ADBI Working Paper Series

WHAT MATTERS FOR PRIVATE INVESTMENT FINANCING IN RENEWABLE ENERGY GLOBALLY AND IN ASIA?

Dina Azhgaliyeva, John Beirne,
and Ranjeeta Mishra

No. 1246
April 2021

Asian Development Bank Institute

Dina Azhgaliyeva and John Beirne are research fellows at the Asian Development Bank Institute (ADBI), Tokyo, Japan. Ranjeeta Mishra is a project consultant at ADBI.

Suggested citation:

Azhgaliyeva, D., J. Beirne, and R. Mishra. 2021. What Matters for Private Investment Financing in Renewable Energy Globally and in Asia?. ADBI Working Paper 1246. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/what-matters-private-investment-financing-renewable-energy-globally-asia

Please contact the authors for information about this paper.

Email: dazhgaliyeva@adbi.org, jbeirne@adbi.org, rmishra2@adbi.org

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This paper examines the drivers of private investment in renewable energy by source of funding for 13 global economies over the period 2008 to 2018, with a focus on a sub-panel of Asian economies. Using a seemingly unrelated regression model, this paper provides a first quantitative estimate of the effect of government renewable energy policies on private investments across different sources of financing. Our results indicate that feed-in-tariffs (FITs) have the greatest overall effect in Asia on driving private investment in renewable energy, particularly from asset finance compared with other funding sources. The impact of FITs in Asia is also greater than that of the global sample. The impact of FITs is amplified in the presence of lower regulatory quality, which may be related to ease of market entry. We also find an important role in Asia for government expenditure on research and development in stimulating private investment. The magnitudes of the effects in Asia are broadly in line with the overall global sample. Finally, we find that technology costs, are less elastic on private investment in Asia compared with globally in affecting private investment in renewable energy across all funding sources, which may be related to the prevailing strong cost competitiveness of Asian economies in renewable energy provision.

Keywords*:* private investment, public investment, renewable energy, green investment, feed-in tariff

JEL Classification: Q28, O3, O38, Q42

Contents

1. INTRODUCTION

Mobilization of climate finance is critical to limit global warming to 1.5˚C and to prevent catastrophic climate change (IPCC 2018). Annual green investments of USD1.5 trillion are needed (UN 2017). Despite the falling cost of renewable energy technologies, energy investments are dominated by investment in fossil fuels (Azhgaliyeva, Kapsalyamova, and Low 2019). Investments in renewable energy are challenged by subsidized electricity and fossil fuels, high initial capital costs of renewable energy technologies, lack of skills or information, and uncertainties. Many countries globally have implemented policies aimed at promoting investment in renewable energy by reducing these barriers. This is a particularly important policy issue in the case of Asia, which accounts for around 50% of global energy consumption, with around 50% of that embodied in fossil fuels. Raising private investments in renewable energy is key to meeting Asia's surging energy demand, which is fueled by economic growth, population growth, and enhanced energy access (Azhgaliyeva and Liddle *2020*; Azhgaliyeva, Kapoor, and Liu 2019). Two-thirds of global energy-demand growth will occur in the developing Asia by 2040. This underscores the importance for the Asian region to progress on its shift to a decarbonized greener economy, with less reliance on fossil fuels for energy. This paper aims to provide an empirical insight into the factors that can help to stimulate private investment in renewable energy not only at the global level, but also specifically in Asian economies. As highlighted by the International Renewable Energy Agency (2016), the Association of Southeast Asian Nations (ASEAN) countries have committed to achieving a target of 23% of total primary energy demand accounted for by renewable energy by 2025. Progress towards achieving this target will require substantial efforts towards the structural transformation to cleaner energy and policy efforts aimed at encouraging private investment in renewable energy.

Against this backdrop, the objective of this paper is to investigate how private investments in renewable energy across different sources are affected by energy policies, with a specific focus on Asia. The International Energy Agency (2019) has highlighted key areas where Southeast Asian economies need to focus on in order to attract private investment in renewable energy, which essentially are aimed at reducing financial risk via improved sustainability and a diversified set of financing sources, as well as reducing entry barriers, such as those related to procurement and contracting mechanisms. For Asia in particular, with a growing demand for energy as the population rises, coupled with insufficient domestic fossil fuels to meet rising energy demand, it is of crucial importance for the region to develop its renewable energy sector. This paper sheds light on which factors are important in driving private investment in renewable energy across different funding sources. We hypothesize that private investments from different sources are not equally affected by energy policies. The impact of energy policies on private investments in renewable energy could vary across sources of financing. The results of this study can help policymakers to promote private investment in renewable energy from underutilized sources. This paper uses a unique dataset compiled by the authors from different sources to assess the drivers of different types of private investment in renewable energy, namely asset finance, corporate research and development (R&D), publicly-quoted markets, and venture capital.

The analysis is carried out using annual data for a global sample of 13 countries and a sub-panel of 4 Asian countries for which data are available over the period 2008 to 2018 across five renewable energy sources: geothermal, small hydro, solar, marine, and wind. Two energy policy instruments are considered: feed-in tariffs and public expenditure on research and development. Importantly, our paper draws on the prevailing literature to enable us to identify suitable macroeconomic and financial controls. This is an important aspect that feeds into our empirical assessment. By controlling for the wider macroeconomic and financial variables, we can be more confident in the magnitude and statistical significance of our energy-specific determinants of private investment in renewable energy. Overall, our results indicate heterogeneous effects of energy policies on stimulating private investment in renewable energy according to the type of financing. Our results show that feed-in-tariffs (FITs) have the greatest overall effective in Asia on driving private investment in renewable energy, particularly from asset finance compared with other funding sources. The impact of FITs in Asia is also greater than that of the global sample. The impact of FITs is amplified in the presence of lower regulatory quality, which may be related to ease of market entry. We also find an important role in Asia for government expenditure on research and development (GERD) in stimulating private investment. The magnitudes of the effects in Asia are broadly in line with the overall global sample. Finally, we find that technology costs, are less elastic on private investment in Asia compared with globally in affecting private investment in renewable energy across all funding sources, which may be related to the prevailing strong cost competitiveness of Asian economies in renewable energy provision. The remainder of the paper is structured as follows: Section 2 describes the related literature; Section 3 outlines the data and methodology used; Section 4 provides a description of our empirical results; and Section 5 concludes.

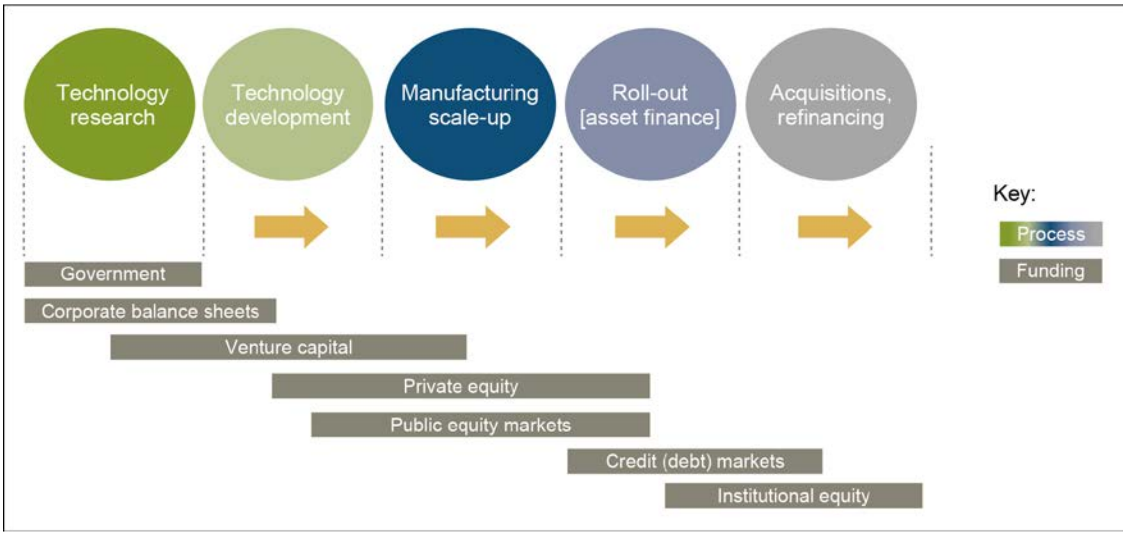
2. RELATED LITERATURE

This paper contributes to the literature on renewable energy policy and, more broadly, on the determinants of private investment. Due to a number of barriers to investments in renewable energy, such as subsidies for electricity generated from fossil fuels, high initial capital costs, lack of skills or information, uncertainties (Azhgaliyeva, Kapsalyamova, and Low 2019; Azhgaliyeva et al. 2018), and positive externalities from renewable energy (Menanteau, Finon, and Lamy 2003), many countries have implemented policies aiming to promote private investments in renewable energy. Since such policies are costly, it is important to measure their effectiveness. Literature studying the impact of energy policies on the production of renewable energy is abundant. Literature studying the effect of energy policies on private investments in renewable energy much more scarce however. Trends in investments in renewable energy are provided in the annual report by Frankfurt School-UNEP Centre/BNEF (2020). However, this report only provides trends and does not analyze the impact of policies.

In the case of Asia, Chang, Fang, and Li (2016) conducted a quantitative assessment of renewable energy policies aimed at promoting investment in the 16 East Asia Summit countries. Using an index across five key areas that can be informative for prospective investors across five key area, namely, (i) market (whether the policies help to create a renewable energy market); (ii) uncertainty (whether policies reduce uncertainty); (iii) profitability (whether policies promote an environment for profitability); (iv) technology (whether policies support technology adoption); and, (v) financial resources (whether policies promote funding availability). Overall, they find heterogeneity in the results, although the People's Republic of China (PRC), India, the Republic of Korea, and Japan are among the highest-ranking Asian countries in terms of the impact of their renewable energy policies. Our paper is related to the work of Chang, Fang, and Li (2016), with the aim of our paper on quantitatively estimating the effect of renewable energy policies on private investment in Asia relative to globally. Other work on examining renewable energy policy effectiveness in Asia includes Bakhtyar et al. 2013), which focuses on FITs for the cases of Indonesia and the Philippines. Earlier work by Chen, Kim, and Yamaguchi (2014) noted that less conservative efforts on development of the renewable energy sector is needed in the economies of East Asia. Related work on the effectiveness of renewable energy policies for various Asian economies have also been carried out by Schmid (2012); Shen and Luo (2015); Toan, Bao, and Dieu (2011); Tongsopit and Greacen (2013); and Wang, Yin, and Li (2010). Also related to this, but focusing on North America and Europe, Bürer and Wüstenhagen (2009) find that FITs are the most important driver of private investment in renewable energy. Based on a survey of 60 investor professionals, their results are more pronounced for Europe, where there is higher exposure to clean energy.

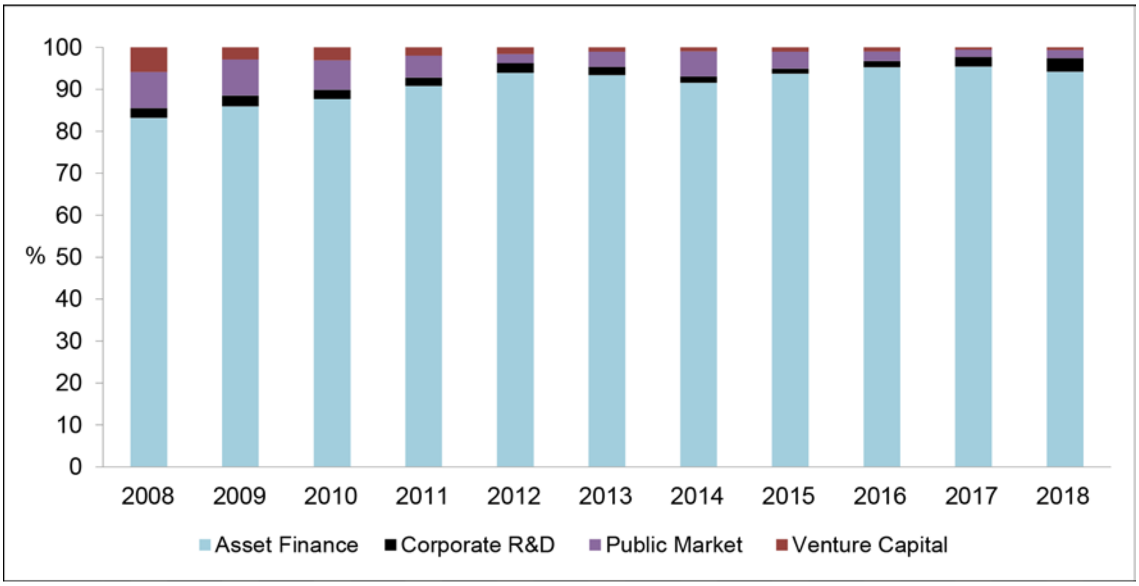
Unlike the existing empirical literature, which focuses on the total investment in renewable energy (Eyraud, Clements, and Wane 2013) or total private investment in renewable energy (Azhgaliyeva, Kapsalyamova, and Low 2019), our paper distinguishes between funding sources of private investment. To the best of our knowledge, this is the first empirical study to measure the effect of energy policies on private investments in renewable energy across different sources of financing. The following issues justify our focus on different funding sources of private investment. The sources of financing which renewable energy projects attract depend on the stage of their technological development (Figure 1). Sources of financing vary not only across years (Figure 2) and renewable energy sources (i.e., geothermal, small hydro, solar, wave and tidal, and wind), but also across countries (Figure 3). For example, hydro, solar, and wind power are more mature technologies, relying less on government investments than ocean and geothermal power (Figure 4).

Figure 1: Sources of Financing and Technology Maturity



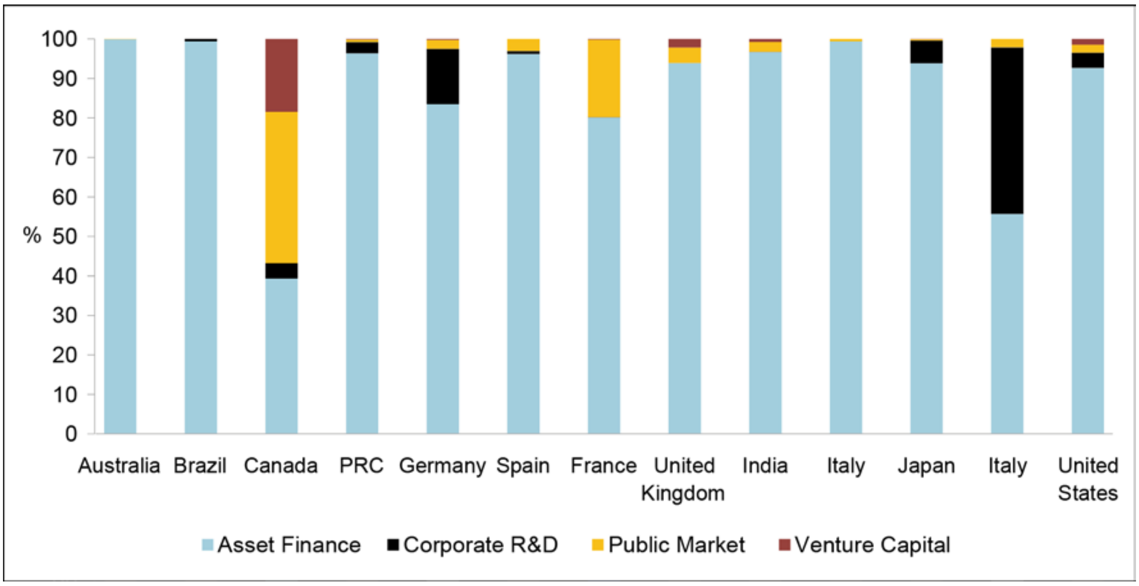
Source: Frankfurt School-UNEP Centre/BNEF (2020).

Figure 2: Share of Asset Class in Renewable Energy Investment
(by year, %)



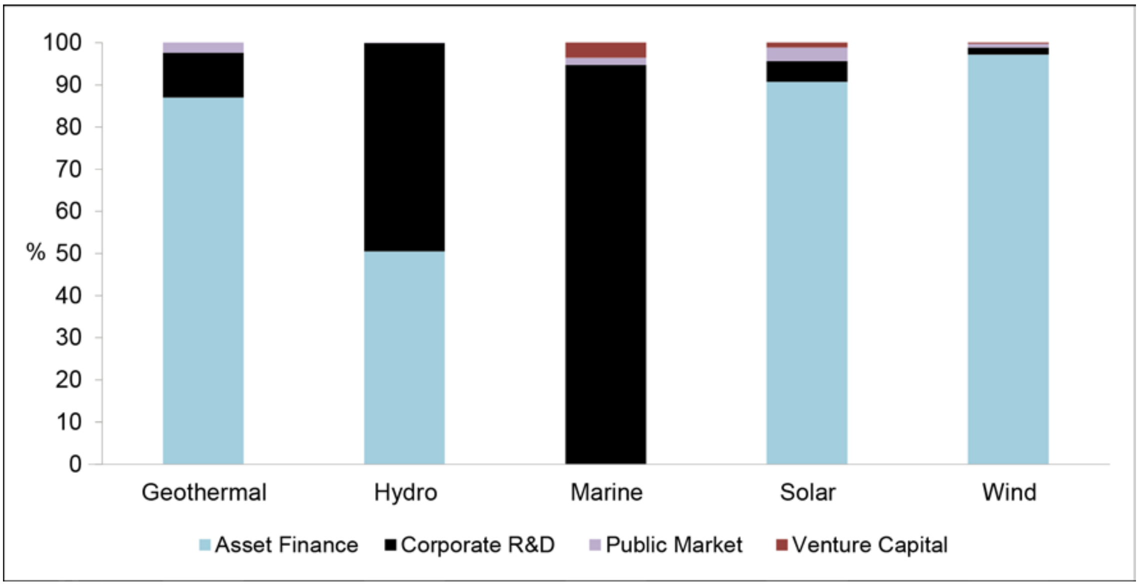
Source: Own elaboration using data from BNEF.

Figure 3: Asset Class in Renewable Energy Investment
(by country, %)



PRC = People's Republic of China.
Source: Own elaboration using data from BNEF.

Figure 4: Asset Classes in Renewable Energy Investment
(by technology, %)



Source: Own elaboration using data from BNEF.

The data available indicate that sources of financing vary across countries even for the same renewable energy technology. For example, Japan has the largest share of corporate R&D, the US has the largest share of venture capital, Canada has the largest share of public markets, and the PRC has the largest share of asset finance. Differences across countries can also be explained by country characteristics, including energy policies. While prevailing studies on renewable energy investigate a diverse set of issues and subjects range from unlocking renewable energy investment to the effects of environmental policies on innovation, studies that look at the determinants of the funding sources of private investment in renewable energy projects are scarce. In addition, drawing on the macrofinancial literature on the drivers of private investment, our paper controls for factors relating to different levels of economic, financial, and institutional development across countries. Importantly, we control for the level of economic development and rate of economic growth, as measured by GDP per capita and GDP growth, respectively, which have shown to be strongly correlated with the level and rate of technological advancement (e.g., Faberberg 1987; Justman and Teubal 1991).

Policies promoting renewable energy are divided into several categories by the International Energy Agency: economic, information and education, institutional, regulation, and voluntary (Azhgaliyeva, Kapsalyamova, and Low 2019). One of the most popular policy instruments is feed-in tariffs. Feed-in tariffs have played a major role in increasing renewable energy capacity in Europe, particularly in Germany, Spain, and France, as well as in Asia, notably in Japan and the Republic of Korea. Feed-in tariffs are pre-determined tariffs that a government can commit to for purchasing renewable energy by signing fixed long-term contracts with renewable energy suppliers. These tariffs are designed to attract private investment in renewable energy sources by providing government-guaranteed compensation above the electricity market price. By providing feed-in tariffs, governments can promote private investment in renewable energy in two ways. First, by setting tariffs, governments can create fixed rather than uncertain revenue flows, thus reducing the risk of investing in renewable energy. Second, by setting a tariff above the market price, governments can increase the profitability of renewable energy projects.

Most of the empirical literature studying public expenditure on R&D of renewable energy technologies focuses on the impact on innovations and technology development (Plank and Doblinger 2018) rather than on private investments. R&D of less mature renewable energy technologies is often financed from public sources. Investments at earlier stages of technology development carry greater risks and are thus less attractive for private investors. By investing in R&D of renewable energy, governments aim to boost private investments at the technology R&D stage or at later stages of technology maturity, such as manufacturing scaling-up, rollout, and acquisition (Figure 1). The literature provides some controversial findings on the impact of government investment on private investment, as well as on the crowding-in and crowding-out effect on private investment of government investment (Wai and Wong 1982; Ghura and Goodwin 2000; Akkina and Celebi 2002; Acosta and Loza 2005; Afonso and Jalles 2015). The literature on investment in renewable energy also lacks evidence on the crowding-in and crowding-out effects on private investment in renewable energy due to government investment (Azhgaliyeva, Kapsalyamova, and Low 2019). However, Deleidi, Mazzucato, and Semieniuk (2020) show that the terms “crowding in” and “crowding out” may be inappropriate in sectoral studies such as renewable energy. These authors show that public direct investments in renewable energy are effective in mobilizing private investments. Our paper delves deeper in this issue by examining different sources of private investment financing, as well as a larger sample size and more timely data.

This paper also contributes to the broader literature on the drivers of private investment. Typical macroeconomic drivers of private investment would include GDP growth, debt/GDP, and inflation. For example, higher GDP growth has been shown to be positively related to the level of private equity investment (Gompers and Lerner 1998). Similarly, Jeng and Wells (2000) make the point that output growth is positively and significantly related to the demand for venture capital. This also holds more broadly across other funding sources (e.g., OECD 2016). Other studies stress the role of exchange rate uncertainty and risk aversion as important factors underpinning private investment (e.g., Servén 2006). Beaudry, Caglayan, and Schiantarelli (2001) proxy macroeconomic uncertainty using inflation, citing a negative effect on investment. Indeed, related to this, it may be expected that real interest rates have a significant negative effect on venture capital investment, given that high real interest rates reduce the propensity to invest in risky assets. This point is reinforced by Gompers and Lerner (1998), who highlight that high-risk investment is negatively associated with interest rates. In relation to financial development, Black and Gilson (1998) stress the importance of a well-developed and liquid stock market for the overall level of venture capital investment (see also Clarysse, Knockaert, and Wright 2009; Kelly 2012; Cherif and Gazdar 2011). The price of sovereign risk and sovereign credit rating have also been cited in some studies as important drivers of private investment (e.g., Chen et al. 2013). On institutional development, a range of studies—particularly those that focus on emerging markets and developing economies—find a strong role to be played by this factor in attracting private investment (e.g., Bernoth and Colavecchio 2014). The added value in our approach will be to include these country-specific macrofinancial factors in conjunction with determinants that are more energy-specific in driving private investment.

3. DATA AND METHODOLOGY

3.1 Data

This section outlines the data and empirical framework that will be employed in the paper to assess the determinants of private investment in renewable energy across different sources of financing. The dependent variable is investment in renewable energy across different sources of financing; the independent variables include energy-specific factors such as government investment in renewable energy and policy instruments promoting private investments in renewable energy, and country-specific factors such as the macroeconomic and financial factors referred to in the previous section. Data are collected from a number of sources, such as Bloomberg New Energy Finance (BNEF), the IEA/IRENA Global Renewable Energy Policies and Measures database, World Bank World Development Indicators, and the International Monetary Fund's International Financial Statistics for 13 major economies—Australia, Brazil, Canada, the PRC, France, Germany, India, Italy, Japan, the Republic of Korea, Spain, the United Kingdom, and the United States—across five renewable energy sources (geothermal, small hydro, solar, wave and tidal, and wind), and across four private sources of financing (venture capital and private equity, public markets, asset finance, and corporate R&D). The disaggregation of private investment by these types of sources of funding was carried out in previous work by Mazzucato and Semieniuk (2018) and Azhgaliyeva, Kapsalyamova, and Low (2019). The paper uses annual data over the period 2008–2018 Since the explanatory variables are lagged by one year, the estimation is carried out over the period 2009–2018.

The dependent variables comprise private investments in renewable energy projects. Four dependent variables measuring private investments in renewable energy are used: asset finance, corporate R&D, public markets, and venture capital. Private investment data are collected from the BNEF desktop database and include private investments in renewable energy projects across five renewable energy technologies: geothermal projects with capacity over 1 MW; small hydropower projects with capacity from 1 to 50 MW; and solar, marine, and wind power projects with capacity over 1 MW. Investments in large hydroelectric projects of more than 50 MW are excluded from the dependent variables. Asset finance includes private investments in renewable energy projects via the balance sheets or financing mechanisms such as syndicated equity from institutional investors, or project debt from banks. Corporate R&D investments include corporates' private expenditure on R&D in renewable energy technologies. Public markets include new equity raised on capital or over-the-counter markets by publicly quoted companies in renewable energy. Venture capital and private equity (VC/PE) includes venture capital funding for the purposes of expansion by companies in the renewable energy industry. All dependent variables are converted from current prices in national currencies to US dollars.[1]

As regards the independent variables, two variables are included to measure policies promoting private investments in renewable energy: government R&D (GERD) and FITs. GERD includes public expenditure on R&D across the six renewable energy technologies mentioned earlier in this section. Government R&D is measured in US dollars, converted from current prices in national currencies. This variable is collected

[1] For more information about the dependent variables, please refer to Louw (2016) and Frankfurt School-UNEP Centre/BNEF (2020).

from BNEF, similar to the dependent variables. Feed-in tariff is a binary variable which equals one when a feed-in tariff or premium exists and zero before it existed or after it was canceled. Feed-in tariff data are collected from the IEA and IRENA Joint Policies and Measures database (IEA/IRENA 2020), not only across countries and years, but also across the six renewable energy technologies mentioned earlier. Institutional development can affect the quality of policy implementation. To account for the quality of implementation, interaction terms of regulatory quality index and two policy variables are included. Regulatory quality index measures “perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development” (World Bank Group 2018). Regulatory quality index is collected from the Worldwide Governance Indicators (World Bank Group 2018). The regulatory quality index varies from -2.5 to 2.5, higher values corresponding to better quality regulation. Technology cost is measured as the annual global average of the levelized cost of renewable energy across the six aforementioned renewable energy technologies. The levelized cost of energy is the average cost of energy over a lifetime of energy technology. It is measured in US$ per MWh. The technology cost data do not vary across countries due to scarcity, and are collected from BNEF. Energy price index is obtained from the Enerdata Global Energy & CO2 database. Energy price index is an annual index of energy prices, including electricity, coal, oil, and gas across countries. Energy price index proxies the cost of renewable energy alternatives. It varies across countries and years, but not across renewable energy technologies. Other variables are included to control for domestic macroeconomic fundamentals, financial development, and global financial market volatility across countries and years (Table 1).

Table 1: Multi-level Variables

Variable	Country-level (13 countries)	Renewable Energy-level (5 Technologies)	Period (2008–2018)
Dependent variables: asset finance, corporate R&D, public markets, venture capital, private equity	√	√	√
Independent variables:			
government R&D	√	√	√
Feed-in tariffs	√	√	√
Technology cost		√	√
Energy price index	√		√
GDP per capita	√		√
Real GDP growth	√		√
Public debt/GDP	√		√
Inflation	√		√
Stock market capitalization/GDP	√		√
Long-term interest rate	√		√
Regulatory quality index	√		√
VIX (global)			√

3.2 Methodology

Our analysis comprises four types of private investment (asset finance, corporate R&D, public markets, and venture capital) in four types of renewable technology (hydro, geothermal, marine, and solar and wind) across 13 countries (Australia, Brazil, Canada, the PRC, Germany, Spain, France, the UK, India, Italy, Japan, the Republic of Korea, and the US) for a period of 10 years (2008–2018). While the different sources of financing may to a certain extent depend on the stage of technological development in the renewable energy sector, we assume that they are not fully independent of each other. As a result, we use a seemingly unrelated regression model (SUR) to estimate the determinants of private investment in renewable energy. SUR is a technique for analyzing a system of multiple equations with cross-equation parameter restrictions and correlated error terms (Biørn 2004; Hayashi 2011). Technological advancement and the different stages of technological development across our sample is proxied in this set-up using measures for economic development and growth. We also examine the correlation of the residuals from the SUR equations, and estimate the 8 models individually by OLS (whereby the results do not take into account interrelationships in the error terms across models). Our baseline specification is given in equation (1), where a pooled SUR model is estimated.

$$Y_{i,j,t} = \alpha + \beta X_{i,j,t-1} + \gamma Z_{i,t-1} + \chi F_{i,t-1} + \mu VIX_{t-1} + \varepsilon_{i,j,t} \quad i=1,\dots,N\,;\ j=1,\dots,J\,;\ t=1,\dots,T \quad (1)$$

where $i = 1$ to 13 (countries), $j = 1$ to 5 (types of renewable energy) and t=1 to 10 (time period)

In equations (1), $Y_{i,j,t}$ measures the log of private investment in renewable energy technology j in country i at time t. The domestic energy specification factors are captured in the vector X with four variables: log of government R&D, technology cost, energy price index, and feed-in tariff. The domestic macroeconomic and institutional factors are represented in the vector Z with six variables: real GDP growth, GDP per capita, public debt/GDP, fixed capital formation/GDP, inflation, and regulatory quality. Vector F comprises the domestic financial factors: stock market capitalization/GDP, and the long-term interest rate. Finally, the VIX controls for global financial market volatility.

4. EMPIRICAL RESULTS

Our empirical results on the determinants of private investment in renewable energy in Asia and across the full sample of countries are provided in Table 2. The drivers are disaggregated into the four main types of financing. Across our sample of countries as a whole, asset finance has been the dominant financing type for private investment in renewable energy over the past decade. This holds for both advanced and emerging economies in our sample. The share accounted for by corporate R&D, public markets, and venture capital is much smaller by comparison. Nonetheless, an understanding of the factors driving different types of financing can have important implications for efforts aimed at boosting renewable energy investment. The discussion of the results focuses on a comparison of Asia with that of the full sample of countries.

Table 2: The Determinants of Private Investment in Renewable Energy by Funding Source

	Asia				Global			
	Asset Finance	Corporate R&D	Public Market	Venture Capital	Asset Finance	Corporate R&D	Public Market	Venture Capital
Energy-specific variables								
Govt R&D, log	1.280***	0.790***	0.424***	0.071	1.166***	0.530***	0.443***	0.287***
	(0.085)	(0.072)	(0.070)	(0.048)	(0.063)	(0.042)	(0.044)	(0.032)
FIT, binary	3.478***	0.725**	2.163***	1.455***	2.750***	0.436*	1.408***	1.031***
	(0.361)	(0.306)	(0.299)	(0.203)	(0.404)	(0.264)	(0.280)	(0.204)
Energy price	0.735	–1.810	–1.092	–0.346	–4.33***	–2.174***	–0.821	–1.298**
	(1.683)	(1.426)	(1.395)	(0.948)	(1.137)	(0.744)	(0.790)	(0.575)
Tech. cost	–0.219	0.287**	0.188	0.106	–0.51***	–0.241***	0.002	0.160**
	(0.164)	(0.139)	(0.136)	(0.092)	(0.131)	(0.086)	(0.091)	(0.066)
Reg. qlty x FIT	–3.893***	–0.125	–1.91***	–1.79***	–1.36***	–1.008***	–1.02***	–0.791***
	(0.545)	(0.462)	(0.451)	(0.307)	(0.350)	(0.229)	(0.243)	(0.177)
Macroeconomic and institutional factors								
GDP per capita	0.000	0.000**	–0.000	–0.000	–0.000	0.0000	–0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP growth	0.224	–0.184	–0.126	0.184	0.121	–0.141*	0.080	0.367***
	(0.203)	(0.172)	(0.168)	(0.114)	(0.116)	(0.076)	(0.081)	(0.059)
Fixed capital	–0.055	–0.196**	–0.024	–0.002	0.005	0.089***	–0.008	–0.074***
	(0.101)	(0.086)	(0.084)	(0.057)	(0.033)	(0.021)	(0.023)	(0.017)
Inflation, log	0.364	–0.100	0.342	0.172	0.212	0.0647	0.0809	0.154*
	(0.359)	(0.305)	(0.298)	(0.203)	(0.156)	(0.102)	(0.108)	(0.079)
Pub. debt/GDP	0.017**	–0.006	–0.009	0.005	0.007**	0.013***	–0.005**	–0.001
	(0.008)	(0.007)	(0.006)	(0.004)	(0.003)	(0.002)	(0.002)	(0.000)
Reg. qlty	–0.687	–6.498***	1.077	1.964	1.714***	1.297***	0.858**	–0.040
	(2.507)	(2.125)	(2.079)	(1.413)	(0.610)	(0.399)	(0.424)	(0.308)
GDPpcXGDPgr	–0.000	0.000	0.000	–0.000	–0.000	0.000***	–0.000	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000	(0.000)
Financial factors								
VIX (Global)	–0.003	0.058**	0.088***	0.011	0.001	–0.008	0.016	0.029**
	(0.032)	(0.027)	(0.026)	(0.018)	(0.023)	(0.015)	(0.016)	(0.012)
Bond yield	0.332	–0.266	–0.483*	0.094	0.325***	0.125**	0.066	0.116**
	(0.305)	(0.258)	(0.252)	(0.172)	(0.094)	(0.062)	(0.065)	(0.048)
Stock mkt cap	0.004	0.016*	0.018**	0.007	–0.007	–0.006**	0.006*	0.0101***
	(0.009)	(0.008)	(0.008)	(0.006)	(0.004)	(0.003)	(0.003)	(0.002)
Constant	–7.086	12.56**	8.045	0.257	17.08***	5.694	3.092	4.164
	(7.230)	(6.128)	(5.994)	(4.075)	(5.523)	(3.616)	(3.835)	(2.792)
Observations	200	200	200	200	650	650	650	650
R-squared	0.747	0.582	0.524	0.491	0.412	0.345	0.231	0.327

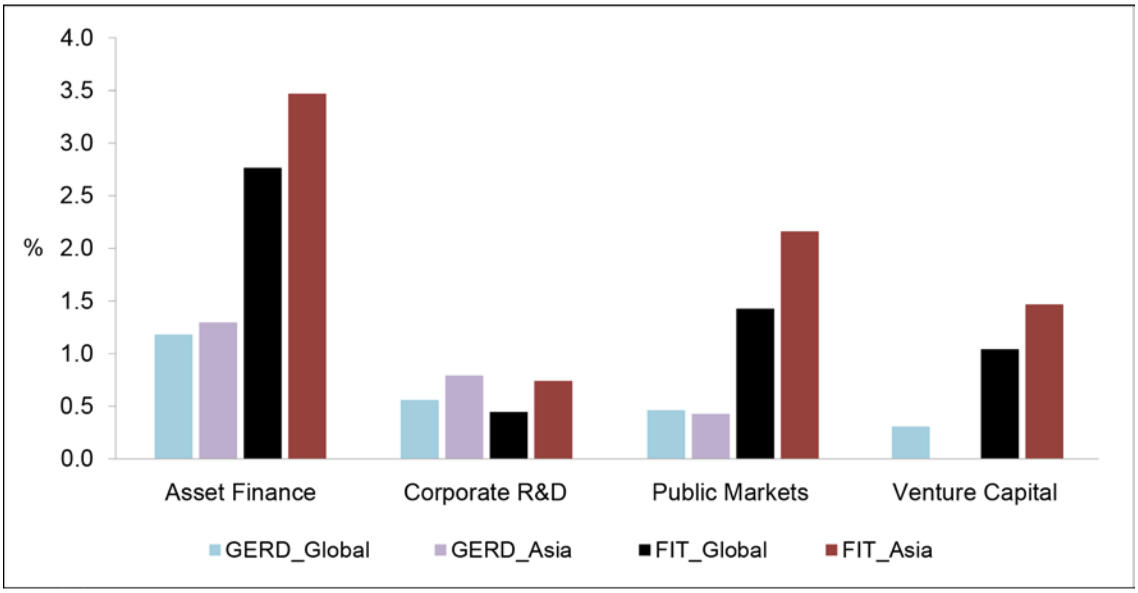
Note: All of the dependent variables are in logarithms, while all independent variables are lagged by one period. Standard errors in parentheses; ***, **, and * denote p<0.01, p<0.05, and p<0.1, respectively. The coefficients are based on the estimation of equation (1) in our methodology. The Appendix provides details on the correlations across all variables used in the analysis, the correlation of the residuals from the SUR equations, and an alternative estimation whereby the eight models are estimated individually by OLS. We find a low and statistically significant correlation in the SUR residuals, while there are differences in the magnitudes of the standard errors, the overall statistical significance of the results is not changed in the OLS set-up, thus allaying potential concerns about contemporaneous correlation in the error terms from the SUR model.

At the global level, public expenditure in R&D of renewable technologies, i.e., government R&D, is an important driver of private investment in renewable energy, particularly asset finance-based private investment, with greater than proportional returns evident—i.e., a 1% increase in government R&D expenditure increases asset finance-based private investment in renewable energy by 1.17% (Table 2). Government R&D expenditure is also statistically significant for other types of private investment financing, but with lower elasticities. This means that public investments in R&D have a greater impact on asset finance relative to other sources of financing, with the magnitude of the additional effect being by a factor of around 2.5. The results showing the positive impact of government R&D on private investments in renewable energy technologies are consistent with the existing literature described earlier, e.g., Deleidi, Mazzucato, and Semieniuk (2020). Our more granular assessment by funding source finds, however, that the impact of government R&D is greater on asset finance-based private investments than on corporate R&D, public markets, and venture capital.

A similar pattern emerges for the sub-panel of Asian economies, with the largest relative effect on asset-finance based private investment being driven by government R&D, with the magnitude of the effect in line with that of the full sample. In comparison to the full set of countries, however, government R&D is a particularly important driver of private investment financed by corporate R&D, with the magnitude of the effect in Asia being around double that of the global sample of economies. Similar effects of government R&D on private investment by publicly-quoted firms in Asia and globally, i.e., public markets. However, in contrast to the full sample, the findings for Asia indicate that government R&D does not stimulate private investment in renewable energy via venture capital.

For the global sample, feed-in tariffs have a statistically significant and positive impact on private investment across all types of sources of financing, particularly from asset finance, followed by public markets, and venture capital, and to a lesser extent corporate R&D. The implementation of FITs is associated with an increase in investments in renewable energy from asset finance by 2.75%, from public markets by 1.41% and from venture capital by 1.03%, and from corporate investments in R&D by 0.44%. For the Asian sample, the impact of FITs is greater in magnitude by a factor of around 1.5 compared with the global sample across private investment funding sources. In particular, FITs in Asia are associated with private investment rises from asset finance of 3.48%. The respective elasticities of FITs for corporate R&D, public markets and venture capital are 0.73%, 2.16%, and 1.46%, respectively. The greater role of FITs in underpinning private investment in Asia may be explained by the fact that their duration has been much longer in fruition compared in other parts of Europe and the US for certain types of renewable energy. Countries in Asia, such as the Republic of Korea and Japan, are at a later stage renewable energy adoption particularly in relation to wind and solar energy, and are already moving to the contracted revenue stream phase. Moreover, it is also important to note that the counterparties to the FITs in Asia have tended to be high quality such as state-owned utilities. Figure 5 provides an illustration of the relative effects of GERD and FITs on private investment funding sources for statistically significant coefficients.

Figure 5: GERD and FIT Estimated Elasticities on Private Investment by Funding Sources



Source: Authors' estimation based on equation (1).

Countries' regulatory quality is important for attracting private investment based on asset finance, corporate R&D, and public markets at the global level. Our results also show that lower regulatory quality increases the effectiveness of FITs on attracting private investment. This result could be related to the possibility that countries with lower regulatory quality offer higher feed-in tariffs, making them more effective at attracting private investments. There may also be greater ease of market access. In the case of Asia, while regulatory quality *per se* in most cases (with the exception of corporate R&D) does not have any significant impact on private investment, a similar phenomenon emerges whereby higher feed-in tariffs stimulates significant private investment where overall regulatory quality is low. Indeed, the magnitude of these effects are considerably higher in the case of Asian economies.

On energy specific costs, for the global sample, we find that lower costs of renewable energy technologies lead to increases private investments in renewable energy, in line with economic intuition. In the case of asset-based financing, however, the magnitude of the effect is greater than that of corporate R&D and venture capital by a factor of around 2.5, with a 1% decline in technology costs associated with an increase in asset finance-based private investment by around 0.51%. In contrast to the full sample model, technology costs in the Asian sample seem to be less important for private investment. This overall finding should be nuanced against the fact that cost competitiveness in the PRC for example is a strong factor that underpins its relative strength in the renewable energy sector.

Our empirical analysis also controls for wider macroeconomic and financial conditions across the full sample of economies and in Asia. Our results account for the level economic development, which proxies overall technological advancement, as well as GDP growth, with some indication that these factors are more important in Asia compared with the overall sample. Other important factors across all types of private investment financing for both Asia and across the global sample include the level of fixed capital formation. Finally, to reflect the level of financial development in the economy, which is an important factor for consideration by foreign investors, particularly given that capital investment is intermediated via the financial sector, we also examine the role played by stock market capitalization, both of which are largely positive and significant as expected.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Mobilizing private sector investments in low carbon infrastructure is important from the perspective of sustainable development. This paper assesses the drivers of private investment in renewable energy by type of financing, namely asset finance, corporate R&D, public markets, and venture capital. The main focus of the paper is to assess the case of Asia relative to the overall global sample of countries. The main contribution of the paper is that unlike previous studies, which have tended to focus on the drivers of the overall level of private investment in renewable energy, our work enables an assessment to be made across different funding sources. As sources of financing for private investment in renewable energy, corporate R&D, public markets, and venture capital together account for only around 20% of the global level across all funding sources, around 80% being based on asset finance.

Our overall results are based on a panel of 13 advanced and emerging economies over the period 2008 to 2018, and a sub-panel comprising 4 Asian economies. While some heterogeneity is found in the effectiveness of renewable energy policies across the Asian and global samples, our main finding is that FITs have the greatest overall effective in Asia on driving private investment in renewable energy, particularly from asset finance compared to other funding sources. The impact of FITs in Asia is also greater than that of the global sample. The impact of FITs is amplified in the presence of lower regulatory quality, which may be related to ease of market entry. We also find an important role in Asia for government expenditure on research and development (GERD) in stimulating private investment. The magnitudes of the effects in Asia are broadly in line with global sample. Finally, we find that technology costs, are less elastic on private investment in Asia compared to globally in affecting private investment in renewable energy across all funding sources, which may be related to the prevailing strong cost competitiveness of Asian economies in renewable energy provision.

The results from this paper have important implications for policy makers in two key respects. First, while FITs in Asia and globally have strongest impacts on driving asset finance based private investment, other sources of financing, namely corporate R&D, public markets, and venture capital also demonstrate positive and statistically significant effects on private investment in renewable energy. Policy makers therefore should be encouraged to develop appropriate policies aimed at encouraging financing from these other avenues. Second, in the case of Asia, while our sample included only 4 countries for which data was available and are relatively more developed in terms of renewable energy adoption and maturity – Japan, Republic of Korea, PRC and India – there are important implications of our results for other Asian economies who may be at an earlier stage of development, particularly regarding the significance of FITs and to a less extent GERD in driving asset finance based private investment in renewable energy.

REFERENCES

Acosta, P., and A. Loza. 2005. "Short and Long Run Determinants of Private Investment in Argentina." *Journal of Applied Economics* 8, no. 2: 389–406.

Afonso, A., and J. T. Jalles. 2015. "How Does Fiscal Policy Affect Investment? Evidence from a Large Panel." *International Journal of Finance & Economics* 20, no. 4: 310–27.

Akkina, K. R., and M. A. Celebi. 2002. "The Determinants of Private Fixed Investment and the Relationship between Public and Private Capital Accumulation in Turkey." Pakistan Institute of Development Economics 41, no. 3: 243–54.

Azhgaliyeva, D., M. Belitski, Y. Kalyuzhnova, and M. Romanov. 2018. "Renewable Energy Policy Instruments: An Empirical Evaluation of Effectiveness." *International Journal of Technology Intelligence and Planning* 12, no. 1: 24–48. https://doi.org/10.1504/ IJTIP.2018.10015611.

Azhgaliyeva, D., Z. Kapsalyamova, and L. Low. 2019. "Implications of Fiscal and Financial Policies in Unlocking Green Finance and Green Investment." in *Handbook on Green Finance: Energy Security and Sustainable Development*, edited by J. Sachs, W. W. Thye, N. Yoshino, and F. Taghizadeh-Hesary, 427–57. Singapore: Springer. https://www.adb.org/publications/ handbook-green-finance-energy-security-sustainable-development.

Azhgaliyeva, Dina, Anant Kapoor, and Yang Liu. 2020. "Green Bonds for Financing Renewable Energy and Energy Efficiency in South-East Asia: A Review of Policies." *Journal of Sustainable Finance & Investment*. https://doi.org/10.1080/ 20430795.2019.1704160.

Azhgaliyeva, Dina, and Brantley Liddle. 2020. "Introduction to the Special Issue: Scaling Up Green Finance in Asia." *Journal of Sustainable Finance & Investment.* doi:10.1080/20430795.2020.1736491.

Bakhtyar, B., K. Sopian, A. Zaharim, E. Salleh, and C.H. Lim. 2013. "Potentials and Challenges in Implementing Feed-in Tariff Policy in Indonesia and the Philippines." *Energy Policy* 60: 418–423.

Beaudry, Paul, Mustafa Caglayan, and Fabio Schiantarelli. 2001. "Monetary Instability, the Predictability of Prices, and the Allocation of Investment: An Empirical Investigation using U.K. Panel Data." *American Economic Review* 91: 648–62.

Bernoth, K., and R. Colavecchio. 2014. "The Macroeconomic Determinants of Private Equity Investment: A European Comparison." *Applied Economics* 46, no. 11: 1170–1183.

Biørn, E. 2004. "Regression Systems for Unbalanced Panel Data: A Stepwise Maximum Likelihood Procedure." *Journal of Econometrics* 122, no. 2: 281–91.

Black, B., and R. Gilson. 1998. "Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets," *Journal of Financial Economics* 47: 243–77.

Bürer, M.J. and R. Wüstenhagen. 2009. "Which Renewable Energy Policy is a Venture Capitalist's Best Friend? Empirical Evidence from a Survey of International Cleantech Investors." *Energy Policy* 37(12): 4997–5006.

Chang, Y., Z. Fang, and Y. Li. 2016. "Renewable energy policies in promoting financing and investment among the East Asia Summit countries: Quantitative assessment and policy implications". *Energy Policy* 95: 427–436.

Chen, S.-S., H.-Y. Chen, C.-C. Chang, and S.-L. Yang. 2013. “How do Sovereign Credit Rating Changes affect Private Investment?” *Journal of Banking & Finance* 37, no. 12: 4820–33.

Chen, W-M., H. Kim, and H. Yamaguchi. 2014. “Renewable energy in eastern Asia: Renewable energy policy review and comparative SWOT analysis for promoting renewable energy in Japan, [Republic of Korea], and [Taipei,China].” *Energy Policy* 74: 319–329.

Cherif, M., and K. Gazdar. 2011. “What Drives Venture Capital Investments in Europe? New Results from a Panel Data Analysis.” *Journal of Applied Business and Economics* 12, no. 3: 122–39.

Clarysse, B., M. Knockaert, and M. Wright. 2009. “Benchmarking UK Venture Capital to the US and Countries.” *Report for British Private Equity and Venture Capital Association*. https://www.bvca.co.uk/Portals/0/library/Files/News/2008/2008_0008_benchmarking_uk_vc_to_israel_and_us.pdf?ver=2012-05-02-162112-000. Accessed on 15 March 2021.

Deleidi, M., M. Mazzucato, and G. Semieniuk. 2020. “Neither Crowding In nor Out: Public Direct Investment Mobilising Private Investment into Renewable Electricity Projects.” *Energy Policy* 111195.

Enerdata. 2020. “Global Energy & CO2 Data.” https://www.enerdata.net/research/energy-market-data-co2-emissions-database.html.

Eyraud, L., B. Clements, and A. Wane. 2013. “Green Investment: Trends and Determinants.” *Energy Policy* 60: 852–65.

Faberberg, J. 1987. “A Technology Gap Approach to Why Growth Rates Differ”. *Research Policy* 16, Issues 2–4: 87–99.

Frankfurt School-UNEP Centre/BNEF. 2020. “Global Trends in Renewable Energy Investment 2020.” https://www.fs-unep-centre.org/wp-content/uploads/2020/06/GTR_2020.pdf.

Ghura, D., and B. Goodwin. 2000. “Determinants of Private Investment: A Cross-Regional Empirical Investigation.” *Applied Economics* 32, no. 14: 1819–29.

Gompers, P., and J. Lerner. 1998. “What Drives Venture Capital Fundraising?” *Brookings Papers on Economic Activity*. *Microeconomics* 149–192 https://doi.org/10.2307/2534802.

Hayashi, F. 2011. *Econometrics*. 3rd edition. Princeton, NJ: Princeton University Press. Intergovernmental Panel on Climate Change (IPCC). (2018). Global Warming of 1.5 °C, IPCC, https://www.ipcc.ch/sr15/.

International Energy Agency. 2019. “Southeast Asia Energy Outlook 2019.” https://www.iea.org/reports/southeast-asia-energy-outlook-2019.

International Energy Agency (IEA) and International Renewable Energy Agency (IRENA). 2020. Joint Policies and Measures Database for Global Renewable Energy. Paris: International Energy Agency. https://www.iea.org/policies (accessed 15 March 2021).

International Renewable Energy Agency. 2016. “Renewable Energy Outlook for ASEAN.” https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_REmap_ASEAN_2016_report.pdf.

Jeng, L. A., and P. C. Wells. 2000. “The Determinants of Venture Capital Funding: Evidence across Countries.” *Journal of Corporate Finance* 6, no. 3: 241–89.

Justman, M. and M. Teubal 1991. “A Structuralist Perspective on the Role of Technology in Economic Growth and Development.” *World Development* 19(9): 1167–1183.

Kelly, R. 2012. “Drivers of Private Equity Investment Activity: Are Buyout and Venture Investors Really So Different?” *Venture Capital* 14, no. 4: 309–30.

Louw, A. 2016. “Global Trends in Clean Energy Investment.” Bloomberg New Energy Finance. https://www.bbhub.io/bnef/sites/4/2016/10/BNEF_2016-10-10_Clean-energy-investment-Q3-2016-factpack.pdf (accessed 15 March 2021).

Mazzucato, M. and G. Semieniuk. 2018. “Financing renewable energy: Who is financing what and why it matters.” *Technological Forecasting and Social Change* 127: 8–22.

Menanteau, P., D. Finon, and M. L. Lamy. 2003. “Prices versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy.” *Energy Policy* 31, no. 8: 799–812.

OECD. 2016. *OECD Business and Finance Outlook 2016.* Paris: OECD Publishing.

Plank, J., and C. Doblinger. 2018. “The Firm-Level Innovation Impact of Public R&D Funding: Evidence from the German Renewable Energy Sector.” *Energy Policy* 113, 430–38.

Schmid, G. 2012. “The Development of Renewable Energy Power in India: Which Policies have been Effective?.” *Energy Policy* 45: 317–326.

Shen, J. and C. Luo. 2015. “Overall Review of Renewable Energy Subsidy Policies in China - Contradictions of Intentions and Effects.” *Renewable and Sustainable Energy Reviews* 41: 1478–1488.

Servén, L. 2006. “Real-Exchange-Rate Uncertainty and Private Investment in LDCS.” *Review of Economics and Statistics* 85, no. 1: 212–8.

Toan, P.K., N.M. Bao, and N.H. Dieu. 2011. “Energy Supply, Demand, and Policy in Viet Nam, with Future Projections.” *Energy Policy* 39(11): 6814–6826.

Tongsopit, S. and C. Greacen. 2013. “An Assessment of Thailand's Feed-in Tariff Program.” *Renewable Energy* 60: 439–445.

Wang, F., H. Yin, and S. Li. 2010. “China’s Renewable Energy Policy: Commitments and Challenges.” *Energy Policy* 38(4): 1872–1878.

United Nations (UN). (2017). Bridging Climate Ambition and Finance Gaps, UN Climate

Press Release, 13 November, https://unfccc.int/news/bridging-climate-ambitionand-finance-gaps.

Wai, U. T., and C. Wong. 1982. “Determinants of Private Investment in Developing Countries.” *Journal of Development Studies* 19, no. 1: 19–36.

World Bank Group. 2018. *Women, Business and the Law 2018*. Washington, DC: World Bank. https://openknowledge.worldbank. org/bitstream/handle/10986/29498/9781464812521.pdf.

APPENDIX

Table A1: Correlation Matrix

	Asset Fin.	Cor. R&D	Public Mkt	Vent. Cap.	GERD	GDP pc	GDP gr	Fixed Cap.	Infl.
Asset Fin.	1.00								
Cor. R&D	0.41	1.00							
Public Mkt	0.57	0.36	1.00						
Vent. Cap.	0.50	0.26	0.41	1.00					
GERD	0.53	0.48	0.40	0.33	1.00				
GDP pc	–0.07	0.16	0.00	0.05	0.18	1.00			
GDP gr	0.10	0.02	0.13	0.05	0.06	–0.56	1.00		
Fixed cap.	0.10	0.07	0.14	–0.06	0.17	–0.58	0.69	1.00	
Infl.	0.06	–0.10	0.03	0.07	–0.19	–0.51	0.35	0.26	1.00
Pub. Debt	–0.01	0.18	–0.12	–0.03	0.04	0.23	–0.35	–0.40	–0.32
Bond yld	0.02	–0.21	–0.05	0.03	–0.33	–0.65	0.12	0.05	0.63
Stk. Mkt. Cap.	0.02	0.11	0.13	0.18	0.16	0.38	0.03	–0.06	–0.14
Energy price	–0.08	0.09	0.00	–0.14	0.24	0.46	–0.17	–0.02	–0.29
Tech cost	0.02	0.00	0.09	0.16	0.19	0.00	0.00	0.00	0.02
FIT	0.14	–0.09	0.09	0.03	0.04	0.20	–0.16	–0.13	–0.20
Reg. Q	–0.08	0.09	0.00	0.01	0.10	0.93	–0.49	–0.51	–0.43
VIX	0.02	–0.07	0.04	0.11	–0.06	–0.05	–0.03	0.08	0.23

	Pub. Debt	Bond Yd	Stk. Mkt. Cap.	Energy Price	Tech. Cost	FIT	Reg. Q	VIX
Asset Fin.								
Cor. R&D								
Public Mkt								
Vent. Cap.								
GERD								
GDP pc								
GDP gr								
Fixed cap.								
Infl.								
Pub. Debt	1.00							
Bond yld	–0.35	1.00						
Stk. Mkt. Cap.	0.00	–0.33	1.00					
Energy price	0.10	–0.51	0.04	1.00				
Tech cost	–0.01	0.01	–0.01	0.01	1.00			
FIT	0.07	–0.28	0.06	0.17	0.05	1.00		
Reg. Q	0.14	–0.63	0.47	0.43	0.00	0.32	1.00	
VIX	–0.15	0.20	–0.17	0.01	0.03	0.01	0.00	1.00

Source: Authors' calculations.

Table A2: Estimation by OLS of Alternative Models – The Determinants of Private Investment in Renewable Energy by Financing Source

	Asia				Global			
	Asset Finance	Corporate R&D	Public Market	Venture Capital	Asset Finance	Corporate R&D	Public Market	Venture Capital
Energy-specific variables								
Govt R&D, log	1.280***	0.790***	0.424***	0.071	1.166***	0.530***	0.443***	0.287***
	(0.089)	(0.075)	(0.073)	(0.049)	(0.064)	(0.042)	(0.045)	(0.032)
FIT, binary	3.478***	0.725**	2.163***	1.455***	2.750***	0.436	1.408***	1.031***
	(0.376)	(0.319)	(0.312)	(0.212)	(0.409)	(0.268)	(0.284)	(0.207)
Energy price	0.735	–1.810	–1.092	–0.346	–4.33***	–2.174***	–0.821	–1.298**
	(1.754)	(1.487)	(1.454)	(0.989)	(1.151)	(0.754)	(0.800)	(0.582)
Tech. cost	–0.219	0.287**	0.188	0.106	–0.51***	–0.241***	0.002	0.160**
	(0.171)	(0.145)	(0.141)	(0.096)	(0.132)	(0.087)	(0.092)	(0.068)
Reg. qlty x FIT	–3.893***	–0.125	–1.91***	–1.79***	–1.36***	–1.008***	–1.02***	–0.791***
	(0.568)	(0.481)	(0.471)	(0.320)	(0.354)	(0.232)	(0.246)	(0.179)
Macroeconomic and institutional factors								
GDP per capita	0.000	0.000**	–0.000	–0.000	–0.000	0.0000	–0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP growth	0.224	–0.184	–0.126	0.184	0.121	–0.141*	0.080	0.367***
	(0.211)	(0.179)	(0.175)	(0.119)	(0.117)	(0.077)	(0.082)	(0.059)
Fixed capital	–0.055	–0.196**	–0.024	–0.002	0.005	0.089***	–0.008	–0.074***
	(0.105)	(0.089)	(0.087)	(0.059)	(0.033)	(0.022)	(0.023)	(0.017)
Inflation, log	0.364	–0.100	0.342	0.172	0.212	0.0647	0.0809	0.154*
	(0.375)	(0.318)	(0.311)	(0.211)	(0.158)	(0.103)	(0.110)	(0.079)
Pub. debt/GDP	0.017**	–0.006	–0.009	0.005	0.007**	0.013***	–0.005**	–0.001
	(0.008)	(0.007)	(0.007)	(0.005)	(0.003)	(0.002)	(0.002)	(0.002)
Reg. qlty	–0.687	–6.498***	1.077	1.964	1.714***	1.297***	0.858**	–0.040
	(2.614)	(2.216)	(2.167)	(1.474)	(0.618)	(0.404)	(0.429)	(0.312)
GDPpcXGDPgr	–0.000	0.000	0.000	–0.000	–0.000	0.000***	–0.000	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000	(0.000)
Financial factors								
VIX (Global)	–0.003	0.058**	0.088***	0.011	0.001	–0.008	0.016	0.029**
	(0.033)	(0.028)	(0.027)	(0.019)	(0.023)	(0.015)	(0.016)	(0.012)
Bond yield	0.332	–0.266	–0.483*	0.094	0.325***	0.125**	0.066	0.116**
	(0.317)	(0.269)	(0.263)	(0.179)	(0.095)	(0.062)	(0.066)	(0.048)
Stock mkt cap	0.004	0.016*	0.018**	0.007	–0.007	–0.006*	0.006*	0.0101***
	(0.010)	(0.009)	(0.009)	(0.006)	(0.005)	(0.003)	(0.003)	(0.002)
Constant	–7.086	12.56*	8.045	0.257	17.08***	5.694	3.092	4.164
	(7.538)	(6.389)	(6.249)	(4.249)	(5.592)	(3.661)	(3.884)	(2.827)
Observations	200	200	200	200	650	650	650	650
R-squared	0.747	0.582	0.524	0.491	0.412	0.345	0.231	0.327

Note: All of the dependent variables are in logarithms, while all independent variables are lagged by one period. Standard errors in parentheses; ***, **, and * denote p<0.01, p<0.05, and p<0.1, respectively.

Table A3: Correlation Matrix of SUR Residuals

	log_Asset_fin	log_Corp_RD	log_Pub_Mkt	log_Venture_cap
Asia				
log_Asset_fin	1			
log_Corp_RD	0.3159	1		
log_Pub_Mkt	0.2672	0.2881	1	
log_Venture_cap	0.2657	0.0276	0.052	1
Breusch-Pagan test of independence: chi2(6) = 65.637, Pr = 0.0000				
Total Sample				
	log_Asset_fin	**log_Corp_RD**	**log_Pub_Mkt**	**log_Venture_cap**
log_Asset_fin	1			
log_Corp_RD	0.231	1		
log_Pub_Mkt	0.4338	0.2469	1	
log_Venture_cap	0.3963	0.1717	0.2691	1
Breusch-Pagan test of independence: chi2(6) = 364.944, Pr = 0.0000				