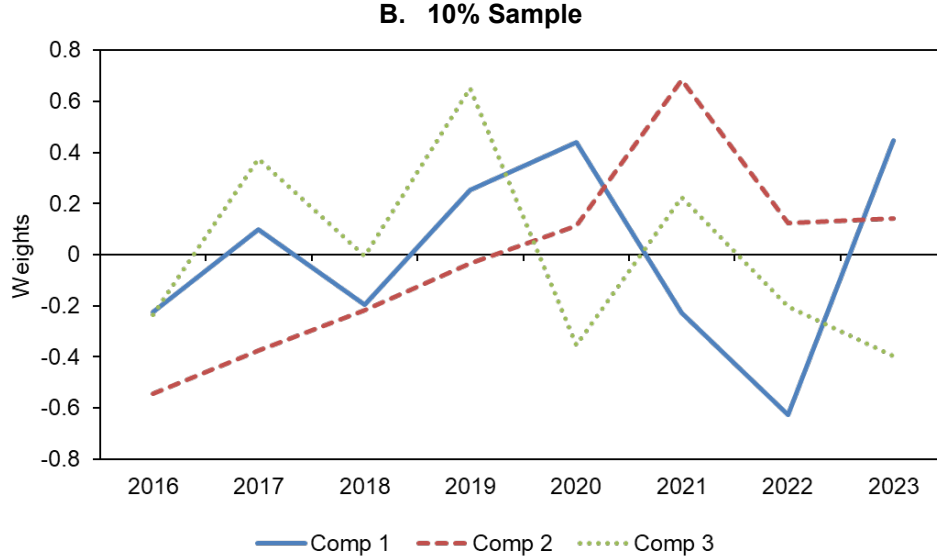
First, we can check the consistency between Figure 1 and Figure 10A. The SME-DI based on 50% of the dataset basically replicates that based on all MSME data. Over the periods of our analysis, the first factor moved from a low to high level, the second factor exhibited a U-shape transition, with the third factor showing more complicated dynamics. A careful inspection of the association between each factor and each variable suggests that the association is compatible with Figure 1 and Table 2. For example, in the first factor based on a 50% sample, MSME sales revenues and net profits before tax deteriorated over the course of the pandemic while they received working capital financing from banks, which contributed to strengthening their balance sheets: a similar result as in the baseline estimate using all MSME data (Appendix 2D1).

**Figure 10: Small Sample Exercises**



*Continued on the next page*

<sup>13</sup> The contribution of each estimated principal component (PC) for Figure 10A is 44% for PC1, an additional 16% for PC2, and a further 12% for PC3, for a total of 72% explained. For Figure 10B, it is 41% for PC1, an additional 16% for PC2, and a further 12% for PC3, for a total of 69% explained.



Source: Authors' calculations.

Second, we can confirm nonetheless that it is not necessarily easy to replicate a SME-DI based on the MSME sample by using randomly chosen and smaller samples. The consistency between the two sets of estimated factors worsens as the size of the subsample becomes smaller. Figure 10B accounts for the three factors based on a randomly chosen 10% size of the entire dataset. It fails to follow the original SME-DI based on the entire dataset. Also, the association between each factor and each variable does not necessarily share the same features as in the full sample (Appendix 2D2). To summarize, the small sample exercise helps us confirm that a certain reduction in sample size does not create any serious problems in estimating the SME-DI. As this critically depends on the target group, it would be interesting to see how this empirical study applies toward other datasets.

## 5.2. Firm-Year Level Raw Granular Data

As a second set of results, we present the SME-DI based on firm-year level “raw” granular data, or MSME data not aggregated at the industry-region level but used as is. Figure 11 shows the top three factors obtained from the P-PCA method applied to 10% randomly chosen data. These three factors explain 62% of the entire variation of the data.<sup>14</sup> Table 5 summarizes the distribution of the estimated impacts of each variable on the three factors. Similar to the baseline exercise using industry-region-year level aggregate data, applying the P-PCA yields the same number of estimated factor loadings as that of firms (around 5,000 firms depending on choice of variables). For each pair, the impacts are computed as the multiplication of the sign of the factor loading of each factor and share of the variation of each variable to that of the variation of the corresponding factor.

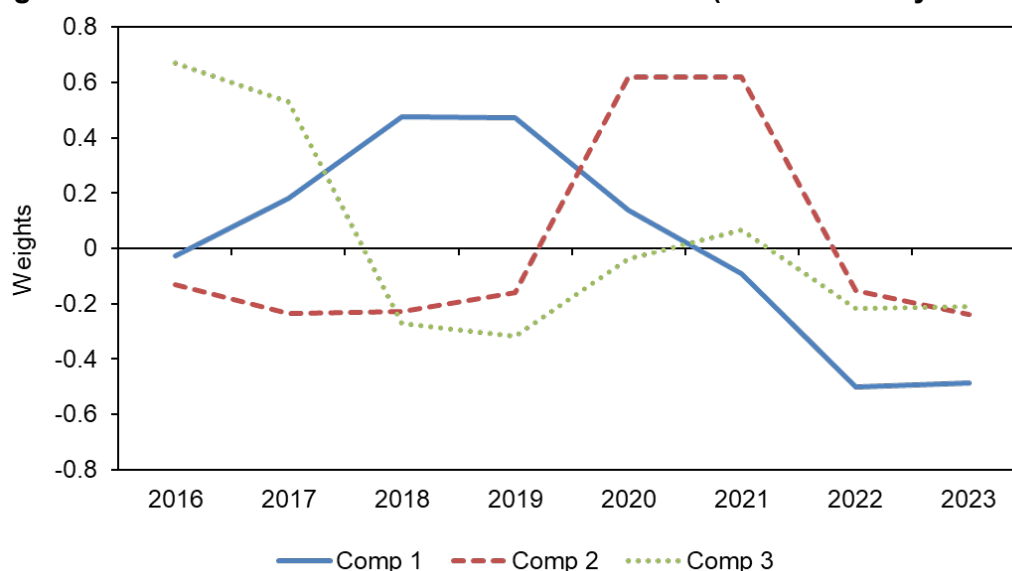
First, we can identify that the first factor in Figure 11 is a mirror image of the first factor in Figure 1. We find that the profit has a positive (negative) association with the first factor in Figure 11 (Figure 1). This suggests that to some extent the 10% randomly chosen raw data reproduce the SME-DI based on more aggregated (but not full) data.

<sup>14</sup> The contribution of each estimated principal component (PC) is 43% for PC1, an additional 12% for PC2, and a further 7% for PC3, for a total of 62% explained.

The second factor in Figure 11 shows a spike over the periods from 2020 to 2021 and negatively associated with sales revenues and profits, which is consistent with the observed episodes during the pandemic. The second factor accounts for the “inverse” of firm profitability, bank borrowing, and various balance sheet items; suggesting some groups of MSMEs had difficulty in obtaining bank funding during the pandemic (2020–2021), but improved after 2022, which is relatively consistent with that found in Table 2B.

Third, the dynamics and the estimated impacts of each variable on the third factor still show some significant discrepancy. The third factors in Figures 11 and 1 both show a U-shape followed by a hump shape. Despite this similarity, however, the signs of the association between the third factors in those two cases and each variable are in most cases flipped. In short, this suggests that the third factor obtained from the industry-region-year data based on the MSME data is distinct from that of the 10% randomly chosen raw data. An obvious conjecture is that the bias originated from the 10% sampling. Another presumption comes from the fact that we do not assign any weight to each sample in the case of the 10% randomly chosen data while the entire industry-region-year MSME data incorporates the weight of each datapoint as we aggregate data by simply summing up the variable over firms in each year. It is important that future work finds a way to obtain compatibility between those two cases.

**Figure 11: SME-DI on the Firm-Year Level Raw Data (10% Randomly Chosen)**



SME-DI = Small and Medium-Sized Enterprise Development Index.  
Source: Authors' calculations.

**Table 5: Factor Loadings based on Probabilistic Principal Component Analysis  
—Raw Data**

**A. Relation Between the First Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0004	0.0000	0.0017	0.0015	0.0021	0.0060	0.0032	0.0035	0.0023	0.0023	0.0055
(-0.9, -0.8)	0.0012	0.0001	0.0029	0.0036	0.0028	0.0065	0.0061	0.0064	0.0060	0.0050	0.0058
(-0.8, -0.7)	0.0005	0.0001	0.0026	0.0033	0.0027	0.0044	0.0037	0.0039	0.0034	0.0026	0.0043
(-0.7, -0.6)	0.0004	0.0000	0.0015	0.0021	0.0016	0.0021	0.0021	0.0019	0.0020	0.0019	0.0027
(-0.6, -0.5)	0.0009	0.0000	0.0023	0.0025	0.0027	0.0038	0.0033	0.0032	0.0031	0.0031	0.0032
(-0.5, -0.4)	0.0006	0.0001	0.0032	0.0035	0.0032	0.0036	0.0035	0.0037	0.0029	0.0026	0.0036
(-0.4, -0.3)	0.0003	0.0000	0.0016	0.0016	0.0017	0.0019	0.0015	0.0014	0.0014	0.0013	0.0018
(-0.3, -0.2)	0.0003	0.0000	0.0014	0.0018	0.0014	0.0017	0.0016	0.0017	0.0015	0.0012	0.0016
(-0.2, -0.1)	0.0007	0.0000	0.0044	0.0054	0.0049	0.0060	0.0052	0.0053	0.0048	0.0038	0.0054
(-0.1, -2.22e-16)	0.0006	0.0000	0.0030	0.0046	0.0036	0.0039	0.0043	0.0042	0.0035	0.0030	0.0043
(-2.22e-16, 0.1)	0.0007	0.0000	0.0036	0.0046	0.0041	0.0046	0.0050	0.0048	0.0041	0.0032	0.0052
(0.1, 0.2)	0.0905	0.0290	0.0253	0.0303	0.0260	0.0302	0.0334	0.0331	0.0424	0.0527	0.0296
(0.2, 0.3)	0.0005	0.0000	0.0047	0.0057	0.0049	0.0055	0.0057	0.0059	0.0045	0.0037	0.0052
(0.3, 0.4)	0.0004	0.0000	0.0040	0.0052	0.0040	0.0038	0.0045	0.0042	0.0036	0.0025	0.0044
(0.4, 0.5)	0.0004	0.0000	0.0026	0.0029	0.0027	0.0017	0.0022	0.0022	0.0020	0.0018	0.0021
(0.5, 0.6)	0.0004	0.0000	0.0028	0.0032	0.0027	0.0021	0.0025	0.0024	0.0021	0.0015	0.0020
(0.6, 0.7)	0.0003	0.0000	0.0033	0.0036	0.0033	0.0024	0.0025	0.0026	0.0023	0.0017	0.0027
(0.7, 0.8)	0.0008	0.0000	0.0038	0.0042	0.0033	0.0030	0.0036	0.0038	0.0034	0.0027	0.0032
(0.8, 0.9)	0.0008	0.0000	0.0047	0.0056	0.0042	0.0044	0.0051	0.0048	0.0041	0.0035	0.0052
(0.9, 1.0)	0.0002	0.0000	0.0027	0.0031	0.0024	0.0030	0.0016	0.0019	0.0012	0.0008	0.0030
mean	0.103*	0.116*	0.108*	0.104*	0.085*	-0.025*	0.025*	0.019*	0.028*	0.031*	-0.002

**B. Relation between the Second Factor and Variables**

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0004	0.0000	0.0035	0.0040	0.0038	0.0050	0.0038	0.0039	0.0030	0.0025	0.0046
(-0.9, -0.8)	0.0002	0.0000	0.0025	0.0019	0.0020	0.0021	0.0020	0.0020	0.0016	0.0014	0.0020
(-0.8, -0.7)	0.0001	0.0000	0.0013	0.0017	0.0011	0.0011	0.0011	0.0012	0.0010	0.0006	0.0013
(-0.7, -0.6)	0.0002	0.0000	0.0016	0.0021	0.0015	0.0011	0.0016	0.0016	0.0013	0.0011	0.0018
(-0.6, -0.5)	0.0007	0.0000	0.0034	0.0042	0.0031	0.0032	0.0043	0.0045	0.0043	0.0031	0.0041
(-0.5, -0.4)	0.0012	0.0001	0.0036	0.0043	0.0035	0.0033	0.0054	0.0052	0.0054	0.0048	0.0037
(-0.4, -0.3)	0.0907	0.0289	0.0260	0.0311	0.0273	0.0303	0.0345	0.0337	0.0439	0.0539	0.0306
(-0.3, -0.2)	0.0007	0.0000	0.0053	0.0064	0.0062	0.0070	0.0065	0.0069	0.0056	0.0050	0.0068
(-0.2, -0.1)	0.0005	0.0001	0.0037	0.0032	0.0044	0.0042	0.0032	0.0034	0.0023	0.0023	0.0043
(-0.1, -2.22e-16)	0.0004	0.0000	0.0031	0.0035	0.0032	0.0046	0.0033	0.0037	0.0027	0.0023	0.0043
(-2.22e-16, 0.1)	0.0004	0.0000	0.0026	0.0030	0.0032	0.0039	0.0030	0.0035	0.0027	0.0022	0.0041
(0.1, 0.2)	0.0007	0.0001	0.0028	0.0032	0.0030	0.0067	0.0042	0.0043	0.0033	0.0027	0.0048
(0.2, 0.3)	0.0005	0.0000	0.0043	0.0058	0.0040	0.0070	0.0045	0.0046	0.0037	0.0026	0.0070
(0.3, 0.4)	0.0011	0.0000	0.0043	0.0066	0.0039	0.0068	0.0058	0.0058	0.0046	0.0037	0.0065
(0.4, 0.5)	0.0007	0.0001	0.0035	0.0049	0.0034	0.0041	0.0045	0.0044	0.0038	0.0031	0.0046
(0.5, 0.6)	0.0010	0.0001	0.0024	0.0036	0.0025	0.0029	0.0034	0.0032	0.0031	0.0029	0.0028
(0.6, 0.7)	0.0005	0.0000	0.0019	0.0025	0.0022	0.0021	0.0024	0.0021	0.0022	0.0019	0.0019
(0.7, 0.8)	0.0003	0.0000	0.0026	0.0021	0.0023	0.0017	0.0022	0.0020	0.0021	0.0013	0.0019
(0.8, 0.9)	0.0003	0.0000	0.0033	0.0036	0.0031	0.0031	0.0037	0.0037	0.0033	0.0024	0.0034
(0.9, 1.0)	0.0002	0.0000	0.0007	0.0008	0.0007	0.0005	0.0012	0.0010	0.0009	0.0010	0.0003
mean	-0.333*	-0.367*	-0.122*	-0.107*	-0.125*	-0.106*	-0.118*	-0.123*	-0.155*	-0.198*	-0.118*

*Continued on the next page*

### C. Relation Between the Third Factor and Variables

	Bank Loan Overdraft	Employees Total	Gross Profit/Loss Amount	Net Profit Before Taxes	Sales Revenue Amount	Total Assets Amount	Total Current Liabilities Amount	Total Liabilities Amount	Trade Credit	Trade Debtors	Working Capital Amount
(-1.0, -0.9)	0.0002	0.0000	0.0012	0.0030	0.0008	0.0021	0.0019	0.0020	0.0017	0.0010	0.0020
(-0.9, -0.8)	0.0002	0.0000	0.0010	0.0016	0.0008	0.0015	0.0011	0.0012	0.0010	0.0008	0.0011
(-0.8, -0.7)	0.0004	0.0000	0.0007	0.0011	0.0007	0.0036	0.0018	0.0019	0.0013	0.0014	0.0024
(-0.7, -0.6)	0.0004	0.0001	0.0007	0.0010	0.0009	0.0051	0.0026	0.0031	0.0019	0.0014	0.0032
(-0.6, -0.5)	0.0003	0.0000	0.0008	0.0010	0.0009	0.0034	0.0020	0.0020	0.0015	0.0013	0.0024
(-0.5, -0.4)	0.0004	0.0000	0.0014	0.0014	0.0013	0.0032	0.0024	0.0025	0.0024	0.0020	0.0026
(-0.4, -0.3)	0.0004	0.0000	0.0018	0.0021	0.0018	0.0038	0.0029	0.0030	0.0024	0.0022	0.0030
(-0.3, -0.2)	0.0008	0.0001	0.0023	0.0026	0.0018	0.0037	0.0035	0.0034	0.0034	0.0026	0.0034
(-0.2, -0.1)	0.0012	0.0000	0.0043	0.0050	0.0034	0.0046	0.0063	0.0057	0.0053	0.0046	0.0053
(-0.1, -2.22e-16)	0.0016	0.0000	0.0077	0.0090	0.0079	0.0091	0.0101	0.0104	0.0088	0.0080	0.0090
(-2.22e-16, 0.1)	0.0016	0.0001	0.0071	0.0089	0.0060	0.0078	0.0094	0.0091	0.0093	0.0070	0.0087
(0.1, 0.2)	0.0014	0.0000	0.0106	0.0129	0.0103	0.0112	0.0115	0.0114	0.0097	0.0080	0.0125
(0.2, 0.3)	0.0006	0.0000	0.0054	0.0062	0.0050	0.0050	0.0042	0.0041	0.0036	0.0031	0.0055
(0.3, 0.4)	0.0006	0.0001	0.0045	0.0055	0.0049	0.0045	0.0043	0.0047	0.0035	0.0028	0.0044
(0.4, 0.5)	0.0003	0.0000	0.0026	0.0028	0.0027	0.0017	0.0019	0.0019	0.0016	0.0013	0.0022
(0.5, 0.6)	0.0001	0.0000	0.0018	0.0016	0.0027	0.0010	0.0012	0.0011	0.0010	0.0007	0.0014
(0.6, 0.7)	0.0001	0.0000	0.0013	0.0013	0.0024	0.0007	0.0008	0.0008	0.0007	0.0005	0.0011
(0.7, 0.8)	0.0895	0.0289	0.0230	0.0266	0.0259	0.0262	0.0294	0.0290	0.0390	0.0493	0.0269
(0.8, 0.9)	0.0004	0.0000	0.0018	0.0016	0.0024	0.0008	0.0012	0.0012	0.0011	0.0011	0.0012
(0.9, 1.0)	0.0003	0.0000	0.0020	0.0030	0.0017	0.0019	0.0023	0.0022	0.0016	0.0018	0.0025
mean	0.629*	0.699*	0.263*	0.234*	0.305*	0.121*	0.197*	0.19*	0.265*	0.345*	0.181*

Source: Authors' calculations.

## 6. Key Findings from Empirical Analyses and Policy Implication

A better understanding the business environment and structural problems associated with business growth is critical to design an effective national policy framework for private sector development, especially for MSMEs. Limited MSME data, however, make it difficult to do so. To overcome the data issue, we have developed a new trial that deals with MSME data limitations to quantitatively assess factors affecting MSME development by using P-PCA—called the SME-DI. Following pilot studies using aggregate data, this study applies the SME-DI method to disaggregated data—including time-series business performance data such as sales and profits—to more accurately identify factors affecting MSME development nationally. We use granular firm-level panel data covering 49,565 MSMEs with a total 353,373 samples for 2016–2023 in Thailand as a case study.

The estimation results suggest that MSME operations largely deteriorated during the pandemic, but were split into two heterogeneous groups in terms of access to finance. One group faced a large sales drop and profit loss but was able to retain bank credit to supplement working capital and secure the workforce, resulting in maintaining a relatively strong balance sheet among MSMEs in this group even during the pandemic. Government emergency support measures for MSMEs—debt financing and employment support—likely helped ease the negative impact of the pandemic. The other group of MSMEs worsened their operational performance and also had problems obtaining working capital during the pandemic; hence, their balance sheet largely deteriorated. These MSMEs were likely unable to access government assistance measures in time.

Industry- and region-level breakdowns of the estimates show a more detailed structure of heterogeneous MSME activities. Wholesale trade is one of the largest sectors among MSMEs in Thailand. During the pre-pandemic period, smaller working capital was likely sufficient to generate

profits for MSMEs dealing wholesale, while those located in some regions experienced the opposite effect. During the pandemic, most wholesale MSMEs likely had lower gains, even when securing larger working capital. Real and financial activities in some groups of wholesale MSMEs were hurt badly by the pandemic and likely continued their negative performance post pandemic with limited access to bank credit. This suggests that government assistance measures—especially debt financing support—did not reach wholesale MSMEs in some regions.

MSMEs in Thailand are spread across the country with over four-fifths operating outside the capital Bangkok. A region-level breakdown of the estimates suggests that capital city-based MSMEs with lower pandemic-induced sales and profits likely received more bank credit. Government assistance measures during the pandemic might have been disproportionately allocated to Bangkok-based MSMEs in some industries, with few signs of effective policy support for local MSMEs. Together with the estimation results on wholesale MSMEs, government MSME assistance during the pandemic likely contributed to strengthening working capital for Bangkok-based wholesale MSMEs, but had limited effects on rebuilding profits. Government assistance did not adequately reach local wholesale MSMEs, leaving them limited funding opportunities with few ways of improving performance during and after the pandemic.

For manufacturing MSMEs, the estimations suggest that Bangkok-based firms conducted cut costs through layoffs and by successfully obtaining bank credit during the pandemic, attributed to less pandemic impact on their operational performance (sales and profits). Emergency government assistance likely helped them access bank credit. Local firms likely saw profits decline during the pandemic, as they did not receive government financial assistance in time. The estimation for agricultural MSMEs implies that Bangkok-based firms saw sales revenue and gross profits drop with no effective support from improved working capital conditions during the pandemic. Meanwhile, local firms constantly saw gross profits drop over the course of the pandemic, accelerated by a constant decrease in access to bank credit even if working capital conditions improved.

In summary, empirical analyses using P-PCA and granular firm-level data in Thailand found a potential disproportionate effect of policy interventions for MSME development (especially debt financing and employment support) during and post pandemic. Capital city-based MSMEs likely overcame a drop in sales and profits, surviving on strengthened working capital financing. This was more pronounced for manufacturing, while MSMEs outside Bangkok continued to see revenues and profits fall with limited access to bank credit in wholesale trade, manufacturing, and agriculture. It is conjectured that government assistance for MSMEs affected by the pandemic were likely more effective for Bangkok-based firms, especially those in manufacturing. By contrast, government assistance unlikely supported local MSMEs in any industry, keeping their operational performance poor both during and post pandemic. This suggests the importance of a focused approach on policy interventions for MSME development, given the more sustainable effects to facilitate resilient private business growth. In the case of Thailand, policy support should be proportionately delivered to underserved/unserved MSME segments such as in wholesale trade and agriculture, and provincial MSMEs.

## 7. Conclusion

In this paper, we apply the method of constructing activity indexes for MSMEs developed and proposed by Shinozaki et al. (2024) to disaggregated firm-level data in Thailand. Shinozaki et al. (2024) aimed to construct an SME-DI accounting for the entire (or sub) Asian region(s) by applying the P-PCA method to aggregated country-level data accounting for multiple timeseries of macroeconomic variables. To complement this, we first used industry-region-year level firm sales, profit, employment, and other financial statement variables based on firm-year level data to construct the SME-DI accounting for MSME activities in Thailand. We also applied the method to firm-year level raw data so as to discuss the validity of the index based on the raw data. The analyses offer an interpretable SME-DI that is immune to discretion and easy to implement.

To develop a more practical use of the P-PCA method that evaluates firm activities quantitatively and provides evidence to design an effective, sustainable, and feasible MSME policies, we tested P-PCA using various types of datasets—real variables only, financial variables only, small sample exercises (50% and 10% random sampling), and raw granular firm-level data—as a robustness check of the SME-DI. These highlighted several issues. For example, a reduction in sample size does not create any serious problems in estimating an SME-DI, but a smaller sample size (10%) may fail to follow the estimation results using the entire dataset. However, analyses by using the 10% randomly chosen raw data instead of industry-region-year level aggregate data produced relatively consistent results with those using aggregate data. For future studies, we recommend applying the SME-DI model to various types of datasets so as to finetune the accuracy of the model, especially granular firm-level data across several countries. In the case of Thailand, the heterogeneity assessment of business activities between domestically-focused enterprises and internationalized firms (exporters) would help design an effective MSME policy framework amid the rapidly changing global trade environment.

## References

- Asian Development Bank (ADB). 2020. *Asia Small and Medium-Sized Enterprise Monitor 2020 Volume II—COVID-19 Impact on Micro, Small, and Medium-Sized Enterprises in Developing Asia*.
- \_\_\_\_\_. 2022. *Asia Small and Medium-Sized Enterprise Monitor 2021 Volume IV—Pilot SME Development Index: Applying Probabilistic Principal Component Analysis*.
- \_\_\_\_\_. 2024. *Asia Small and Medium-Sized Enterprise Monitor 2024: Designing an MSME Ecosystem for Resilient Growth in Asia and the Pacific*.
- Ebeke, C. H., Jovanovic, N., Valderrama, L., and Zhou, J. 2021. Corporate Liquidity and Solvency in Europe during COVID-19: The Role of Policies. IMF Working Papers 2021/056, International Monetary Fund.
- Gourinchas, P.O., Kalemli-Ozcan, S., Penciakova, V., and Sander, N., 2020. COVID-19 and SME Failures. IMF Working Paper 2020/207. International Monetary Fund.
- Maehashi, K. and M. Shintani, 2020. Macroeconomic Forecasting Using Factor Models and Machine Learning: An application to Japan. *Journal of the Japanese and International Economies* 58.
- Office of Small and Medium Enterprises Promotion (OSMEP) 2022. *Situation Report of MSMEs in 2022*.
- Shinozaki, S., D. Miyakawa, and R. Araham, 2024. Factors Affecting Micro, Small, and Medium-Sized Enterprise Development in Developing Asia: Findings from a Probabilistic Principal Component Analysis. ADB Economics Working Paper Series No.715.

## **Designing a Country's Small and Medium-Sized Enterprise Development Index Using Firm-Level Data**

*The Case of Thailand*

This paper employs probabilistic principal component analysis to develop a new way to quantitatively assess what affects micro, small, and medium-sized enterprise (MSME) development nationally, by using granular firm-level panel data for 49,565 MSMEs in Thailand. The estimation results found a potential disproportionate effect of MSME policy interventions during and after the coronavirus disease pandemic. This underscores the importance of using a focused approach when designing policies for MSME development to facilitate more sustainable, resilient private sector growth.

### **About the Asian Development Bank**

ADB is a leading multilateral development bank supporting inclusive, resilient, and sustainable growth across Asia and the Pacific. Working with its members and partners to solve complex challenges together, ADB harnesses innovative financial tools and strategic partnerships to transform lives, build quality infrastructure, and safeguard our planet. Founded in 1966, ADB is owned by 69 members—50 from the region.



**ASIAN DEVELOPMENT BANK**

6 ADB Avenue, Mandaluyong City

1550 Metro Manila, Philippines

[www.adb.org](http://www.adb.org)