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Article

Impacts of fiscal decentralization on performance of local government expenditure: Evidence from Vietnam

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Abstract: This article aims to examine the impact of fiscal decentralization on the performance of local government expenditure in Vietnam. By using a dataset including 63 provinces from 2012 to 2021, the research shows the more expenditure-based fiscal decentralization occurs, the better is the performance of local expenditure. Moreover, the level of provincial literacy and the size of the private sector have positive impacts on the local expenditure index, while the opposite effect can be seen in the case of the ratios of local citizens to total citizens of the country. Besides this, the study also provides some recommendations which are strictly related to the mechanism of fiscal decentralization to improve local expenditure performance of Vietnamese provinces, such as more effective decentralization of budget expenditures to local government, improving the vertical budget imbalance at local budget level, increasing local government budget autonomy, and establishing stronger mechanisms to control public spending.

Keywords: fiscal decentralization; expenditure performance; local governments; national budget
JEL Classification: H71; H73; H75

1. Introduction

Fiscal decentralization is known as one of the public sector reform solutions taken by different countries to improve the competitiveness of governments, contributing to increased economic growth (Bahl and Linn, 1992; Bird and Wallich, 1993). According to Hanai and Bach (2004), fiscal decentralization is defined as the division of responsibilities, powers, benefits and public resources between central and local governments. To be precise, based on the functions of local governments, central government determines the revenue and expenditure that local governments have to collect from or spend on their activities. In other words, fiscal decentralization allows local governments to increase or share income and expenditure with the state budget (Fritzen, 2006).

In fact, there is differences in the impact of fiscal decentralization on the expenditure performance of local government among different countries or provinces. The research of Dreher (2006) shows that different results can be seen in low-income and high-income countries. In other words, there is a strong relationship between local budget efficiency and local government fiscal decentralization in low-income countries, but this does not apply to high-income countries, which is similar to the findings of Kyriacou (2009). Elhiraika (2007) indicates that in South Africa, fiscal decentralization has an impact on health care, but this effect is different among poor and rich provinces. Similarly, Eggleston et al. (2007) argue that this difference in 28

provinces of China during the period from 1993 to 2000, is originated from the ways that localities use to deploy and manage financial resources. In particular, some scholars such as Elhiraika's (2007) and Martinez-Vazquez and Sepulveda (2011) do not find evidence on the positive impact of fiscal decentralization on education in South Africa and in the US, respectively.

In transition economies like Vietnam, fiscal decentralization primarily aims to reduce poverty and promote economic growth, while the second objective is to allocate resources efficiently and improve the quality of public goods and services. Since the national economic-political reforms of the 1980s, public administration as well as the fiscal and legal framework have changed significantly. Beside the central budget, local budgets, which comprise provincial, district, and community budgets, have played an important role in the hierarchical budget system of Vietnam. According to the State Budget Law of 2002, the decentralized revenues of local governments include 100% retained revenues and shared revenues, while their borrowing and expenditure responsibilities depend on their respective jurisdictions. In particular, the 2015 State Budget Law highlights the leading role of the central budget and the revenue-sharing mechanism as well as the additional mechanism for budget balancing. To reduce fiscal imbalances, including horizontal and vertical fiscal imbalances, Vietnamese fiscal transfers from the central government to local governments follow both fiscal balancing transfers and targeted transfers. Targeted transfers aim to meet national goals, as well as the objectives of specific provincial programs, while fiscal balancing transfers are offered to provinces where revenues do not match expenditures, or a horizontal fiscal imbalance occurs.

When examining detailed information about fiscal decentralization in Vietnam, it can be seen that the central government is responsible for determining all tax bases and rates, while local governments have the right to establish some types of retained revenues such as fees and charges. In addition, revenue-sharing arrangements with a three- to five-year stability period, which are set by the central government, encourage local governments to implement measures to increase their revenues to finance increasing local expenditures. Nguyen et al. (2019) indicate that the fiscal autonomy has a positive impact on economic growth across 63 Vietnameses provinces. However, many studies provide evidence of the disadvantages of fiscal decentralization in Vietnam. For instance, Vu (2016) confirms that fiscal decentralization does not ensure an equitable distribution of revenue and financial resources or prevent fiscal imbalances. Tran (2019) mentions that Ho Chi Minh City has retained only 18% of its annual revenues for its local budget, which is not sufficient to invest in the city's infrastructure and meet other necessary expenditure, while many subsidized provinces use their local budgets ineffectively. Besides the above, fiscal decentralization in Vietnam has been investigated from different social and economic perspectives, such as the impact of fiscal decentralisation on economic growth (Nguyen and Anwar, 2011; Nguyen, 2017; Nguyen et al., 2019; Su et al., 2020), the relation between fiscal decentralization and poverty reduction (Rao et al., 1998; Nguyen, 2008; Bjornestad, 2009), the effects of fiscal decentralisation on health services (Vo and Lofgren, 2019). Nguyen et al. (2019) show a negative impact of the fiscal importance and the fiscal decentralisation index on economic growth in Vietnam. It can be seen that there has

been no research examining the relationship between fiscal decentralization and the expenditure performance of individual provinces in Vietnam.

Considering the actual situation and the limitations observed in the current literature, this study aims to investigate the impact of fiscal decentralization on the performance of local government expenditure in Vietnam over a period from 2012 to 2021. In particular, this impact is compared in two cases, including: i) the period from 2012 to 2016 (when the 2002 State Budget Law was applied) and the period from 2017 to 2021 (when the 2015 State Budget Law has been applied); ii) the group of localities that receive additional budget from the central government and the group of localities that exceed the required budget from the central government. According to statistics, the group of localities exceeding the required budget includes 13 provinces/cities such as Hanoi, Quang Ninh, Hai Phong, Vinh Phuc, Bac Ninh, Hai Duong, Da Nang, Quang Nam, Khanh Hoa, Ho Chi Minh City, Dong Nai, Binh Duong, and Can Tho. The group of localities receiving additional budget from the central government includes the remaining 50 Provinces/Cities. This paper works on Vietnamese 63 province-level datasets from 2012 to 2021 and uses regression models to achieve the research objectives.

This paper makes the following two contributions. First, this paper adds to the research on fiscal decentralisation and the expenditure performance of local governments. On the one hand, this paper tries to build an expenditure performance index of local governments through Principal Component Analysis (PCA). On the other hand, it provides evidence on the positive impact of fiscal decentralization on the performance of local government expenditure in Vietnam, providing support for the theory of fiscal decentralization. The empirical results show that local governments with a higher degree of fiscal decentralization have a stronger incentive to spend effectively. In addition, the impact of fiscal decentralisation on the expenditure performance of local governments is much better over a period from 2017 to 2021 when the new State Budget Law has been applied, and for provinces which receive additional budget from the central government. Furthermore, this paper makes policy recommendations to assist the Vietnamese government in dealing with the relationship between fiscal decentralization and the expenditure performance of local governments.

This paper proceeds in five sections. Section two presents a related literature review on fiscal decentralization, performance of public expenditure, and the link between fiscal decentralization and expenditure performance, and then develops hypotheses. Section three explains the variables, the data collection method, and the data analysis. Section four describes the analysis results before discussing them and providing conclusions in section five and section six.

2. Literature review and developing hypotheses

According to Mandl et al. (2008), the expenditure performance of local governments reflects the level of output achievable compared to the scale of inputs realized in a given locality. For this purpose, inputs are defined as financial resources spent by local governments for activities shown in legal documents on financial management and budget, and may include administrative, economic, social, defense, security, and foreign affairs fields. In addition, Lonti and Woods (2008) and Lopez

(2006, 2009) highlight this relative relationship between outputs and inputs, in comparison with standards considered optimal. There are both direct and indirect impacts of fiscal decentralization on the performance of local government expenditure.

Regarding the indirect impact of fiscal decentralization on the performance of local government expenditure, many empirical studies have examined the relationship between fiscal decentralization and economic growth, and social development outcomes, as well as competitiveness of governments or provinces.

Applying a simple growth model in association with the history, culture, and economic development stages in the United States and using sub-national data with various measures of fiscal decentralization, Akai and Sakata (2002) maintain that fiscal decentralization enhances economic growth and that shifts toward further fiscal decentralization are appropriate to achieve economic growth in the United States. Similarly, Jin and Zou (2005) confirm a positive relationship between the fiscal incentives of 29 Chinese local governments and local economic growth for a research period between 1970 and 1999. Similar evidence can be found relating to East European countries over the 2002–2008 period through the research of Abdellatif et al. (2015), or in OECD countries with the study of Filippetti and Sacchi (2016). It is believed that with fiscal decentralization, local governments pay more attention to improving the life conditions of citizens, and thus a higher level of fiscal decentralization enables them to utilize fiscal resources better to foster local economic development (Hao et al., 2021).

By contrast, unfavorable impacts of fiscal decentralization on economic growth were found by Davoodi and Zou (1998) for 46 developing countries, Xie et al. (1999) for the US, Jin and Zou (2005) for China, Rodriguez-Pose and Ezcurra (2010) as well as Baskaran and Feld (2013) for OECD countries. This negative linkage could be attributable to the differences in the expenditure preferences of sub-national governments (Rodriguez-Pose and Ezcurra, 2010). In addition, an inverted U-shaped linkage between these two variables was observed by Thiessen (2004) for OECD and Sun et al. (2017) for China. Moreover, several studies that show an insignificant relationship between fiscal decentralization and economic growth (Woller and Phillips, 1998; Thornton, 2007; Baskaran and Feld, 2013), which results from the limited informational benefits of conducting policies and providing public goods and services at the local level in small and homogeneous countries (Martinez-Vazquez and McNab, 2003). In particular, Im (2010) found a negative relationship between political decentralization and growth in developing countries, between fiscal decentralization and growth in semi-developed countries, but insignificant relationships in developed countries, when using a data set of 63 countries with a time series spanning from 1960 to 2007. Similarly, Bodman (2011) found no compelling evidence of a direct relationship between fiscal decentralization and output growth, suggesting that federal systems tend to have lower growth rates than unitary states and that countries, especially OECD countries, with more elected tiers of government generally achieve lower economic growth.

It can be seen that studies which were conducted with multi-country data or national or sub-national data provide inconsistent results about the impact of fiscal decentralization on economic growth. This stems from the fact that not all studies treat

social welfare as a proxy for the field of state budget expenditure (Oates, 2005). However, most studies believe that fiscal decentralization has a positive effect.

Regarding social development outcomes, theories proposed by Tiebout (1956) and Brenan and Buchanan (1980) suggest that voters will vote for packages of public goods and taxes that suit their needs and preferences. In other words, giving local authorities the autonomy in revenue to finance the provision of their public services will promote local governments to improve the quality of public service delivery in order to attract voters. The positive effects of fiscal decentralization on the quality of public services like education and health were empirically analysed in several studies. Bahl and Linn (1992) and Bird and Wallich (1993) argue that fiscal decentralization, which transfers budgetary power from higher-level government to lower-level government, is part of a group of solutions to reform the public sector, increase the competitiveness of lower-level governments in the provision of goods and services and escape from slow economic growth.

According to Estach and Shinha (1995), Khaleghian (2004), and Bardhan and Mookherjee (2006), the quality of public services can be understood as the quality of labour training, education services, and health services. Bahiigwa et al. (2005) and Treisman (2007) documented that fiscal decentralization may worsen the delivery of public services. Some examine the impact of fiscal decentralization on education which is proxied by schooling quality (Falch and Fisher, 2012) for OECD countries, or students' enrolment (Faguet and Sanchez, 2014) for Columbia, or the drop-out rate in secondary education (Salinas and Albert, 2018) for Spain. Similarly, but to lesser extents, there is a positive impact of fiscal decentralization on healthcare services in general (Sow and Razafimahefa, 2015; Martinez-Vazquez et al., 2017), and the aspect of infant mortality (Habibi et al., 2003; Jimenez-Rubio, 2011; Cavalieri and Ferrante, 2016), and strengthened access to public health services/insurance (Faguet and Sánchez, 2014).

Moreover, because of fiscal decentralization, local governments are obligated to compete with others to attract populations, leading to benefits such as eliminating monopolies in local regulations, improving institutional enforcement, reducing transaction costs, and limiting opportunistic behaviour by local governments. It is believed that delegating more spending tasks to local governments can help increase transparency and reduce corruption and transaction costs because local governments are more accountable to local people. However, these benefits depend much on the behaviour and attitude of the local leaders towards the people. For example, local leaders who are directly elected by local people focus much more on benefits for their citizens, which is totally opposite to the case where the central government appoints the local head (Seabright, 1996; Kyriacou and Sagales, 2009; De Mello and Barenstein, 2001). Furthermore, giving local governments autonomy over revenue sources and ensuring their rights to finance expenditure tasks will create a driving force for local governments to reform institutions, improve transparency, and reduce corruption. Fisman and Gatti (2002) showed that in this case, local governments will have to strive to better mobilize resources to meet their spending needs. Knappeler et al. (2013) by examining the sub-national infrastructure investment in 20 European countries during the period from 1990 to 2009, show evidence on a positive impact of revenue

decentralization on the sub-national infrastructure investment but this effect is better if infrastructure investment is funded lesser by earmarked grants.

In terms of the direct impact of fiscal decentralization on the performance of local government expenditure, by assuming that local budget expenditure efficiency can be measured by criteria such as citizen participation, accountability, social justice, improved economic governance, and reduced corruption (all of which are calculated from cross-country data), Huther and Shah (1998) show that fiscal decentralization has a positive relationship with local budget expenditure. Using a broader approach, De Mello and Barenstein (2001) indicate that fiscal decentralization is associated with many indicators of local budget expenditure efficiency in 78 countries, but local budget expenditure efficiency also depends on how expenditure is financed. To be precise, some countries with a high degree of decentralization of revenue sources will have a stronger relationship between fiscal decentralization and local budget expenditure efficiency. Similarly, Fisman and Gatti (2002) show by using data from 57 countries for the period 1980–1995 with some added control variables such as population and the ratio of government spending to GDP, that the decentralization of state budget expenditure has a strong impact on promoting the efficiency of local budgetary spending. This conclusion is also supported by Arikan (2004) who shows a link between fiscal decentralization and local budget expenditure efficiency in many countries. However, the research of Dreher (2006) shows that different results can be seen in low-income and high-income countries. In summary, there is a strong relationship between local budget efficiency and local government fiscal decentralization in low-income countries, but this does not apply to high-income countries.

In theories, the link between fiscal decentralization and the expenditure performance of local government is related to advantages brought by fiscal decentralization, in comparison with a centralized budgeting system. Firstly, fiscal decentralization establishes a mechanism empowering local governments to determine both aggregated and detailed revenue and expenditure. By realigning the institutional structure of government in terms of responsibilities, as well as the allocation of resources among different levels of government, fiscal decentralization makes local governments more active and powerful when using revenues and expenditures. Secondly, it is believed that fiscal decentralization increases the efficiency of public service delivery in terms of quality and price. Instead of uniform goods and services which are offered by the central government, local governments that have close relationships with local people can optimize services to better meet their demands or needs, contributing to maximization of social welfare. Furthermore, the competitiveness between local governments can eliminate monopolies and avoid excessive taxation (Brennan and Buchanan, 1980). People can freely move to locations where local governments offer the best services in line with their needs. In other words, Pareto optimality in resource allocation can be achieved thanks to fiscal decentralization. Finally, fiscal decentralization can lead to a decrease in information and operation costs of public services, and a growth of the private sector, leading to greater stability of the national macroeconomy. For instance, the federal states following strong decentralization with strict fiscal discipline (such as Switzerland, Germany, Austria, and the United States) usually experience low inflation rates and

macroeconomic stability. However, fiscal decentralization can cause monetary and fiscal imbalances in cases of poor fiscal discipline (Shah, 2006).

Moreover, the variable of fiscal decentralization can be defined as the degree of expenditure (De Mello, 2001; Quiao et al., 2019; Xin and Quian, 2022; etc.) or the degree of fiscal autonomy (Ebel and Yilmaz, 2002; Zhao et al., 2022). For the first definition, there are two approaches to measure this variable, including: expenditure-based decentralization (measured by the ratio of local expenditure to total general government expenditure) and revenue-based decentralization (measured by the ratio of local revenue to total general government revenue). Many studies, such as the research of Kasssouri (2022), use both ratios but expenditure-based decentralization has been most widely used in the existing literature (De Mello, 2001; Quiao et al., 2019; Xin and Quian, 2022; Siburian, 2022). As regards to the second definition, fiscal decentralization can be calculated by the ratio of general budgetary revenue to general budgetary expenditure of local finance (Huther and Shah, 1998). Based on the current situation in Vietnam, where decentralization laws authorize the local government to prioritize its own expenditure with significant discretion, but the primary right of taxation remains with the central government, this paper employs both expenditure-based decentralization (FDEX) and financial autonomy (FDFA) to measure Vietnamese fiscal decentralization. Therefore, this paper proposes the first two hypotheses as follows:

- Hypothesis 1 (H1): Expenditure-based decentralization (FDEX) has a positive impact on the expenditure performance index of provinces (EPI).
- Hypothesis 2 (H2): Financial autonomy (FDFA) has a positive impact on the expenditure performance index of provinces (EPI).

Furthermore, the impact of fiscal decentralization on the performance of local government expenditure experiences the moderating role of different variables. To be precise, to control for characteristics of varying population size that local governments are responsible for managing, the paper uses the local population variable (PPL). In theory, Higher values of this variable reflect the level of difficulty in management and affect the effectiveness of state governance of local authorities. Therefore, this paper proposes the third hypothesis as follows:

- Hypothesis 3 (H3): Population (PPL) has a negative impact on the expenditure performance index of provinces (EPI).

In addition, for the social characteristics of the locality, this paper follows the footsteps of the study of Fisman and Gatti (2000) by using a provincial literacy (LTR) variable. In theory, higher values of this variable reflect the higher educational level of the locality. Therefore, this paper proposes the fourth hypothesis as follows:

- Hypothesis 4 (H4): Provincial literacy (LTR) has a positive impact on the expenditure performance index of provinces (EPI).

Finally, to control the conditions of market decentralization of each locality as suggested by Adam et al. (2008), this paper uses the variable of private sector size (PRS). The level of development of the private sector is seen as the driving force for improving the effectiveness of local governance in the context of competition. The higher the value of this variable, the larger the size of the private sector. Therefore, this paper proposes the fifth hypothesis as follows:

- Hypothesis 5 (H5): Size of private sector (PRS) has a positive impact on the expenditure performance index of provinces (EPI).

3. Methodology

3.1. Measuring variables and hypotheses

3.1.1. Dependent variable: Expenditure performance index of provinces (EPI)

Expenditure performance, which is defined as the level of output achievable compared to the scale of inputs realized in a given locality, can be explained through some indicators such as the quality of public services, the growth rate of the provincial economy, and the provincial competitiveness index (Huther and Shah, 1998). Based on the studies of Estach and Shinha (1995), Khaleghian (2004), and Bardhan and Mookherjee (2006), this paper approaches the quality of public services (QPS) through variables of labor training (LBR), education services (EDU), and health services (MED). Higher values of these variables reflect better quality of local government public service delivery. With regard to the growth rate of the provincial economy, the article employs gross regional domestic product (GRDP) as a statistic that measures the size of a province's economy, while the provincial competitiveness index (PCI) is used as a variable of the competitiveness of provinces (Huther and Shah, 1998). **Table 1** summarizes components used as indicators measuring the expenditure performance of provinces.

Table 1. Dimensions and indicators of the expenditure performance index (EPI) (Source: Authors).

Dimensions		**Code**	**Measurement**
Quality of public services—QPS	Labor training (0.33)	LBR	$LBR = \frac{Number\ of\ trained\ laborers\ in\ province}{Total\ laborers\ of\ province}$
	Education services (0.33)	EDU	$EDU = \frac{Number\ of\ teachers\ in\ province}{Total\ population\ of\ province}$
	Health services (0.33)	MED	$MED = \frac{Number\ of\ doctors\ in\ province}{Total\ population\ of\ province}$
Growth rate of provincial economy		GRDP	$GRDP_t = \frac{\text{Gross provincial domestic product}_t - \text{Gross provincial domestic product}_{t-1}}{\text{Gross provincial domestic product}_{t-1}}$
Provincial competitiveness Index		PCI	PCI Index published by VCCI and USAID

It can be seen that using each component cannot solve the multidimensional issue because each indicator can only explain a specific aspect of the expenditure performance of provinces. This motivates us to build the expenditure performance index by combining the principal components of the above-mentioned dimensions through Principal Component Analysis (PCA). This method is based on the idea that data is typically not distributed randomly in space, but rather near specific lines/planes. PCA is based on the linear transformation of a list of variables into orthogonal pairs. In a nutshell, PCA transforms data into new variables (principal components) that do not correlate. The process for calculating the weights is shown in Appendix A.

3.1.2. Independent variable and control variables

The independent variable of fiscal decentralization is measured by expenditure-based decentralization (FDEX) and financial autonomy (FDFA). So, expenditure-based decentralization (FDEX) calculated by the ratio of local expenditure to total general government expenditure, while financial autonomy (FDFA) is computed by the ratio of general budgetary revenue to general budgetary expenditure of local finance. In terms of control variables, the local population variable (PPL) is expressed by the logarithm of thousands of people, whereas the provincial literacy variable (LTR) is calculated by the ratio of number of literate people to the total number of people over 15 years old, to express the literacy level of each locality by population, and the private sector size (PRS) is measured by the ratio of private investment capital to local GDP, reflecting the openness of private resources of the local economy and is considered an exogenous variable for governance (Porcelli, 2005). Detailed definitions and measurements of all variables are shown in **Table 2** as follows:

Table 2. Variables and definitions (Source: Authors).

Variables		Code	Measurement	Sources
Major explained variables (Expenditure performance of provinces—EP)	Expenditure performance index	EPI	Index created by Principal Component Analysis approach	Authors
Explanatory variables (Fiscal decentralization of provinces—FD)	Expenditure-based decentralization	FDEX	$FDEX = \frac{Local\ expenditure}{Total\ general\ government\ expenditure}$	De Mello (2000); Quiao et al. (2019); Xin and Quian (2022); Siburian (2022)
	Financial autonomy	FDFA	$FDFA = \frac{General\ budgetary\ revenue\ of\ local\ finance}{General\ budgetary\ expenditure\ of\ local\ finance}$	Huther and Shah (1998); Ebel and Yilmaz (2022); Zhao et al. (2022)
Control variables (CV)	Population	PPL	$PPL = \frac{Population\ of\ province}{Total\ population\ of\ country}$	Fisman and Gatti (2000) Porcelli (2005); Adam et al. (2008)
	Provincial literacy	LTR	$LTR = \frac{Number\ of\ literate\ people}{Number\ of\ provicial\ citizens\ above\ 15\ years\ old}$	
	Size of private sector	PRS	$LTR = \frac{Private\ investment\ capital}{Local\ GDP}$	

3.2. Data collection and data analysis

This paper employs Vietnamese 63 province-level datasets from 2012 to 2021 (with size of 509 × 6 observations) to investigate the impact of fiscal decentralization on the performance of local expenditure in Vietnam. First, the data on fiscal decentralization comes from the settlement of local budgets of the Ministry of Finance. Second, data was collected on GRDP, foreign capital, population, human index, the number of teachers at high school and the number of doctors working in local hospitals from the General statistic office of Vietnam. Third, the statistics of provincial competitiveness come from the data set of the provincial competitiveness index in Vietnam.

To analyse the effect of fiscal decentralization on the performance of local expenditure in Vietnam, this paper applies the following model:

$$\mathrm{EPI_{it}} = \alpha_0 + \beta_1 \mathrm{FD_{it}} + \beta_2 \mathrm{CV_{it}} + \varepsilon_{it} \quad (1)$$

where: EPI_{it}: Expenditure performance index of local government *i* in the year *t*; FD_{it}: Fiscal decentralization of local government *i* in the year *t*; CV_{it}: Control variables of local government *i* in the year *t*.

The research uses regression models to investigate the impact of fiscal decentralization on the performance of local government expenditure in Vietnam. The explanatory variable in this paper is fiscal decentralization in prefecture-level provinces, while the major explained variable is expenditure performance. In terms of the process of analyzing data, there are 5 steps as following: i) Stationary test; ii) Correlation matrix and multicollinearity test based on variance inflation factors (VIF); iii) Regression test to check if ordinary least squares (OLS) or the fixed effect model (FEM)/ the random effects model (REM) is more appropriate based on the *p*-value; iv) Hausman test and Breusch-Pagan LM test to determine if FEM or REM is appropriate: If the *P*-value of Chi^2 is smaller than 0.05, FEM is an appropriate model and vice versa; v) panel-corrected standard error (PCSE) and feasible generalized least squares (FGLS) estimators to deal with issues of cross-sectional data, such as serial correlation, heteroskedasticity, cross-sectional dependence, autocorrelation (Parks, 1967; Le and Nguyen, 2019), and the problem that there are more cross-sections than intervals (N>T).

4. Empirical results

4.1. Descriptive statistics

Table 3 shows the summary statistics for the variables in this paper. The EPI variable has a mean of 0.304236 and a standard deviation of 0.02605. The mean values of FDEX and FDFA are 0.009722 and 0.005583, while their volatility values are 0.010048 and 0.006875, accordingly. Concerning control variables, PRS has the highest standard deviation (0.090789) with the min value of 0.013697 and the max value of 0.493387, while PPL has the lowest standard deviation (0.014756).

Table 3. Summary statistics (Source: Results extracted from Stata).

	N	Mean	Std. Dev.	Min	Max
EPI	509	0.304236	0.02605	0.229126	0.394471
FDEX	509	0.009722	0.010048	0.00078	0.082936
FDFA	509	0.005583	0.006875	0.00011	0.079023
PPL	509	0.016033	0.014651	0.003243	0.09368
LTR	509	0.932027	0.067514	0.592	0.992
PRS	509	0.230762	0.090789	0.013697	0.493387

Moreover, **Figure 1** describes an increase in the average expenditure performance index of Vietnamese provinces over a period from 2012 to 2021. To be precise, the average EPI started at 28.81% in 2012, after which it saw a slight increase to 29.57% in 2016 before reaching a peak of 32.47% in 2019. A significant increase

in the average EPI of provinces in Vietnam over the period from 2017 to 2019 is primarily attributable to the introduction of the 2015 state budget law, containing many changes that officially took effect from the 2017 budget. According to the new State Budget Law, central budget revenues account for an average of 66%–70% of total state budget revenue, while the figure ranges from 25% to 30% for local budget revenues. This means that the central budget still plays the leading role when it comes to budgetary expenditure, as stipulated in the 2013 Constitution. In addition, the 2015 State Budget Law clearly describes the remit of provincial budgets compared to the central budget, as well as local authorities' rights in relation to local budget revenues, all of which make local authorities more active and responsible for local revenue and expenditure.

However, during the COVID-19 pandemic, the average EPI slightly decreased to 31.56% in 2020 before recovering at 32.14% in 2021. It is clear that the Covid-19 pandemic led to the share of local budget revenues decreasing, although the spending responsibility of local governments did not decrease (Zhang and Liu, 2021). During COVID-19, Vietnamese local governments were forced to increase spending on health care services, environmental sanitation in schools and activities to support epidemic control, while businesses had to face various difficulties causing an increase in the unemployment ratio, which negatively impacted the GRDP and the provincial competitiveness index. Since 2021, by which point COVID-19 was well controlled, provinces can focus on production and developing production and services infrastructure, leading to a slight increase in the average EPI of provinces in Vietnam.

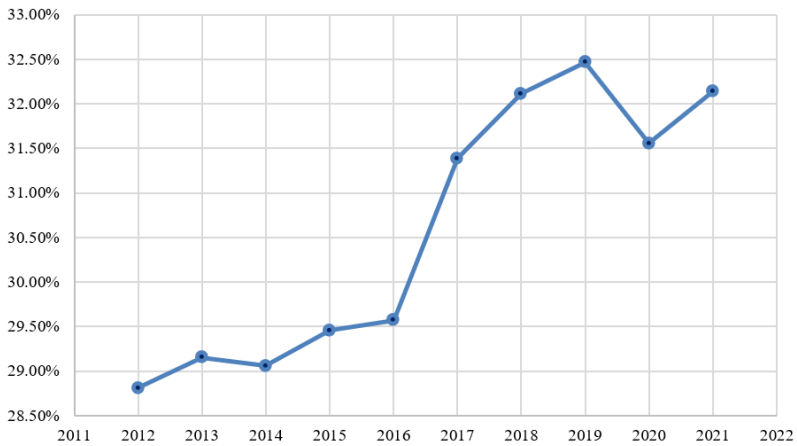

Figure 1. Average EPI of provinces in Vietnam from 2012 to 2022.

4.2. Impacts of fiscal decentralization on expenditure performance of local governments in Vietnam

Appendix B show the stationary of data with first difference and detailed results of the correlation and multicollinearity among variables. It can be seen that there is no multicollinearity among variables since VIF values are smaller than 10. Consequently, Appendix C indicates that the *p*-values of Chi^2 are smaller than 0.05, meaning that FEM or REM is more appropriate than OLS to evaluate the effects of both FDEX and FDFA on EPI. Furthermore, the research shows that Hausman and Breusch-Pagan LM tests have a *P*-value of 0.000 in Appendix D, which is smaller than 0.05. This means

that the fixed effect model is an appropriate model to investigate the impacts of FDEX and FDFA on EPI. Finally, Appendix E shows that FGLS is appropriate to deal with issues of cross-sectional data, such as heteroskedasticity and autocorrelation. **Tables 4** and **5** present the results of the baseline model 1.

It can be seen that FDEX has a positive impact on EPI with a *p*-value smaller than 0.01 (**Table 4**), while FDFA has no impact on EPI with a *p*-value bigger than 0.05 (**Table 5**). This means that Hypothesis 1 (H1) is accepted, while Hypothesis 2 (H2) is rejected. For control variables, LTR and PRS positively impact EPI with *p*-values smaller than 0.01 and 0.05, respectively, while PPL has a negative effect on EPI with a *p*-value smaller than 0.05, meaning that all three hypotheses such as H3, H4, and H5 are accepted.

Table 4. Impacts of FDEX on EPI (Source: Authors).

	OLS	**FEM**	**REM**	**FGLS**
FDEX	1.415***	0.00917	0.693**	1.205***
	(6.11)	(0.03)	(2.54)	(4.76)
PPL	−0.471***	0.316	−0.0577	−0.232
	(−2.91)	(0.26)	(−0.27)	(−1.55)
LTR	0.0914***	0.312***	0.109***	0.0680***
	(5.63)	(3.45)	(3.83)	(4.93)
PRS	0.00819	0.0526***	0.0326**	0.0226***
	(0.71)	(3.09)	(2.28)	(2.75)
_cons	0.211***	−0.00412	0.190***	0.225***
	(14.03)	(−0.05)	(7.27)	(18.28)
N	509	509	509	509
R−square	0.189	0.052	-	-
OLS vs FEM	*Prob* > *F* = 0.000			
OLS vs REM	*Prob* > *Chi*^{2} = 0.000			
Hausman Test	*Prob* > *Chi*^{2} = 0.000			
Modified Wald test for groupwise heteroskedasticity			*Prob* > *Chi*^{2} =0.000	
Wooldridge test for autocorrelation in panel data			*Prob* > *F* = 0.000	
Pesaran's test of cross-sectional dependence			*P*-value = 0.000	

Note: The sign *, ** and *** represents significance at 10%, 5% and 1% level of significance, and values within parenthesis represent standard errors.

Table 5. Impacts of FDFA on EPI (Source: Authors).

	OLS	**FEM**	**REM**	**FGLS**
FDFA	−0.110	−0.00194	−0.0770	−0.170
	(−0.69)	(−0.01)	(−0.49)	(−1.42)
PPL	0.401***	0.318	0.346**	0.422***
	(5.17)	(0.26)	(2.15)	(8.19)
LTR	0.0849***	0.312***	0.115***	0.0627***
	(5.04)	(3.45)	(3.53)	(4.56)

Table 5. (*Continued*).

	OLS	**FEM**	**REM**	**FGLS**
PRS	0.00738	0.0526***	0.0380**	0.0276***
	(0.62)	(3.07)	(2.57)	(3.35)
_cons	0.218***	−0.00403	0.183***	0.229***
	(14.00)	(−0.05)	(6.11)	(18.82)
N	509	509	509	-
R−square	0.130	0.052	-	-
OLS vs FEM	*Prob* > *F* = 0.000			
OLS vs REM	*Prob* > Chi^2 = 0.000			
Hausman Test	*Prob* > Chi^2 = 0.000			
Modified Wald test for groupwise heteroskedasticity			*Prob* > Chi^2 =0.000	
Wooldridge test for autocorrelation in panel data			*Prob* > *F* = 0.00093	
Pesaran's test of cross-sectional dependence			*P*-value = 0.0000	

Note: The sign *, ** and *** represents significance at 10%, 5% and 1% level of significance, and values within parenthesis represent standard errors.

Tables 6 and **7** show the difference on impacts of fiscal decentralization on expenditure performance of local governments by periods and groups of provinces. It can be seen that there is no evidence of the effect of FDFA on EPI since *p*-value is bigger than 0.05, while FDEX has a bigger positive influence on EPI over a period from 2017 to 2021 than a period from 2012 to 2016. Moreover, the impacts of FDEX and FDFA on EPI are bigger in provinces receiving additional budget from the central government at the significant level of 1%. However, FDEX has a positive effect on FPI while the opposite influence can be seen for FDFA.

Table 6. Impacts of FDEX and FDFA on EPI by periods.

	Period 2012–2016		**Period 2017–2021**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
FDEX	0.981***	-	1.790***	-
	(2.63)	-	(4.54)	-
FDFA	-	0.00636	-	0.281
	-	(0.06)	-	(0.92)
PPL	−0.173	0.471***	−0.703***	0.340***
	(−0.77)	(6.11)	(−2.60)	(4.09)
LTR	0.0675***	0.0575**	0.104***	0.100***
	(2.60)	(2.24)	(6.97)	(5.77)
PRS	−0.0130	−0.0104	−0.0172*	−0.0234**
	(−0.90)	(−0.72)	(−1.81)	(−2.32)
_cons	0.225***	0.233***	0.220***	0.224***
	(9.46)	(9.88)	(16.53)	(14.87)
R-square	0.182	0.142	0.349	0.231
N	278	278	231	231

Note: The sign *, ** and *** represents significance at 10%, 5% and 1% level of significance, and values within parenthesis represent standard errors.

Table 7. Impacts of FDEX and FDFA on EPI by groups of provinces.

	Provinces exceed the required budget from the central government (Group 1)		**Provinces receive additional budget from the central government (Group 2)**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
FDEX	0.569	-	2.244***	-
	(1.49)	-	(4.54)	-
FDFA	-	0.394	-	−0.397***
	-	(1.15)	-	(−3.59)
PPL	−0.392*	−0.0450	−0.456*	0.375***
	(−1.77)	(−0.44)	(−1.89)	(2.67)
LTR	0.563***	0.647***	0.0545***	0.0459***
	(2.99)	(3.35)	(3.14)	(2.69)
PRS	0.0769*	0.0934**	0.0223*	0.0248**
	(1.95)	(2.32)	(1.95)	(2.14)
_cons	−0.235	−0.322*	0.233***	0.248***
	(−1.31)	(−1.75)	(15.05)	(16.56)
R-square	0.168	0.153	0.104	0.074
N	98	98	411	411

Note: The sign *, ** and *** represents significance at 10%, 5% and 1% level of significance, and values within parenthesis represent standard errors.

5. Discussions

Firstly, expenditure-based fiscal decentralization has a positive impact on the expenditure performance index of provinces, meaning that local governments with a higher degree of expenditure-based fiscal decentralization have a stronger incentive to spend effectively. This finding supports the theory of fiscal decentralization and is consistent with the findings of De Mello and Barenstein (2001), Arikan (2004), Sow and Razafimahefa (2015), and Martinez-Vazquez et al. (2017) who all show a positive relationship between fiscal decentralization and local expenditure performance in terms of labor training, education services, and health care services.

In fact, expenditure-based fiscal decentralization means that local governments have some rights to decide how to spend on public services, as well as how to use revenues such as taxes, fees, charges, and debt financing arrangements (Bahl et al., 1992). This provides an open mechanism for local governments to increase autonomy in resource allocation, and use resources in ways more closely aligned to local priorities, realities and social welfare (Oates, 2005). In theory, there are three methods of performing those expenditure tasks taken by local governments, including: i) Two-tier local governance: Local governments have a certain degree of autonomy in deciding how to spend on public services, as well as authority over revenues such as taxes, fees, charges, grants, and debts, while the central government only performs the tasks that the local government cannot undertake or the tasks that are connected between many localities; ii) Single-tier local governance: Some local government functions will be performed through state-owned public companies in order to reduce the effects of economies of scale as well as equity across levels of local government. Moreover, localities are allowed to perform their own expenditure tasks, but some

expenditure tasks will be performed according to standards common to all localities in the country; iii) Unitary governance: As a single unified or tier-coordinated governance, localities carry out their expenditure tasks and at the same time the central government performs tasks oriented towards achieving socio-economic development (Slack, 2007).

Following the two-tier local governance model, Vietnamese local government budgets are allocated in line with spending tasks. The spending scale of local budget levels is fixed according to each spending task in the stable period. Based on the State budget data of the Ministry of Finance, the total local budget expenditure in the total state budget expenditure has increased from 45.8% in 2011 to 56.7% in 2021. Accordingly, an increase in the size of local budgets reflects the transfer of spending duties of the central government to local governments. The advantage of this model is that localities still have autonomy over expenditure and sources of income, and can carry out their tasks in line with local realities (Shah, 2012). To be precise, the positive impacts of expenditure-based fiscal decentralization on the expenditure performance index of Vietnamese provinces are presented through three aspects as following:

1) Provinces are fully responsible for spending on infrastructure, health, and education. To be precise, ¥localities must be proactive in making a spending plan and allocating budgets for activities such as managing and operating schools, hospitals, and roads. This encourages them to be more proactive and creative in their activities. Some typical examples include Ho Chi Minh City which is responsible for managing and operating the school and hospital system in the city, Binh Duong province which proactively allocates the budget to repair inter-commune roads, rural schools, and build mobile medical stations, and Da Nang city which is in charge of mobilizing capital and financing operations of central general hospitals and as well as investing in upgrading school facilities according to the actual conditions of each district.
2) Expenditure-based fiscal decentralization allows localities to implement a democratic financial model through dialogues with citizens, whereby citizens can present their needs and give opinions on investment projects. Citizens' proposals will be considered, selected, and funded for implementation by provinces. So, this is a way for people's voices to be heard in the process of developing local public investment plans, from which local authorities will grasp actual needs to make appropriate spending decisions. For example, the Hanoi People's Committee annually organizes dialogues between local authorities and citizens to get opinions on priority needs and public investment projects. Ho Chi Minh City builds and manages a portal to receive direct feedback from people about local projects. The People's Council of da Nang City organizes meetings with voters to discuss the master plan, identify potential issues and projects. This transparency helps strengthen the accountability of local governments, helping them allocate capital more appropriately to community needs.
3) According to current regulations in Vietnam, the Government mainly spends on national fields (such as national defense, security, foreign affairs, justice, higher education, and specialized healthcare, national transportation), and a number of social security activities. At the same time, through the annual central budget

fund decentralization, the Government shares budget with localities to support them to finance local socio-economic development activities.

Secondly, financial autonomy (FDFA) has no impact on the expenditure performance index of provinces. This research result is consistent with the findings of Huther and Shah (1998) in 80 countries and Fisman and Gatti (2002) in 65 countries who argue that the financial autonomy mechanism only has an impact on the expenditure performance of local governments if they have more rights to make decisions related to revenue allocation. These scholars believe that the above-mentioned conditions motivate local governments to reform institutions, improve transparency, and reduce corruption, as well as to try to better mobilize resources to meet their spending needs (Huther and Shah, 1998; Fisman and Gatti, 2002; Oates, 2008).

In theory, local fiscal autonomy is the extent to which local governments rely on locally raised revenues for funding (rather than receiving transfers from federal or provincial governments) and on their ability to set their own tax rates (Slack, 2017). In Vietnam, the degree of autonomy of local authorities in budget management is shown through the powers and responsibilities of local government in promulgating policies and regimes on the state budget, in the implementation of the budget cycle. Although local authorities in Vietnam are assigned some revenue sources, they still basically depend on the superior budget. In addition, although revenue sources are considered to belong to the local budget, the local government only has the right to manage but does not really have the right to make budgetary decisions. Besides this, the financial autonomy of local governments in Vietnam has certain limitations. Moreover, there is a mismatch between the spending tasks and assigned revenue sources which occur in most provinces, which primarily stems from the fact that decentralization of public service spending tasks is highly encouraged although the primacy of centralized revenue remains. According to the State budget's report of the Ministry of Finance (2022), only 15 out of 63 provinces can balance their budgets. In addition, regional inequality or horizontal budget imbalance is quite stark. For instance, some poor provinces such as Yen Bai, Ha Giang, Lai Chau, and Son La always provide public services of low quality. It is believed that these are socio-economically underdeveloped localities. The provision of basic public services in these localities depends on subsidies from superior budgets. However, the balance additions are mainly to cover the operating costs of local service providers, while the target additions are made according to the objectives of the central government and sometimes do not meet the needs of the localities. Furthermore, decentralization of some spending tasks to the local budget is ineffective (Bui and Le, 2022). For example, the assignment of responsibility for social security and price subsidies to local budgets increases the spending burden on decentralized budget levels, and then makes it difficult to ensure equity among localities.

Finally, several control variables have an impact on the expenditure performance index of provinces. To be precise, population has a negative impact on the expenditure performance index of provinces, while provincial literacy and size of private sector positively affect the expenditure performance index of provinces.

In terms of the impact of population on the expenditure performance of local governments, it can be seen that this finding fully supports the research results of

Fisman and Gatti (2000). In fact, in some provinces with a large population, the need for public services is always very high, leading to poor quality of public services and significant challenges for local leaders (Backoff et al., 1993). Therefore, Vietnam is planning to merge localities that are not eligible in terms of population or area to enhance the efficiency of local governments and increase the level of decentralization. Moreover, the larger the local population, the more responsibilities and powers are assigned, contributing to improving the efficiency of providing public services to the people (Nguyen and Le, 2017).

As regards to the effect of provincial literacy on the expenditure performance of local governments, it can be seen that this finding entirely supports the research results of Fisman and Gatti (2000). In fact, the literacy level shows that people's understanding of law, culture, society, economy, science, engineering, and technology is increasingly improved (Bird et al., 1995). Therefore, when participating in work related to state management, people with high levels of literacy can easily and quickly grasp the administrative processes and procedures prescribed by law. Furthermore, their participation requires higher quality planning which is more responsive to citizens' requirements (Bird et al., 1998). Simultaneously, such participation can reduce barriers between the government and local people, enabling the formation of partnerships between them (Manor, 1997). In particular, local people of high educational levels contribute to an increase in the responsibility of local authorities (Rondinelli et al., 1984). In front of people with high levels of education, local leaders seem to be more careful when being required to explain their actions or justify measures taken by them.

Concerning the impact of the private sector on the expenditure performance of local governments, this paper shows that the increase in the size of the private sector leads to an increase in the local expenditure index. This finding fully supports the research results of Porcelli (2005) and Adam et al. (2008). In fact, the private sector plays an important role in local economic growth. The scale and diversity of the private sector strongly influence overall financial flows into the economy of localities. The Department of Foreign affairs and Trade (2014) argued that higher private investment is associated with faster-growing economies. Moreover, a large private sector also points to greater dynamism and responsibility of local government leaders. Liu (2018) shows that an open business operating environment with attractive incentives offered by local governments can facilitate more investment from the private sector. With the dynamism of local government leaders bolstered by investment attraction policies, investment activities from private organizations have significantly stimulated the development of local small and medium enterprises and the process of industrialization, thereby contributing to improvement of the operational efficiency of the government and local socio-economic development. Furthermore, the development of the private sector challenges the quality of public services. According to PCI's survey (2021), in order to receive the support of the private sector, localities need to continue to strongly reform administrative procedures, especially business licensing procedures, administrative procedures on land, and favorable land access. In addition, local authorities need to try to minimize administrative procedures for issues such as tax, fire prevention, import and export, investment registration, and social insurance because there are still a large proportion of enterprises that experience

significant administrative difficulties. Local authorities also need to create more favorable conditions for businesses in carrying out procedures for implementing investment projects with construction works, namely building permits, fire prevention and control appraisal, environmental impact assessment, etc. The fight against corruption needs to continue to be promoted, especially in a number of areas such as import and export, inspection, court proceedings, and administrative procedures for land.

6. Conclusions

By using FGLS with Vietnamese 63 province-level datasets from 2012 to 2021, this paper shows a positive effect of expenditure-based fiscal decentralization on the expenditure performance index of local governments in Vietnam. To the best of our knowledge, as the first quantitative study about the relationship between fiscal decentralization and the performance of local expenditure, this research has important theoretical and practical contributions.

In terms of theory, this paper contributes to verify theories of fiscal decentralization by providing evidence on the positive impact of expenditure-based fiscal decentralization on the expenditure performance in Vietnamese provinces. Furthermore, the study tries to build a local expenditure performance index based on Principal Component Analysis (PCA).

As regards to practical aspects, this paper argues that fiscal decentralization is necessary to improve the performance of local expenditure in Vietnamese provinces. Therefore, some policy implications on fiscal decentralization to improve the expenditure performance of local government include: i) Decentralization of budget expenditures means not only an increase in the size of expenditure but also an appropriate spending allocation in line with the tasks allocated to each level of government; ii) Improving the vertical budget imbalance by decentralizing revenue sources in line with assigned spending tasks, and/or reducing spending responsibilities by transferring them back to higher authorities in case of non-efficiency; iii) Increasing the autonomy of local government budgets by giving local governments more rights to make decisions over allocated revenue; and iv) Improving the capacity of the administrative apparatus at all levels of local government and controlling public spending of local governments.

Beside the above-mentioned contributions, this paper still has certain limitations. The first one stems from the proposed model, which does not account for the lagged effects of fiscal decentralization on the expenditure performance of provinces. The second concern is the endogenous problem of fiscal decentralization's impact on local expenditure performance not having been addressed yet. Finally, the data is not fully up to date, as the settlement of local budgets in 2022 will not be released until 2024 after being approved by the National Assembly. These gaps are expected to be filled in future studies.

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Appendixes

Appendix A. Expenditure performance index of provinces (EPI)

Table A1. PCA table output (Source: Results extracted from EViews).

Principal Components Analysis					
Date: 03/10/23 Time: 08:51					
Sample: 1500					
Included observations: 500					
Computed using: Ordinary correlations					
Extracting 3 of 3 possible components					
Eigenvalues: (Sum = 3, Average = 1)					
Number	**Value**	**Difference**	**Proportion**	**Cumulative value**	**Cumulative proportion**
1	1.409177	0.419685	0.4697	1.409177	0.4697
2	0.989492	0.388160	0.3298	2.398669	0.7996
3	0.601331	-	0.2004	3.000000	1.0000
Eigenvectors (loadings):					
Variable	**PC 1**	**PC 2**	**PC 3**	**-**	**-**
GRDP	−0.289791	0.923198	0.252442	-	-
PCI	0.702263	0.025900	0.711446	-	-
QPS	0.650267	0.383452	−0.655833	-	-
Ordinary correlations:					
	GRDP	**PCI**	**QPS**	**-**	**-**
GRDP	1.000000	-	-	-	-
PCI	−0.155123	1.000000	-	-	-
QPS	−0.014822	0.372765	1.000000	-	-

There are three principal components. The first principal direction explains roughly 46.97% of the information contained in the underlying correlation matrix. The second one explains 38.81%, while the figure for the third one is 20.04%. So, the cumulative proportion of information explains by the first two principal direction is roughly 79.96%. Proportions of variables are calculated in **Table A2** as follows:

Table A2. Proportions of variables (Source: Results extracted from EViews).

Component	**Variables**	**Eigenvectors**	**Proportions of the overall direction length**
1	GRDP	−0.289791	8.40%
	PCI	0.702263	49.32%
	QPS	0.650267	42.28%
2	GRDP	0.923198	85.23%
	PCI	0.025900	0.07%
	QPS	0.383452	14.70%
3	GRDP	0.252442	6.37%
	PCI	0.711446	50.62%
	QPS	−0.655833	43.01%

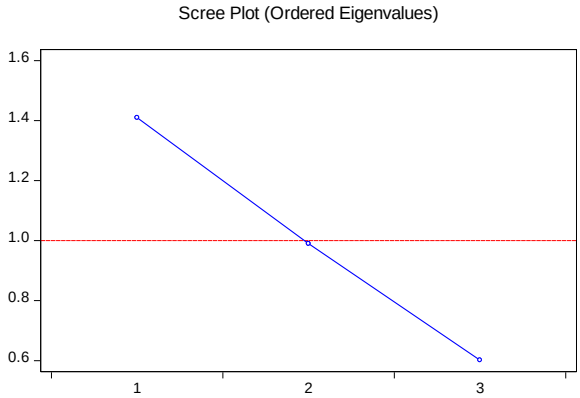

Figure A1. Eigenvalue plots output (Source: Results extracted from EViews).

From the plot, it is evident that a kick occurs at the second eigenvalue, indicating that we should retain the first two eigenvalues. In addition, this conclusion is supported by the PCA table output where the average of the eigenvalues is 1, and the second eigenvalue is just below this cut-off. Since the second value is so close to this average, it is safe to conclude that the scree plot analysis indicates that only the first two eigenvalues ought to be retained.

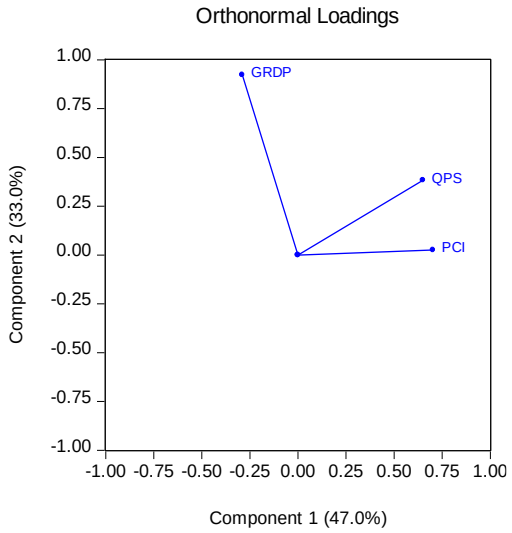

Figure A2. Variable loading plots output (Source: Results extracted from EViews).

It can be seen that PCI and QPS are moderately positively correlated while QPS and GRDP, PCI and GRDP are nearly negative correlation since they form a degree angle of more than 90. The above chart is a two-dimensional graphical representation of the three-dimensional correlation matrix. Furthermore, variables PCI and QPS, are strongly correlated with the first principal direction, whereas GRDP is strongly correlated with the second principal direction.

Table A3. Components (Source: Results extracted from Eviews).

	Component		**Eigenvalues**		**Weights**	
	1	**2**	**1**	**2**	**Absolute**	**Percent**
GRDP	−0.289791	0.923198	1.409177	0.989492	1.321864	36.39%
PCI	0.702263	0.0259	1.409177	0.989492	1.015241	27.95%
QPS	0.650267	0.383452	1.409177	0.989492	1.295764	35.67%
Total weight					3.632869	-

The first principal component with an eigenvalue of 1.4 (which is bigger than 1) is retained. Then, the eigenvalue is multiplied with the respective varimax rotated component. Adding up the resultant values give the weights of the respective dimension. For calculation of the weighted dimensional index and the value of the expenditure performance index for a particular province, the normalized valued of each dimension is then multiplied by its respective percentage point weightage and summed up in **Table A4**:

Table A4. Principal component analysis for weight construction (Source: Results extracted from Eviews).

	Component	**Eigenvalues**	**Weights**	
			Absolute	**Percent**
GRDP	−0.2898	1.409177	0.408367	17.65%
PCI	0.70226	1.409177	0.989613	42.76%
QPS	0.65027	1.409177	0.916341	39.59%
Total weight			2.314321	100.00%

Appendix B. Correlation matrix, multicollinearity analysis and unit root test

Table B1. Correlation matrix (corr EPI FDEX FDFA PPL LTR PRS).

	EPI	**FDEX**	**FDFA**	**PPL**	**LTR**	**PRS**
EPI	1	-	-	-	-	-
FDEX	0.3628	1	-	-	-	-
FDFA	−0.0302	−0.0355	1	-	-	-
PPL	0.2912	0.8928	−0.0643	1	-	-
LTR	0.2845	0.2284	0.0627	0.2924	1	-
PRS	0.0275	−0.0159	−0.0179	−0.0125	0.0185	1

Table B2. Multicollinearity analysis (reg EPI FDEX FDFA PPL LTR PRS vif).

Variable	**VIF**	**1/VIF**
PPL	5.18	0.193061
FDEX	4.97	0.201064
LTR	1.11	0.901444
FDFA	1.02	0.985157
PRS	1.00	0.998813
Mean VIF	2.66	-

Table B3. Fisher-type unit-root tests.

Variables	**Level**		**1st difference**	
	Inverse *Chi*^{2}	**Sig.**	**Inverse *Chi*^{2}**	**Sig.**
EPI	255.0937***	0.000	661.8751***	0.000
FDEX	285.0826***	0.000	458.8955***	0.000
FDFA	367.6264***	0.000	717.1035***	0.000
PPL	131.7980	0.2175	260.5598***	0.000
LTR	297.4254***	0.000	674.2026***	0.000
PRS	285.2999***	0.000	544.2557***	0.000

Note: The sign *, ** and *** represents significance at 10%, 5% and 1% level of significance, and values within parenthesis represent standard errors.

Appendix C. Regression test

1) FDEX and EPI

OLS:

Source	SS	df	MS	Number of obs	=	509
				F(4, 504)	=	29.36
Model	.06514909	4	.016287273	Prob > F	=	0.0000
Residual	.279579679	504	.000554722	R-squared	=	0.1890
				Adj R-squared	=	0.1825
Total	.344728769	508	.0006786	Root MSE	=	.02355

EPI	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDEX	1.41464	.2315853	6.11	0.000	.9596483	1.869631
PPL	-.4708955	.1616869	-2.91	0.004	-.7885589	-.1532322
LTR	.0913528	.016236	5.63	0.000	.0594541	.1232515
PRS	.008185	.0115143	0.71	0.478	-.014437	.030807
_cons	.2110012	.0150402	14.03	0.000	.1814519	.2405504

Figure C1. reg EPI FDEX PPL LTR PRS EST STO OLS1.

FEM:

xtreg EPI FDEX PPL LTR PRS, fe est sto fe1

```
Fixed-effects (within) regression               Number of obs      =       509
Group variable: MH                              Number of groups   =        63

R-squared:                                      Obs per group:
     Within  = 0.0524                                         min =         1
     Between = 0.1672                                         avg =       8.1
     Overall = 0.1024                                         max =        10

                                                F(4,442)           =      6.10
corr(u_i, Xb) = -0.6646                         Prob > F           =    0.0001
```

EPI	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDEX	.009166	.3135512	0.03	0.977	-.6070705	.6254025
PPL	.3159757	1.214267	0.26	0.795	-2.070479	2.70243
LTR	.3122753	.0904676	3.45	0.001	.1344751	.4900754
PRS	.0526434	.0170448	3.09	0.002	.0191444	.0861424
_cons	-.0041162	.0861161	-0.05	0.962	-.173364	.1651317
sigma_u	.02332653					
sigma_e	.01917155					
rho	.59684287	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(62, 442) = 5.14                     Prob > F = 0.0000
```

Figure C2. xtreg EPI FDEX PPL LTR PRS, fe est sto fe1.

REM:

```
Random-effects GLS regression                   Number of obs     =        509
Group variable: MH                              Number of groups  =         63

R-squared:                                      Obs per group:
     Within  = 0.0274                                         min =          1
     Between = 0.2895                                         avg =        8.1
     Overall = 0.1633                                         max =         10

                                                Wald chi2(4)      =      41.52
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000
```

EPI	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDEX	.6925114	.2722321	2.54	0.011	.1589462	1.226077
PPL	-.0576613	.2153761	-0.27	0.789	-.4797907	.3644681
LTR	.1088415	.0284206	3.83	0.000	.053138	.1645449
PRS	.0325723	.0142615	2.28	0.022	.0046204	.0605243
_cons	.1897169	.0260834	7.27	0.000	.1385943	.2408394
sigma_u	.01287612					
sigma_e	.01917155					
rho	.31085906	(fraction of variance due to u_i)				

```
.
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        EPI[MH,t] = Xb + u[MH] + e[MH,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                     EPI |   .0006786         .02605
                       e |   .0003675        .0191716
                       u |   .0001658        .0128761

        Test: Var(u) = 0
                                  chibar2(01) =   138.31
                              Prob > chibar2 =   0.0000
```

Figure C3. xtreg EPI FDEX PPL LTR PRS, re xttest0.

2) FDFA and EPI

OLS:

Source	SS	df	MS	Number of obs	=	509
				F(4, 504)	=	18.79
Model	.0447377	4	.011184425	Prob > F	=	0.0000
Residual	.29999107	504	.00059522	R-squared	=	0.1298
				Adj R-squared	=	0.1229
Total	.344728769	508	.0006786	Root MSE	=	.0244

EPI	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDFA	-.1100582	.1583889	-0.69	0.487	-.421242	.2011256
PPL	.4006749	.0775689	5.17	0.000	.2482766	.5530732
LTR	.0848644	.0168324	5.04	0.000	.0517941	.1179347
PRS	.0073825	.0119293	0.62	0.536	-.0160549	.0308199
_cons	.217627	.0155393	14.00	0.000	.1870973	.2481567

Figure C4. reg EPI FDFA PPL LTR PRS EST STO OLS2.

FEM:

```
Fixed-effects (within) regression               Number of obs     =       509
Group variable: MH                              Number of groups  =        63

R-squared:                                      Obs per group:
     Within  = 0.0524                                         min =         1
     Between = 0.1664                                         avg =       8.1
     Overall = 0.1020                                         max =        10

                                                F(4,442)          =      6.10
corr(u_i, Xb) = -0.6643                         Prob > F          =    0.0001
```

EPI	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDFA	-.0019415	.1708993	-0.01	0.991	-.3378176	.3339346
PPL	.318143	1.213706	0.26	0.793	-2.067209	2.703495
LTR	.3122553	.0904703	3.45	0.001	.1344499	.4900608
PRS	.0526435	.0171537	3.07	0.002	.0189305	.0863565
_cons	-.0040324	.0860981	-0.05	0.963	-.1732448	.1651801
sigma_u	.02333165					
sigma_e	.01917157					
rho	.59694812	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(62, 442) = 6.04                     Prob > F = 0.0000
```

Figure C5. xtreg EPI FDFA PPL LTR PRS, fe EST STO fe2.

REM:

```
Random-effects GLS regression                   Number of obs     =       509
Group variable: MH                              Number of groups  =        63

R-squared:                                      Obs per group:
     Within  = 0.0467                                         min =         1
     Between = 0.1846                                         avg =       8.1
     Overall = 0.1185                                         max =        10

                                                Wald chi2(4)      =      31.02
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

EPI	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDFA	-.0769651	.1583552	-0.49	0.627	-.3873356	.2334055
PPL	.3463841	.1610876	2.15	0.032	.0306583	.66211
LTR	.1154613	.032697	3.53	0.000	.0513763	.1795462
PRS	.0380309	.0147895	2.57	0.010	.009044	.0670178
_cons	.1830483	.0299484	6.11	0.000	.1243506	.2417461
sigma_u	.01600958					
sigma_e	.01917157					
rho	.41084269	(fraction of variance due to u_i)				

```
.
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        EPI[MH,t] = Xb + u[MH] + e[MH,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                     EPI |    .0006786         .02605
                       e |    .0003675        .0191716
                       u |    .0002563        .0160096

        Test: Var(u) = 0
                                  chibar2(01) =   210.00
                              Prob > chibar2 =   0.0000
```

Figure C6. xtreg EPI FDFA PPL LTR PRS, re xttest0 EST STO re2.

Appendix D. Hausman and Breusch-Pagan LM tests

1) FDEX and EPI

	Coefficients (b) fe1	(B) re1	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDEX	.009166	.6925114	-.6833454	.1555765
PPL	.3159757	-.0576613	.373637	1.195014
LTR	.3122753	.1088415	.2034338	.0858875
PRS	.0526434	.0325723	.0200711	.0093347

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

Test of H0: Difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 30.18
Prob > chi2 = 0.0000

Figure D1. Hausman fe1 re1 (Breusch-Pagan LM).

2) FDFA and EPI

	Coefficients (b) fe2	(B) re2	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDFA	-.0019415	-.0769651	.0750236	.0642664
PPL	.318143	.3463841	-.0282411	1.202969
LTR	.3122553	.1154613	.196794	.0843551
PRS	.0526435	.0380309	.0146126	.0086903

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

Test of H0: Difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 10.72
Prob > chi2 = 0.0300

Figure D2. Hausman fe2 re2 (Breusch-Pagan LM).

Appendix E. PCSE and FGLS estimators to deal with issues of cross-sectional data

1) FDEX and EPI

Heteroskedasticity issue:

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (63)  =     650.58
Prob>chi2 =      0.0000
```

Figure E1. xtreg EPI FDEX PPL LTR PRS, fe xttest3.

There exists heteroskedasticity because *P*-value of Chi^2 is smaller than 0.05.

Autocorrelation:

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      59) =      7.372
           Prob > F =      0.0087
```

Figure E2. xtserial EPI FDEX PPL LTR PRS.

There exists autocorrelation because *P*-value of Chi^2 is smaller than 0.05. ≥ FGLS is applied to deal with above-mentioned issues.

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   no autocorrelation

Estimated covariances      =        63          Number of obs     =        509
Estimated autocorrelations =         0          Number of groups  =         63
Estimated coefficients     =         5          Obs per group:
                                                            min =          1
                                                            avg =   8.079365
                                                            max =         10
                                                Wald chi2(4)      =     126.62
                                                Prob > chi2       =     0.0000

------------------------------------------------------------------------------
         EPI | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
        FDEX |   1.372295   .2570396     5.34   0.000     .8685071    1.876084
         PPL |  -.3443913   .1528592    -2.25   0.024    -.6439899   -.0447928
         LTR |   .0777795    .014111     5.51   0.000     .0501223    .1054366
         PRS |   .0161898   .0083097     1.95   0.051     -.000097    .0324766
       _cons |   .2187375   .0125807    17.39   0.000     .1940798    .2433952
------------------------------------------------------------------------------
```

Figure E3. xtgls EPI FDEX PPL LTR PRS, panel(hetero) EST STO GLS1.

2) FDFA and EPI

Heteroskedasticity issue:

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (63)  =    3.8e+30
Prob>chi2 =      0.0000
```

Figure E4. xtreg EPI FDFA PPL LTR PRS, fe xttest3.

There exists heteroskedasticity because *P*-value of Chi^2 is smaller than 0.05.

Autocorrelation:

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      59) =      7.236
           Prob > F =      0.0093
```

Figure E5. xtserial EPI FDFA PPL LTR PRS.

There exists autocorrelation because *P*-value of Chi^2 is smaller than 0.05. ≥ FGLS is applied to deal with above-mentioned issues.

```
Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   no autocorrelation

Estimated covariances      =        63          Number of obs     =        509
Estimated autocorrelations =         0          Number of groups  =         63
Estimated coefficients     =         5          Obs per group:
                                                              min =          1
                                                              avg =   8.079365
                                                              max =         10
                                                Wald chi2(4)      =     132.62
                                                Prob > chi2       =     0.0000
```

EPI	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDFA	-.0912579	.1147145	-0.80	0.426	-.3160941	.1335784
PPL	.4080637	.0545381	7.48	0.000	.301171	.5149564
LTR	.0745961	.0140693	5.30	0.000	.0470207	.1021714
PRS	.0167627	.0086735	1.93	0.053	-.0002371	.0337624
_cons	.2223389	.0125682	17.69	0.000	.1977056	.2469722

Figure E6. xtgls EPI FDFA PPL LTR PRS, panel(hetero) EST STO GLS2.