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Does the Sustainable PPI Investments Promote Financial Market's Sustainable Development?

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Abstract: Since the late 1980s, most developing countries adopt a policy of attracting investments for Private Participation in Infrastructure (PPI) projects. With a perspective of sustainability, this paper offers a first attempt to examine whether the sustainable PPI investments promote financial market development. First, we demonstrate how the PPI policy enlargers the size of financial markets and then fosters the liquidity of financial markets in the static and dynamic conditions. Using the data from 33 developing countries during 1997–2012, we discover the significant promotion effect of PPI investments on the development of financial markets in the dimensions of size and liquidity. Additionally, we confirm the significant mediator effect of financial market size for the positive relationship between PPI investments and financial market liquidity. Both the promotion effect and mediation effect are robust to different control variables and estimation techniques used.

Keywords: sustainable investments; private participation in infrastructure; sustainable financial market development

1. Introduction

Since the late 1980s, most developing countries adopt a variety of Private Participation in Infrastructure (PPI) programs. Referring to Environmental, Social and Governance (ESG) criteria suggested by recent sustainability literature [1–5], both PPI investments and financial markets development (hereafter FMD) are sustainable (discussed in the second section). With a sustainability perspective, this paper studies whether the PPI investments promote FMD. However, some evidence suggests that governmental policies are unsustainable [6–8] and that sustainable investments do not spur sustainable development [9]. To examine the promotion effect, this paper first demonstrates the theoretical effect of the PPI policy on financial markets in the static and dynamic conditions. With historical data, we then provide objective evidence of the positive relationship between PPI investments and FMD. To the best of our knowledge, we offer a first attempt to examine the promotion effect of the sustainable PPI investments on the sustainable development of financial markets. Given that PPI investments and financial market development are sustainable, we omit the term of sustainability (or sustainable) hereafter unless otherwise especially emphasized.

This paper is motivated by the fact that the PPI policy attracts a large amount of investment capital into financial markets of developing countries. As discovered by Fu [10], 24.457% (13.078%) of PPI investments are larger than foreign direct investment (FDI) in 109 developing countries during 1984–2007. Namely, PPI investments can be significant for financial markets as FDI (for economic growths) are concerned (FDI [11] and inflation [12] are regarded as independent variables

for FMD).This paper is also motivated by the poor explanation of economic theories for PPI programs. The existing industrial economics cannot explain the surge of PPI investments in developing countries. Many industrial economists have been "flirting with the idea of PPI and often owed to it" [13], but the efficiency gains of the PPI policy are "neither systematic nor guaranteed" in reality [14]. Most relevant works explicitly or implicitly assume that the privatization policy improves industrial efficiency [15–20]. Therefore, the existing literature cannot explain why the PPI policy is prevalent though its efficiency is controversial.

In contrast with the traditional government procurement, a PPI policy attracts investment capitals into the financial market. In a static condition, PPI investments necessarily enlarge the size of financial markets and improve the liquidity of financial markets. To describe the promotion effect of PPI policy in a dynamic condition, we follow the framework of Perotti and Laeven [21] to explain how the PPI policy establishes the government credibility and then builds the confidence of shareholders.

We use three empirical approaches to deal with the above mentioned concerns. First, we include the fixed effects of country and time in estimation to account for un-measurable country characteristics and common shocks across countries, respectively. Second, to address the potential heteroskedasticity and auto-correlation issue, we estimate the same equations with robust standard errors. Third, we conduct instrumental variable (hereafter, IV) estimations to address the endogeneity issues. We net out the country-specific component to yield a measure of PPI investments that only depends on the underlying characteristics inherent to the particular year and legal origin. Precisely, our instrument variable is the average of PPI investments within other countries at the same year *and* with the same legal origin. To lessen the concern of reverse causality, we lag all independent variables one period in IV estimations. We provide evidence of the significant promotion effect and mediation effect, irrespective of different control variables and estimation techniques used.

The paper is structured in six sections. Section 2 reviews the existing literature and illustrates our contributions. Section 3 demonstrates the promotion effect and mediation effect. Section 4 introduces our data and empirical methodology. Section 5 reports the estimation results and Section 6 presents the conclusions.

2. PPI in Developing Countries

Scholars expect an investment increase due to PPI policy, but overlook the promotion effect of sustainable PPI investments on FMD. The following explains the overlook, then introduces the sustainability perspective for PPI investments and FMD and finally illustrates our contributions.

2.1. The Gap in the Existing Literature

First, most sustainability scholars focus on social behavior or policies that directly impact ecological systems, e.g., the issue concerning resource consumption, carbon dioxide emissions [22,23] or waste recycling [24,25]. However, not only sustainable investments [26–28] but also the market share of sustainable investments [29] has been increasing at a fast pace in recent years. Some investors realize the relevance of sustainability for capital markets [30], but no academic works study the effect of sustainable investments on financial markets.

Second, a number of industrial economists analyze how the industrial behavior is affected by the particular types of private participation, including the privatization issue, Public Private Partnerships issue and concession issue (According to PPIAF [31], there is a fourth type of private participation, management & lease contract. However, the management & lease contract is equal to concession contract when it does not involve the construction of projects; otherwise, it equals actually Public Private Partnerships). However, the private participation literature ignores the effect of PPI on financial markets. Estache [13] explains the history of PPI, whereas Estache and Philippe [14] summarize the lessons of PPI in developing countries. The performance of PPI programsis qualitatively studied [32–34] or quantitatively assessed [35], but the corresponding findings are limited in the particular infrastructure sectors such as electricity.

Third, financial or development economists uncover the sources of FMD, but overlook PPI investments. Financial economists have studied the link between FMD and GDP [36–38]. Development economists have investigated multiple types of capital inflow for financial sector development, e.g., FDI [11], official aids [39] and portfolio investments [40]. Boutchkova and Megginson [15] examine the legal environment effect on stock market development, but no attention is paid on whether the corresponding investments promote FMD.

2.2. A New Perspective: Sustainable Investments and Sustainable Development

Estache [13] points out that a PPI policy is adopted in developing countries because there are outcomes expected as follows.

> Contribution to fiscal stabilization, increased investments, improved efficiency from a more competitive environment, contribution to growth, better access and affordability for residential users and improved governance.

Where fiscal stabilization and growth are macroeconomic benefits and the other expected outcomes reflect the micro performance. Both of these expected outcomes expose the properties of PPI investments. Combining the properties with the historical background, the PPI policy should satisfy ESG criteria such that the PPI investments are sustainable investments. The criteria are examined as follows.

First, the PPI policy is initiated in the context of reforms that generate unemployment or other negative macro-economic effects [13]; hence, fiscal stabilization and growth mentioned above contribute to social stability. The social criterion is satisfied. Second, increased investments need to ensure improved efficiency and governance. In fact, PPI programs are launched in developing countries when the efficiency of public service is severally criticized [13]. Therefore, the governance criterion is satisfied. Third, "better access and affordability for residential users" actually require the investments to satisfy the basic needs of the public. To satisfy the basic needs, the PPI policy generates the positive macro performance, but PPI investments cannot be the driving force of economic growth. In other words, the increased and improved public service need to consume some natural resources, but it is difficult to imagine how the basic needs over-consume the natural resources such that the ability of the next generation to obtain their basic needs is compromised.

Recalling that PPI investments are attracted to address the poor service quality and service deterioration that are the norm in many developing countries [41], nobody will suspect that PPI investments may disobey the requirement of sustainable development. When the present generation may not meet the public services, the PPI policy almost has no possibility to compromise the future generation's ability to meet their basic needs. More practically and reasonably, the potential detriment of PPI investments on ecological systems should be reduced because the infrastructure industry before a PPI policy is operated by governments with the lack of transparency and damaging political interference [42]. Therefore, PPI investments at least have the relative advantage of satisfying the ecological criterion than the public funds.

Despite PPI investments, FMD satisfies ESG criteria suggested by sustainability literature [1–5]. Unlike real economy, the development of financial markets has no causal impact on ecological systems. Equity issuing and transactions in financial markets do not violate ESG criteria. Intrinsically, there is no reason to say that the present generation over-develops financial markets such that the future generation cannot develop financial markets any more. In fact, if a development indicator is measured for social behavior, it must consider the sustainability requirement; otherwise it measures growth instead of development. This paper uses standardized measures in the existing literature on the development of financial markets; the sustainability of FMD should be naturally satisfied.

2.3. Our Contribution

To test the promotion effect of PPI policy on sustainable FMD, we include investments due to all types of private participation (The previous works only focus on one particular form of private participation). Moreover, considering that previous scholars measure the privatization policy by the number of privatized firm, ignoring (or overlooking) the scale difference across the firms. We measure the private participation by the investment size, avoiding the heterogeneity issue.

Our paper confirms the promotion effect of PPI investments on financial markets. For one thing, our work offers a first attempt to study the effect of sustainable investments on financial markets. For another, given that sustainable FMD is significant for macroeconomic performance, e.g., economic growth or development [36–38], the promotion effect explains why most developing countries actively attract PPI investments although the efficiency of private participation (In fact, the negative feedbacks can be found in any particular type of private participation (see [43] for privatization, see [44] for Public Private Partnerships and see [45–47] for concession))is controversial [14].Comparing with the traditional perspective for economic efficiency, the sustainability perspective for FMD conforms more closely to reality. Most relevantly, several scholars study the effect of privatization policies on FMD [16–19], but they explicitly or implicitly assume that the privatization policy improves industrial efficiency. Their findings are un-robust to the potential inefficiency of private participations.

FMD is measured in the dimension of size or liquidity. Despite confirming the promotion effect on financial market size and financial market liquidity, we uncover the mediation effect of financial market size for the relationship between PPI investments and financial market liquidity. The significance of mediation mechanism illustrates the PPI policy first enlarges financial market size and then fosters financial market liquidity as we expect.

3. PPI Investments and FMD

Before formulating hypotheses, the following model demonstrates why the PPI policy promotes the credibility of a government for PPI investments and then increases share prices of PPI programs over time.

3.1. The Model

Our model assumes the industrial efficiency is unchanged after introducing private participation. Thus, the promotion effect of PPI investments in this paper is not based on the potential improvement of industrial efficiency.

A government announces the policy of introducing private participation for n infrastructure projects. For simplicity, we assume that every project requiring PPI investments, I, is completed in one period. The discount factor is $\delta < 1$, whereas $\frac{1}{\delta}$ is the inflation factor. Moreover, we follow the assumptions provided by Perotti and Laeven [21] for the framework. First, if the government does not intervene ex post, investors will obtain normal profits. Otherwise, the investors will lose all investments. In other words, the investors will obtain the values of shares I or 0 for investments.

Second, if the government reverses the policy with ex post intervention, despite the investment expropriation, I, the government will benefit from controlling the projects, b. The government requires state-owned-firms to complete the remaining projects for the control benefit, which depends on the size of control. On the other hand, the government will lose the reputation and undertake the financial cost to raise the public fund for the remaining projects. The financial cost for future investments is fc; the reputation loss leads to a political cost. As Perotti and Laeven [21] assume, the political cost is private information of government. Relative to the PPI investments, the political cost, pc, is distributed in the range $[0, \overline{pc}]$. The control benefit and financial cost satisfy the following relationship.

Proposition 1. b $<$ fc for PPI programs.

Proof. A government has three optional strategies for infrastructure projects, (1) continuing to use public fund; (2) introducing private participation with no ex post intervention and (3) introducing private participation but reversing the policy in future periods. For convenience, let X^1, X^2 and X^3 to be these three optional strategies in order. Only when the ex post policy reversal leads to a negative payoff, the government will introduce private participation without ex post intervention. Therefore, investors require the government to promise no intervention in future such that a reputation constraint ensures $X^2 > X^3$. Moreover, the government should obtain more from the strategy of introducing private participation than the strategy of using public fund; namely, $X^2 > X^1$ and $X^3 > X^1$. Otherwise, the government has no incentive to attract PPI investments for infrastructure programs. Combining the above conditions, the government effectively attracts PPI investments only when $X^2 > X^3 > X^1$ at the policy-decision stage. The condition of $X^2 > X^3 > X^1$ is based on $b < fc$. By the way of contradiction, If $b \geqslant fc$, *i.e.*, the benefit of controlling the project is not less than the cost-saving from attracting PPI investments such that $X^1 \geqslant X^2$ (whether $X^1 \geqslant X^3$ or not) or $X^3 \geqslant X^2$ (whether $X^3 \geqslant X^1$ or not), the government either drops attracting PPI investments or intervening private participation ex post. In anticipation of these government decisions, the investors will abandon investments for the PPI programs. Even when the government decides to introduce private participation in infrastructure projects, the government will fail to attract the PPI investments.

Due to the limited public fund and demands for the viable reform [13], the financial cost increases over time in developing countries and the political benefit decreases. Proposition 1 conforms to reality.

If the government adopts a policy reversal at period t, he will obtain the payoff as

$$R_t^{gi} = \sum_{j=1}^{j=t} \left(\frac{1}{\delta}\right)^j * I + \sum_{j=t+1}^{j=n} \delta^{j-t} * b * I - \sum_{j=1}^{j=t} \left(\frac{1}{\delta}\right)^j * pc * I - \sum_{j=t+1}^{j=n} \delta^{j-t} * fc * I, \quad t = 1, 2, \ldots, n \tag{1}$$

where the superscript of gi refers to government intervention, which incurs when the government reverses the policy after introducing private participation.

Let $Pr_t = Prob\left\{R_t^{gi} < 0\right\}$; Pr_t is the probability that the government does not reverse his policy at period t. Investors pay shares (equities) for PPI investments as

$$P_t = I * Pr_t + 0 * (1 - Pr_t) = I * Pr_t \tag{2}$$

Proposition 2. A government policy of attracting PPI investments fosters the share prices for the investments over time.

Proof. The government obtains the net payoff described by Equation (1) if he reverses the PPI policy. If the government waits one more period to adopt the policy reversal (*i.e.*, at period $t + 1$), he will obtain the following payoff

$$\begin{aligned} &\delta * \left[(1 - pc) \sum_{j=1}^{j=t+1} \left(\frac{1}{\delta}\right)^j * I + (b - fc) \sum_{j=t+2}^{j=n} \delta^{j-t} * I\right] \\ &= (1 - pc) \sum_{j=0}^{j=t} \left(\frac{1}{\delta}\right)^j * I + (b - fc) \sum_{j=t+3}^{j=n+1} \delta^{j-t} * I \end{aligned}$$

The government will continue encouraging private participation (without the policy reversal) at period t, if

$$\delta R_{t+1}^{gi} - R_t^{gi} = (1 - pc_t)\, I + \left(\delta^{n+1-t} - \delta - \delta^2\right)(b - fc)\, I > 0, \text{or}$$

$$pc_t < 1 - \left(\delta^{n+1-t} - \delta - \delta^2\right)(b - fc) \equiv pc_t^* \tag{3}$$

Thus, Equation (2) is equivalent to the following equation.

$$P_t = I * Pr_t = I * Prob\left\{pc < pc_t^* \left| pc < pc_{t-1}^* \right.\right\} = I * \frac{Prob\left\{pc < pc_t^*\right\}}{Prob\left\{pc < pc_{t-1}^*\right\}} \tag{4}$$

Because the decision at period t is based on that the government does not reverse the policy at period $t-1$, P_t is a function of pc_t^* and pc_{t-1}^*, as shown by Equation (4). Considering the political cost of government is exogenous, the investors expect that $Prob\left\{pc < pc_t^*\right\}$ is independent from $Prob\left\{pc < pc_{t-1}^*\right\}$. Accordingly,

$$P_t = I * \frac{Prob\left\{pc < pc_t^*\right\}}{Prob\left\{pc < pc_{t-1}^*\right\}} = I * \frac{\prod_1^t F\left(pc_t^*\right)}{\prod_1^{t-1} F\left(pc_t^*\right)} = I * F\left(pc_t^*\right) \tag{5}$$

where $F\left(pc_t^*\right)$ is the probability for $pc_t < pc_t^*$, $pc_t \in [0, \overline{pc}]$. Correspondingly, $f\left(pc_t^*\right)$ in following inference is the probability density value.

$$\left.\begin{array}{c} Inequality\ (3):\ pc_t^* = 1 - \left(\delta^{n+1-t} - \delta - \delta^2\right)(b - fc) \\ Equation\ (5):\ P_t = I * F\left(pc_t^*\right) \end{array}\right\}$$

$$\rightarrow \frac{\partial P_t}{\partial t} = f\left(pc_t^*\right)\frac{\partial pc_t^*}{\partial t} = f\left(pc_t^*\right)(b - fc)\left(\delta^{n+1-t} ln^{\delta}\right) I \left.\begin{array}{c} \\ Propostion\ 1: b < fc \\ \delta \in (0,\ 1) \rightarrow ln^{\delta} < 0 \end{array}\right\} \rightarrow \frac{\partial P_t}{\partial t} > 0 \tag{6}$$

Our model demonstrates $\frac{\partial P_t}{\partial t} > 0$ for PPI investments, and it also shows that the positive derivative is not based on the industry-efficiency improvement.

3.2. Hypotheses: Promotion Effects of PPI Investments

In the existing literature, financial market size is measured by the ratio of market capitalization of listed companies expressed as a percentage of GDP [15,17,48,49]. Namely, $Capital = \frac{\sum P_{i,t} Q_{i,t}}{GDP_{i,t}}$, where P_i is the share price level, Q_i is the share quantity and GDP_i is the Gross Domestic Product at period t. Using this standard measure in the existing literature, we expect the promotion effect of PPI investments on financial market size because of the following reasons: First, unlike public funds, PPI investments go into financial markets as a new capital inflow such that they enlarge the financial market size. In other words, The PPI investments enlarge the value of capitalization by increasing $Q_{i,t}$. Second, PPI investments enlarge the capitalization value dynamically by increasing $P_{i,t}$. As our model demonstrates, the PPI investments build the confidence of shareholders and then increase the expected share prices for the investments. In fact, as the signal of government, the promotion effect is not restricted on PPI shares because the government credibility can ensure the sustainable development of the whole financial market.

Hypothesis 1. PPI investments in the developing countries are positively related to financial market size.

In the existing literature, financial market liquidity is measured by the percentage of total value of stocks traded relative to GDP [16,49]. Namely, $Stocks = \sum P_{i,t}^{tr} Q_{i,t}^{tr} / GDP_{i,t}$, where $P_{i,t}^{tr}$ and $Q_{i,t}^{tr}$ are the price and quantity of shares *traded* in the financial market. Unlike the public fund, PPI investments issue new shares in the financial market. Shareholders have more opportunities to improve their risk diversifications. Precisely, if the portfolio of shareholders is $\sum P_{i,j,0}^{tr} Q_{i,j,0}^{tr}, j \in [1, \ldots, N]$ at period 0 (*i.e.*, before PPI investments), the shareholders have different share portfolios as $\sum P_{i,j',t}^{tr} Q_{i,j',t}^{tr}$, $j' \in [1, \ldots, N, \ldots N+M]$, $t \in [1, \ldots, n]$. Namely, after PPI investments, there are M additional

options for share portfolios. Transactions must incur except that the new shares ($P^{tr}_{i,j',t}Q^{tr}_{i,j',t}$, $j' = N+1, \ldots, N+m$) cannot improve risk diversifications for all shareholders. This type of transaction is only based on the risk diversification improvement. Even when all the (potential) shareholders do not expect the share prices to increase, the financial market will become more liquid because of the transaction incurrence.

Moreover, financial market liquidity will be promoted dynamically. According to Equation (5), the share price level of PPI investments, $P_{i,\,t}$ depends on the expectations of shareholders on the political cost of the government. As long as the expectations are not common, some shareholders are willing to hold the shares of PPI programs via transaction to improve their risk portfolios. The expectation difference is satisfied because the political cost is the private information of the government. Therefore, transactions will not stop until all shares of PPI investments are held by the shareholders with the best expectations; all share prices of PPI programs converge to the highest prices, *i.e.*, $P^{PPI}_{i,t+1} \to \overline{P^{PPI}_{i,t+1}}$.

Hypothesis 2. PPI investments in the developing countries are positively related to financial market liquidity.

As mentioned above, PPI investments issue new shares and then increase new share portfolios in financial markets. PPI investments either increase the share quantity or the expected share prices of shareholders, both of which will provide more options for risk diversification and then intrigue equity transactions. Consequently, when PPI investments enlarge financial market size, they also foster financial market liquidity. In other words, PPI investments are expected to positively affect the financial market liquidity by the mediator variable of financial market size.

Hypothesis 3. The mediator effect of financial capitalization is significant for the promotion effect of PPI investments on financial market liquidity.

4. Empirical Methodology and Variables

We empirically examine the relationship between PPI investmentsand FMD by estimating Equations (7) and (8).

$$Capital_{i,t} = \beta_1 PPIG_{i,t} + \beta_2' X_{i,t} + \alpha_i + \gamma_t + \mu_{i,t} \tag{7}$$

$$stocks_{i,t} = \beta_3 PPIG_{i,t} + \beta_4' X_{i,t} + \alpha_i + \gamma_t + \mu_{i,t} \tag{8}$$

Using the data from 33 developing countries over the period 1997–2012, we measure financial market size by the percentage of market capitalization of listed companies to GDP, whereas we measure financial market liquidity by the percentage of stocks traded to GDP. Both of these percentages are standardized measures in the existing literature. Considering that a financial market tends to be more liquid when its size is enlarged [18,20], we also test the mediator effect of financial market size for the relationship between PPI investments and financial market liquidity. To test the promotion effect and mediator effect, we need to consider the endogeneity issue. First, our panel data may omit the properties related to FMD or measure the relevant properties imperfectly. Second, FMD decreases the financial cost of PPI investments, leading to reverse causality.

Theoretically, our data should include all countries such that our findings can be generalized to all the developing countries. However, some developing countries either have no PPI investments or have no data for the dependent variable or control variables. We take full use of all available data to investigate our research question. First, the data collection based on the data availability ensures that the data has no artificial selection bias. Thus, the findings conform more closely to reality. Second, the data collection method based on the data availability can lessen the potential endogenuity issue due to omitted variables. If we include some countries whose data is unavailable for some control variables, the corresponding regression results may be biased due to the variable omitting issue. In fact, this data collection strategy is the common method used in the relevant literature (e.g., Aggarwal *et al.* [39]).

We planned to collect the data in 2015. However, the newest data for PPI investments is only updated to 2012. Our findings are only based on the data from the period 1997–2012, but they are at least robust for the 15-year-period. More interesting, our findings are robust for the period over financial crises in 1998 and 2008. Our finding considers no situation in the last three years, but they are at least robust for those financial crises. This reflects that our findings are robust enough to the external shocks and then our findings are reliable.

As mentioned above, *Capital* is the percentage of market capitalization of listed companies to GDP, whereas *Stocks* is the percentage of stocks traded to GDP. The former percentage reflects financial market size; the latter one represents financial market liquidity (The turnover ratio in the literature [48,50] is also used to measure the liquidity. According to the definition of turnover ratio, $Turnover = \sum P_{i,t}^{tr} Q_{i,t}^{tr} / \sum P_{i,t} Q_{i,t} = Stocks_{i,t}/Capital_{i,t}$, its value reflects the financial market liquidity relative to the financial market size. In other words, the turnover ratio assumes that financial market liquidity is inversely related to financial market size ($Capital_{i,t}$). This assumption is actually rejected by our evidence. Moreover, regressing $Stocks_{i,t}$ but controlling for $Capital_{i,t}$ (our strategy) is better than regressing turnover ratio because the latter strategy does not really control for financial market size). *PPIG* refers to the percentage of PPI investments to GDP. In Equations (7) and (8), i represents the country and t indicates the time period from 1997 to 2012.

Table A1 list developing countries used in this research; Table A1 presents the variable descriptions and data sources. Table 1 reports descriptive statistics and Table 2 presents correlations for the variables used in this research.

Table 1. Descriptive statistics.

Variable	Mean	Min	Max	Std.Dev	Obs
Capitalization to GDP	39.891	0.018	298.99	42.197	519
Stocks traded to GDP	16.837	0	222.999	44.508	519
Turnover	38.212	0	497.403	29.586	514
PPI investments to GDP	1.277	0	15.966	58.576	528
Inflation	4.452	−14.8	33.736	1.646	528
GDP per capital	3229.391	316.746	11,749.75	3.919	522
Foreign trades to GDP	77.392	15.841	220.407	2416.163	528
Remittances to GDP	3.651	0.005	26.675	41.068	513
S and P global equity index	14.462	−82.25	189.23	4.871	475
Lending interest	17.014	4.731	213.018	44.964	507
Legal origin	4.212	2	7	14.743	528

Table 2. Correlationmatrix.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Capitalization to GDP	1										
(2)	Stocks Traded to GDP	0.724	1									
(3)	Turnover	0.137	0.620	1								
(4)	PPI Investments to GDP	0.160	0.111	0.010	1							
(5)	Inflation	0.111	0.204	0.178	0.040	1						
(6)	GDP per Capital	0.129	−0.001	−0.133	−0.210	−0.171	1					
(7)	Foreign Trades to GDP	0.281	0.120	−0.114	0.017	−0.007	0.327	1				
(8)	Remittances to GDP	0.039	−0.071	−0.092	0.148	0.078	−0.219	0.114	1			
(9)	S and PGlobal Equity Index	0.141	0.050	0.051	−0.060	0.165	0.005	−0.053	0.032	1		
(10)	Lending Interest	−0.181	−0.178	−0.132	0.074	−0.247	−0.019	−0.270	−0.194	−0.110	1	
(11)	Legal Origin	0.285	0.158	−0.001	0.043	0.092	−0.312	0.043	0.344	−0.019	−0.289	1

To test the mediator effect between PPI investments ($PPIG$) and financial market liquidity ($Stocks$), we especially control for financial market size ($Capital$) as in the following Equation (9). Intuitively, we will check whether if the coefficient of $PPIG$ will decrease after controlling for $Stocks$.

$$Stocks_{i,t} = \beta_5 PPIG_{i,t} + \beta_6 Capital_{i,t} + \beta_7' X_{i,t} + \alpha_i + \gamma_t + \mu_{i,t} \tag{9}$$

Formally, we will use z-test to judge whether the coefficient decrease is really significant. In particular, z-tests for mediator effect are suggested by Sobel [51], Baron and Kenny [52] and Goodman [53] as follows.

$$z = \frac{\beta_1 * \beta_6}{\sqrt{(\beta_6)^2 * (S_{\beta_1})^2 + (\beta_1)^2 * (S_{\beta_6})^2}} \tag{10}$$

$$z = \frac{\beta_1 * \beta_6}{\sqrt{(\beta_6)^2 * (S_{\beta_1})^2 + (\beta_1)^2 * (S_{\beta_6})^2 + (S_{\beta_1})^2 * (S_{\beta_6})^2}} \tag{11}$$

$$z = \frac{\beta_1 * \beta_6}{\sqrt{(\beta_6)^2 * (S_{\beta_1})^2 + (\beta_1)^2 * (S_{\beta_6})^2 - + (S_{\beta_1})^2 * (S_{\beta_6})^2}} \tag{12}$$

The matrix of X in Equations (7) and (9) represents a group of traditional exogenous variables related to FMD in literature. In our estimations, we control for inflation and GDP per capital. Boyd *et al.* [12] provide evidence of a negative and significant link between inflation and FMD. The inflation indicator is defined by the annual percentage change in the GDP deflator. GDP per capital can proxy for the level of economic development; we control for the effect of economic development on financial market development.

The liberalization has also been shown to generate an impact on the size and liquidity of financial markets [48]. There are two categories of liberation indicators in the existing literature, *de jure* openness and *de facto* openness. The *de jure* openness is indicated by the restriction removals for capital account transactions. Because the regime is always adopted for months instead of years (see [54]), the *de jure* openness cannot be measured objectively (because it is unsuitable to define the dummy variable as either zero or one when the regime is adopted for several months). The *de facto* openness is indicated by the relevant inflow ratios. We control for the ratio of foreign trades (see [40]) to GDP (We do not control for FDI because it includes part of PPI investments).

Moreover, remittances are also controlled in this paper. Aggarwal *et al.* [39] shows that remittances become the second largest source of external finance for developing countries after FDI and they are twice as the amount of official aid received. For FMD, we cannot overlook this capital inflow.

Finally, we control for the lending interest rate and annual percentage change of S and P global equity indices. The former rate represents the domestic investment background in the developing country. A larger lending interest rate witnesses a higher cost of raising fund for investments, but it may also reflect a higher investment demand. The latter indices measure US dollar price changes in the international stock market, thereby reflecting the characteristics of the international financial market.

To examine the relationship between PPI investments and FMD, we first control the fixed effect of country for un-measurable country characteristics and the fixed effect of time for common shocks across countries. The fixed effects lessen the endogeneity bias due to omitted factors. Table 1 shows that the average percentage of PPI investments to GDP is 1.277%, but the standard deviation is 58.576, which indicates a significant heterogeneity across countries. To avoid the influence of heteroskedasticiy and autocorrelation, we run a second round of estimations with robust standard errors and test the mediator effect with the corresponding coefficients.

Third, we further conduct IV estimations and test the mediator effect. We admit that a country with a more developed financial market more likely attracts a larger amount of PPI investments. Moreover, we use foreign trades to GDP to measure the influence of liberalization policies, which may include some data noise. To settle the endogeneity problems, we net out the country-specific

component to yield a measure of PPI investments that only depends on the underlying characteristics inherent to the particular time and legal origin. In particular, we keep the characteristics related to the particular legal origin because the legal origin effectively reflects the institution background [38,55]. As many empirical scholars (e.g., [56,57]) do, we use these two constraints (*i.e.*, in the same year and with the same legal origin) to define the average value of the variable of interest, generating the IV for estimations. Specifically, our instrumental variable ($PPIGiv$) is obtained as the following equation.

$$PPIGiv_i = \frac{\sum_{j=1,\ldots,n;j\neq i} PPIG_j}{n-1} = \frac{\sum_{j=1}^{j=n} PPIG_j - PPIG_i}{n-1},\ i,\ j \in I_{legal\ origin-year} \tag{13}$$

Equation (13) shows the value of $PPIGiv$ for a particular country equals the average value of $PPIG$ within other similar countries (I) in the same year. In particular, the similar countries are defined by the legal origin. For calculating the average value for each country, we abandon the country's value. In this way, we completely nets out the country-specific component. Considering that our IV may be still affected by the dependent variable ($FMD_{i,t}$), we especially lag all independent variable in IV estimations one period. Before Z-test, the regression equations estimated are of the following equation:

$$Capital_{i,t} = \beta_1 \widehat{PPIG}_{i,t-1} + \beta_2 X_{i,t-1} + a_i + \gamma_t + u_{i,t} \tag{14}$$

$$stocks_{i,t} = \beta_1 \widehat{PPIG}_{i,t-1} + \beta_2 X_{i,t-1} + a_i + \gamma_t + u_{i,t} \tag{15}$$

$$stocks_{i,t} = \beta_5 \widehat{PPIG}_{i,t-1} + \beta_6 Capital_{i,t-1} + \beta_7 X_{i,t-1} + a_i + \gamma_t + u_{i,t} \tag{16}$$

where $\widehat{PPIG}_{i,t-1}$ is obtained by estimating $\widehat{PPIG}_{i,t-1} = b_1 PPIGiv_{i,t-1} + b_2 X_{i,t-1} + a_i + \gamma_t + u_{i,t}$.

5. Empirical Results

Columns (1)–(3) in Table 3 report the estimation results of Equations (7)–(9). Table 3 shows that PPI investments have a positive relationship with FMD in the dimension of size or liquidity. A one percentage point increase in the share of PPI investments to GDP is related to 1.653 (2.053) one percentage point increase in the ratio of capitalization (stocks traded) to GDP. Moreover, Table 3 presents that the coefficient of PPI investments to GDP decrease (to only 1.076) after controlling for financial market size measured by the capitalization to GDP. The variable of interest is highly significant and the capitalization to GDP is also significant for explaining stocks traded to GDP.

As expected, the results show that FMD is promoted by the inflation and foreign trades. Moreover, the results confirm a negative effect of remittances and a positive effect of lending interest rate for FMD. The negative effect of remittances shows that remittance received from foreign countries decreases the participation willingness of individuals in their home country, whereas the positive effect of lending interest rate indicates that the lending interest rate mainly reflects the investment demand that fosters FMD. The effects of GDP per capital and S and P global equity indices are not robust, but they are (partially) significant for explaining FMD.

Table 3. Fixed effects estimations with original standard errors.

Method	**OLS with Original Standard Errors**		
Model for Variables	**Size**	**Liquidity**	**Mediator Effect**
	Capitalization to GDP	**Stocks Traded to GDP**	**Stocks Traded to GDP**
	(1)	**(2)**	**(3)**
Capitalization to GDP			0.591 *** (0.037)
PPI investments to GDP	1.653 ** (0.795)	2.053 *** (0.755)	1.076 ** (0.595)
Inflation	0.616 * (0.319)	0.773 *** (0.302)	0.409 ** (0.239)

Table 3. *Cont.*

Method	OLS with Original Standard Errors		
Model for Variables	Size	Liquidity	Mediator Effect
	Capitalization to GDP	Stocks Traded to GDP	Stocks Traded to GDP
	(1)	(2)	(3)
GDP per capital	−5.865 * (3.019)	0.480 (2.869)	3.945 ** (2.26)
Foreign trades to GDP	0.312 *** (0.003)	0.249 *** (0.087)	0.065 + (0.069)
Remittances to GDP	−1.876 *** (0.623)	−1.230 *** (0.592)	−0.101 + (0.470)
S and P global equity indices	0.106 *** (0.029)	0.024 + (0.028)	−0.038 ** (0.022)
Lending interest	0.091+ (0.099)	0.077 + (0.094)	0.023 + (0.073)
Constant	33.678 *** (11.961)	−11.288 + (11.366)	−31.126 *** (9.000)
p-value for F-statistics	0.000	0.000	0.000
R-square	0.0736	0.072	0.435
Observations	460	460	460
Number of countries	33	33	33

T-statistics are given in brackets. +, *, **, or *** denotes the significance at 15%, 10%, 5%, and 1% level, respectively.

To avoid the influence of heteroskedasticity and autocorrelation issue, we further conduct estimation with robust standard errors. Table 4 reports the estimation results and also confirm the positive and significant effect of PPI investments on FMD. Moreover, after controlling financial market size that is significant and positive, the coefficient of PPI investments decreases.

Table 4. Fixed effects estimations with robust standard errors.

Method	OLS with Robust Standard Errors		
Model for Variables	Size	Liquidity	Mediator effect
	Capitalization to GDP	Stocks Traded to GDP	Stocks Traded to GDP
	(1)	(2)	(3)
Capitalization to GDP			0.591 *** (0.109)
PPI investments to GDP	1.653 ** (0.793)	2.053 *** (0.746)	1.076 ** (0.578)
Inflation	0.616 + (0.527)	0.773 ** (0.370)	0.409 * (0.272)
GDP per capital	−5.865 * (2.904)	0.480 (4.879)	3.945 (4.387)
Foreign trades to GDP	0.312 ** (0.152)	0.249 ** (0.125)	0.065 + (0.075)
Remittances to GDP	−10876 *** (0.477)	−1.210 ** (0.454)	−0.101 + 0.445
S and P global equity index	0.106 *** (0.030)	0.024 + (0.025)	−0.038 ** (0.022)
Lending interest rate	0.091 + (0.088)	0.075 + (0.103)	0.023 + (0.077)

Table 4. *Cont.*

Method	OLS with Robust Standard Errors		
Model for Variables	Size	Liquidity	Mediator effect
	Capitalization to GDP	Stocks Traded to GDP	Stocks Traded to GDP
	(1)	(2)	(3)
Constant	33.678 * (20.264)	−11.228 + (24.077)	−31.126 ** (17.536)
p-value for F-statistics	0.000	0.001	0.000
R-square	0.074	0.072	0.435
Observations	460	460	460
Number of countries	33	33	33

T-statistics are given in brackets. +, *, **, or *** denotes the significance at 15%, 10%, 5%, and 1% level, respectively.

The following results are obtained by estimating $FMD_{i,t} = \beta_1 PPIG_{i,t} + \beta_2' X_{i,t} + a_i + \gamma_t + u_{i,t}$, where FMD refers to financial market development measured by the size or liquidity of the financial market. The size is defined as the % of market capitalization (of listed companies) to GDP, whereas the liquidity is measured by the stocks traded relative to GDP. $PPIG$ is the % of PPI investment to GDP. To test the mediator effect of financial market size between PPI investments and financial market liquidity, we control the market capitalization to estimate the effect of PPI investments on financial market liquidity (see Column 3). X, the matrix of control variables includes Inflation stated as the % change of GDP each year, GDP per capital in thousands of dollars, foreign trades to GDP measured as % of total foreign trades to GDP, remittances to GDP measured as % of remittances to GDP, lending interest rate and annual percentage change of S and P global equity indices.

In comparison with estimation results in Table 3, the following estimation results are obtained with robust standard errors. The following results are obtained by estimating $FMD_{i,t} = \beta_1 PPIG_{i,t} + \beta_2' X_{i,t} + a_i + \gamma_t + u_{i,t}$, where FMD refers to financial market development measured by the size or liquidity of the financial market. The size is defined as the % of market capitalization (of listed companies) to GDP, whereas the liquidity is measured by the stocks traded relative to GDP. $PPIG$ is the % of PPI investment to GDP. To test the mediator effect of financial market size between PPI investments and financial market liquidity, we control the market capitalization to estimate the effect of PPI investments on financial market liquidity (see Column 3). X, the matrix of control variables includes Inflation stated as the % change of GDP each year, GDP per capital in thousands of dollars, foreign trades to GDP measured as % of total foreign trades to GDP, remittances to GDP measured as % of remittances to GDP, lending interest rate and annual percentage change of S and P global equity indices.

Similar to Table 3, Table 4 also reflects the direct effect of PPI investments to financial market liquidity is less significant than the indirect effect of PPI investments through financial market size. Control variables obtain the same signals after including robust standard errors; all significant control variables in Table 3 are also significant in Table 4.

To address the concern due to the potential measurement errors and reverse causality, we further report the results of the IV estimations in Table 5. Table 5 shows that the coefficient of PPI investments on financial market size or liquidity is positive and significant. Consequently, the promotion effect of PPI investments on FMD is confirmed in IV estimations. Moreover, Table 5 presents that the coefficient of PPI investments in the regression of financial market liquidity decrease (from 1.708 to 0.426) and the significance is not satisfied any more. The finding shows that the effect of PPI investments on financial market liquidity relies on financial market size such that the direct effect of PPI investments to financial market liquidity is insignificant.

Table 5. The results of IV estimations.

Method	2SLS		
Model for Variables	Size	Liquidity	Mediator Effect
	Capitalization to GDP	Stocks Traded to GDP	Stocks Traded to GDP
	(1)	(2)	(3)
Capitalization to GDP			0.530 *** (0.039)
PPI investments to GDP	1.708 *** (0.774)	1.303 ** (0.743)	0.386 (0.614)
Inflation	−0.285 + (0.313)	0.383 + (0.301)	0.139 (0.248)
GDP per capital	−0.006 ** (0.003)	−0.001 + (0.003)	0.003 (0.002)
Foreign trades to GDP	0.230 ** (0.094)	0.261 *** (0.091)	0.064 (0.076)
Remittances to GDP	−1.525 ** (0.645)	1.241 ** (0.620)	0.022 (0.518)
S and P global equity index	0.088 *** (0.028)	0.088 *** (0.027)	0.030 (0.023)
Lending interest	0.067 + (0.096)	0.091 + (0.092)	0.054 (0.076)
Constant	25.586 ** (11.999)	−4.877 + (11.527)	−23.051 (9.565)
p-value for F-statistics	0.000	0.000	0.000
R-square	0.046	0.064	0.441
Observations	431	431	431
Number of countries	33	33	33

T-statistics are given in brackets. +, *, **, or *** denotes the significance at 15%, 10%, 5%, and 1% level, respectively.

The regression equation estimated is of the form of $FMD_{i,t} = b_1 PPIG_{i,t-1} + b_2 \hat{X}_{i,t-1} + a_i + \gamma_t + u_{i,t}$, $\hat{X}_{i,t-1}$ is obtained by estimating $\hat{X}_{i,t-1} = b_1 PPIG_{i,t-1} + b_2 Z_{i,t-1} + a_i + \gamma_t + u_{i,t}$. We especially lag all independent variable in IV estimations one period because our instrument variable may be still affected by the time trend such that $FMD_{i,t}$ affects $Z_{i,t}$ or $\hat{X}_{i,t}$. FMD refers to financial market development measured by the size or liquidity of the financial market. The size is defined as the % of market capitalization (of listed companies) to GDP, whereas the liquidity is measured by the stocks traded relative to GDP. $PPIG$ is the % of PPI investment to GDP. To test the mediator effect of financial market size between PPI investments and financial market liquidity, we control the market capitalization to estimate the effect of PPI investments on financial market liquidity (see Column 3). X, the matrix of control variables includes Inflation stated as the % change of GDP each year, GDP per capital in thousands of dollars, foreign trades to GDP measured as % of total foreign trades to GDP, remittances to GDP measured as % of remittances to GDP, lending interest rate and annual percentage change of S and P global equity indices. Z is the vector of instrumental variable, the average value of PPI investments within the other countries at the same year and with the same legal origin that approximates economic institutions.

All control variables in Columns (1)and (2) in Table 5 are significant and obtain the same signals as before, whereas all of them in Column (3) are positive and insignificant. The change in the signal and significance of control variables in Column (3) may reflect the fact that financial market size is much more important than other control variables for explaining financial market liquidity. Table 5 reports

that the *p*-value for F-statistic is zero for IV estimations, which shows that our IV has appropriate explanatory power.

Table 6. Results of z-test for mediator effect.

Model	Z Test Results		
	Sobel [51]'s Model	Baron and Kenny [52]'s Model	Goodman [53]'s Model
OLS estimations (in Table 3)	2.062 **	2.058 **	2.066 **
OLS estimations with robust standard errors (in Table 4)	1.946 *	1.917 *	1.975 **
IV estimations (in Table 5)	2.180 **	2.174 **	2.185 **

Z-test for mediator effect can be obtained in three models. To ensure the robustness of mediator effect, we calculate the z-test results for all potential models, using estimations in Tables 3–5. $^{+}$, *, **, or *** denotes the significance at 15%, 10%, 5%, and 1% level, respectively.

Tables 3–5 intuitively show that the coefficient of PPI investments decreases after controlling the mediator variable, but, to formally test the significance of coefficient decreases, we use all optional Z-tests and report the results in Table 6. Table 6 shows the coefficient decrease is significant, irrespective of different estimation methods and mediator models. Therefore, our results confirm PPI investments first promote the development of financial market size and then foster the development of financial market liquidity.

6. Conclusions

Since the late 1980s, most developing countries adopt a policy of attracting investments for Private Participation in Infrastructure (PPI) projects. Given the significance of PPI investments on financial markets, it is important to assess the promotion effect of PPI policy on financial market development. Referring to Environmental, Social and Governance (ESG) criteria, the PPI investments and financial market development (hereafter FMD) are sustainable. However, the existing literature does not explore or investigate whether the sustainable PPI investments promote the sustainable development of financial markets.

Our model demonstrates how PPI investments dynamically promote the expected prices of shares/equities for PPI programs by building the government creditability. Following the existing literature, we measure FMD in the dimension of size or liquidity. Financial market size is measured by the share of capitalization of listed companies to GDP, whereas financial market liquidity is measured by the share of stocks traded to GDP. Based on our model, we demonstrate the promotion effect of sustainable PPI investments on sustainable development of financial markets and also explain the mediation mechanism that the PPI investments enlarge financial market size, which, in turn, fosters financial market liquidity.

Using the data from developing countries, we provide evidence of a positive and significant relationship between PPI investment and FMD. Moreover, this paper confirms the significant mediator effect of financial market size for the relationship between PPI investments and financial market liquidity. These findings are robust to different control variables and estimation techniques. With the sustainability perspective, this paper contributes to the literature on transitional economy or industrial policy by providing a practical reason for the PPI policy prevalence in reality. Precisely, the promotion effect confirmed in this paper explains why the developing countries have been actively attracting PPI investments although the efficiency of PPI policy is controversial. Additionally, the promotion effect and the mediator effect are not based on endogenous mechanism designs; it can be generalized to all new capital inflows. It may have some limits due to the out-dated data and data collection based on the availability. Nonetheless, this paper contributes to financial economics and development economics in the perspectives of sustainable PPI promotion.

Author Contributions: Tong Fu designs the research and wrote the paper; whereas Hongzheng Chen partially undertook data analysis. Tong Fu and Yongrok Choi revise the paper after review. All authors read and approved the final manuscript.

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Appendix

The data out of the period 1997–2012 are unavailable in developing countries. This Table A1 lists developing countries included in our estimations.

Table A1. Countries involved in our data.

Argentina	Hungary	Morocco	Sri Lanka
Bangladesh	India	Namibia	Thailand
Botswana	Indonesia	Nigeria	Ukraine
Brazil	Jordan	Pakistan	Venezuela, RB
Bulgaria	Kenya	Panama	Vietnam
China	Lebanon	Peru	Zambia
Colombia	Malaysia	Philippines	
Ecuador	Mauritius	Romania	
Egypt, Arab Rep	Mexico	South Africa	

In Table A2, the variables marked by an asterisk are used to obtain instrumental variables. The variable market by + is the instrumental variable in this research. All following variables are collected from developing countries.

Table A2. The definition and data source.

Variable	Definition	Source
Capitalization to GDP (%)	Market capitalization of listed companies (% of GDP). It represents financial market size.	World Bank
Stocks traded to GDP (%)	Total value of stocks traded (% of GDP). It represents financial market liquidity.	World Bank
PPI investments to GDP (%) *	Investments due to private participation in infrastructure (% of GDP).	World Bank
Inflation (%)	The annual percentage change in the GDP deflator (%). It represents economic growth.	World Bank
GDP per capital (in thousands of US$)	GDP per capital in thousands of constant 2005 US$. It represents the economic development.	World Bank
Foreign trades to GDP (%)	Total foreign trades (exports plus imports, % of GDP).It represents *de facto* openness.	World Bank
Remittances to GDP (%)	Remittances received (% of GDP), as the 2nd largest source of external finance.	World Bank
Lending interest rate (%)	The interest rate required by banks from private sector. It reflects the domestic investment background.	World Bank
S and P global equity indices (%)	The annual percentage change in S and P global equity indices. It reflects the characteristics of the international market.	World Bank

Table A2. *Cont.*

Variable	Definition	Source
Legal origin *	There are three legal origins, including common law, civil law and religious law (also including custom law/traditional thoughts). Considering many countries' legal systems are affected by more than one legal origin. let legal = 1, 2, 3, 4, 5, 6 or 7 if legal origin is common law, civil law, religious law, common law & civil law, common law & religious law, civil law & religious law or the combination of common law, civil law & religious law.	Compiled from World Factbook, Wikipedia, Globalex index.
Averaged PPI investment to GDP+	The average value of "PPI investments to GDP" within the other countries at the same year and with the same legal origin. For each country, it reflects the PPI investments (to GDP) that only depend on the underlying characteristics inherent to the particular time and legal origin.	Compiled from the variable of PPI investments to GDP and the legal origin variable.

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