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**A MODEL FOR UTILIZING SPILLOVER
TAXES AND COMMUNITY-BASED
FUNDS TO FILL THE GREEN ENERGY
FINANCING GAP IN ASIA**

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Abstract

In 2016, 88.90% of Asia and the Pacific's primary energy consumption was from fossil fuel, and almost 40% of the global CO₂ emissions were from Asia and the Pacific. In order to ensure the increasing energy needs of the region are in line with sustainable development goals, addressing the financing gaps of green-energy projects is critical. The major challenge for filling the financing gaps of green energy is the lower rate of return on green projects compared to fossil fuels. Electricity tariffs are often regulated by governments. Electricity has to be kept low in price to serve every household as a necessary good. Green energy's sources of revenue are only from user charges. Hence, it is not so attractive to investors. This paper proposes a model for utilization of the tax revenue spillover from green-energy supply by returning a portion of the taxes to green-energy projects in order to increase their rate of return. In addition, the paper proposes a social community-based funding scheme for smaller-scale green projects (e.g., solar and wind). The paper theoretically shows that using this model for funding green-energy projects will increase the rate of return and make them feasible and interesting to private investors.

Keywords: green energy, green finance, renewable energy, hometown investment trust funds, community-based fund, spillover effect

JEL Classification: Q21, E62, G21

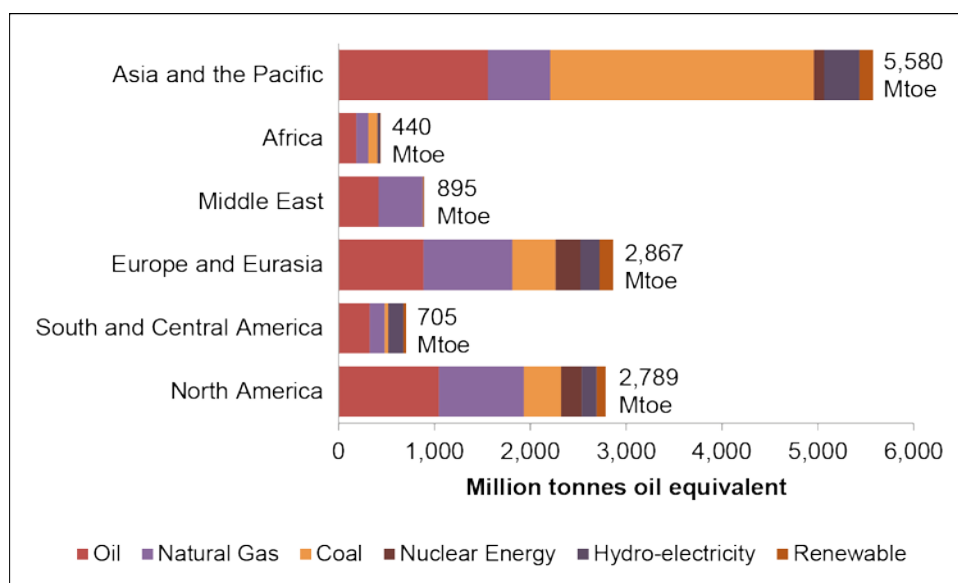
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1. INTRODUCTION

Asia is the leading consumer of oil, coal, hydroelectricity, and, for the first time in 2016, the leading consumer of renewables in power generation, overtaking Europe and Eurasia. Europe and Eurasia remain the leading consumers of natural gas and nuclear power. Asia dominates global coal consumption, accounting for almost three-quarters of global consumption (73.80%). Fossil fuels are the main sources of fuel for the Asian economies; their greater reliance on fossil fuels has caused climate issues and global warming to become serious matters. Figure 1 compares the primary energy consumption in Asia and the Pacific with Africa, the Middle East, Europe and Eurasia, South and Central America, and North America. In 2016, 49.34% of energy consumption in Asia and the Pacific was from coal; their share of oil was 27.90%, and their share of natural gas and LNG was 11.65%. This means a total of 88.90% of the energy consumption in Asia and the Pacific was from fossil fuel and less than 12% of energy consumption was from nuclear and renewable energy resources (BP 2017)

Figure 1: Regional Consumption of Energy by Fuel, 2016



Mtoe = Million tons oil equivalent.
 Source: BP (2017).

Most climate scientists agree that the main cause of the current global warming trend is human aggravation of the "greenhouse effect" from fossil fuel warming that is a consequence of the atmosphere trapping heat radiating from Earth toward space. Hence, renewable-energy projects would be a sustainable solution for mitigating the climate issues from the current serious level.

Another reason for the development of renewable projects is raising energy self-sufficiency¹ and energy security by diversification of energy resources. Too much reliance on limited resources of energy (coal, oil, or gas) will reduce the resiliency of the economy and make it more prone to energy price fluctuations. Several studies (see, inter alia, Hamilton 1983; Barsky and Killian 2004; Taghizadeh-Hesary et al.

¹ Domestic production of primary energy (including nuclear)/domestic supply of primary energy x 100 (Yoshino, Taghizadeh-Hesary, and Tawk 2017).

2013, 2016; Taghizadeh-Hesary and Yoshino 2016) have evaluated the impacts of oil price fluctuations on various macroeconomic indicators and generally found that oil shocks are disruptive to economic growth and create inflation for most oil-importing countries.

In a more recent study, Taghizadeh-Hesary, Yoshino, and Rasoulinezhad (2017) showed that after the Fukushima nuclear disaster in March 2011, which resulted in the shutting down of nuclear plants and the substitution of nuclear power with fossil fuels, energy security in Japan suffered. The authors applied a cointegration analysis and performed a vector error correction (VEC) variance decomposition by using quarterly data from Q1 1981 to Q4 2010 and from Q1 2011 to Q4 2015. Their findings reveal that the absolute value of elasticities in oil consumption in some economic sectors decreased after the disaster because of an increased dependency on oil consumption, which endangered the country's energy security. They suggested that to raise energy self-dependency and energy security, Japan needs to diversify its energy supplies.

As a result of eliminating nuclear power generation and substituting it with fossil fuels, energy self-sufficiency fell from 19.6% in fiscal year 2000 to 8.6% in fiscal year 2013 (MIAC 2015). Before the 2011 earthquake, Japan was the third largest consumer of nuclear power in the world after the United States and France. In 2010, nuclear power accounted for about 13% of Japan's total energy supply (Taghizadeh-Hesary et al. 2016). In 2012, the nuclear energy share fell to 1% of total energy supply (and contributed at a similar level to primary energy consumption in 2013 because only two reactors were operating for a little more than half of the year). In 2014–2015, Japan did not generate any nuclear power (Taghizadeh-Hesary and Yoshino 2015).

Hence, increasing the share of renewable energy resources in the energy basket is required. One of the obstacles to development of renewable-energy projects is lack of private sector finance. Easing finance for investment in green-energy projects is a key challenge for climate change mitigation (Dangerman and Schellnhuber 2013; Grubb 2014; Stern 2015).

In recent years, several new methods for financing green-energy projects have been developed, including green bonds, green banks, and village funds. Green banks and green bonds have some potential to help clean-energy financing. The advantages of green banks include improved credit conditions for clean-energy projects, aggregation of small projects to reach a commercially attractive scale, creation of innovative financial products, and market expansion through dissemination of information about the benefits of clean energy. Supporters of green bonds believe that they can provide long-term and reasonably priced capital to refinance a project once it has passed through the construction phase and is operating successfully (NRDC 2016). However, it is necessary to secure a high rate of return to mitigate various risks associated with green energy.

Although the aforementioned methods were somehow helpful for development of green projects, the data suggest they are inadequate. Fossil fuel investments continue to be much larger than investments in renewable energy. In 2013, renewable energy received investments of about \$260 billion, which is only 16% of the \$1.6 trillion in total energy-sector investments (IEA 2014). Meanwhile, investment in fossil fuels in the power sector, where they compete directly with electricity from renewable energy, rose by 7% from 2013 to 2014 (UNEP and BNEF 2015). Clearly, fossil fuels still dominate energy investment. A major concern in the transition to low-carbon energy provision, therefore, is how to obtain sufficient financing to steer investments toward renewable energy (Mazzucato and Semieniuk 2017).

Due to the limitations of the Basel capital requirements on lending by financial institutions, and because banks consider most renewable-energy projects as risky, banks are reluctant to finance them. Hence, only relying on bank financing is not a sustainable solution for funding green-energy projects, and we need to look for new channels of financing this sector to fill the financing gap for such projects.

In line with nonbanking financing solutions, Gouldson et al. (2015) proposed revolving funds as an innovative financing mechanism that could reduce investment requirements and enhance investment impacts by recovering and reinvesting some of the savings generated by early investments. Such funds have been created in various contexts. Gouldson et al. (2015) proposed a generic revolving fund model and applied it by using data on the costs and benefits of domestic-sector retrofitting in the UK. They found that a revolving fund could reduce the costs of domestic-sector retrofitting in the UK by 26%, or £9 billion. They concluded that revolving funds could enable countries with limited resources to invest more heavily and more effectively in low-carbon developments, even in contexts of austerity. Ng and Tao (2016), explored the cause of the financing gap in Asia and proposed the use of bond financing to address the financing gap, specifically, three fixed-income instruments: local currency denominated corporate bonds, asset-backed project bonds and financial green bonds. In the most recent research examining the potential of the capital market for filling the financing gap of green-energy projects, Monaca, Assereto, and Byrne (2018) examined whether publicly traded financial products offer investors competitive risk-adjusted returns, or whether renewable-energy investors face a penalty for choosing sustainable assets. They used a traditional portfolio approach to test whether adding renewable energy exchange-traded funds (ETFs) to a standard portfolio provides diversification benefits over study periods of two, six, and nine years. Their results show that the renewable energy ETFs provide only minimal diversification benefits.

Our paper provides two types of innovative financing solutions which involve utilizing spillover taxes originally generated by green-energy supply and returning them to green-energy projects in order to increase the rate of return of these projects to make them interesting to private investors. The first solution is more practical for larger green-energy projects (hydropower). The second uses hometown investment trust funds, community-based trust funds for filling the financing gap of smaller scale green-energy projects (solar and wind). This paper's proposed method is the joint utilization of spillover tax payments and the hometown investment trust (HIT) funds (HITs) to increase the supply of funds to green-energy projects (see Yoshino and Kaji 2013; Yoshino and Taghizadeh-Hesary 2014a).

The paper is structured as follows. In section 2, we propose utilization of the spillover effect for the green-energy projects. Section 3 focuses on modelling the utilization of the spillover effects of green-energy supply and application of hometown investment trust funds in green finance. The last section provides concluding remarks.

2. UTILIZATION OF THE SPILLOVER EFFECTS OF GREEN-ENERGY SUPPLY

Asian economies are usually characterized as bank-oriented economies. Banks account for a major share of the financial system in almost all Asian countries. Western economies are more capital market-oriented. When looking at the financial assets of households in Asian countries, bank deposits and cash in most of them account for the largest share, with insurance companies and pension funds accounting for the

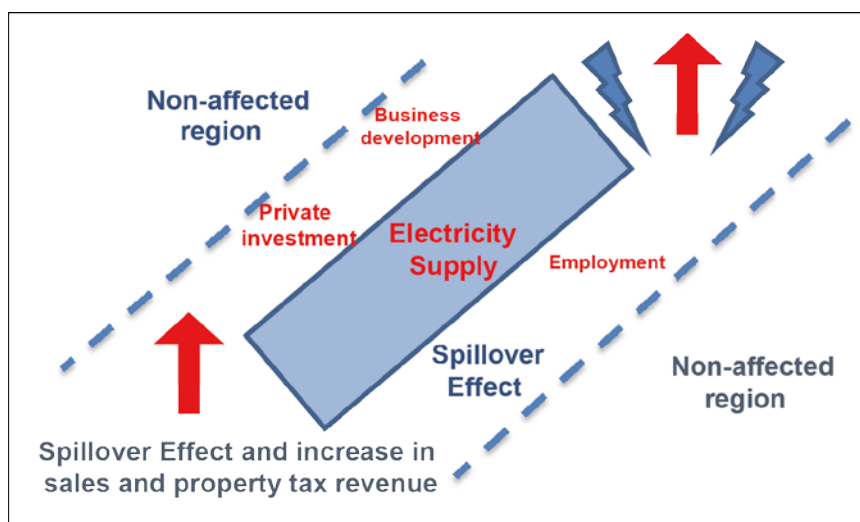
second-largest share. In Japan in 2013, 55% of the total financial assets of households were in the form of cash and deposits at banks, 28% in the form of insurance and pensions, 12% in the form of securities and stock, and 5% in other forms. For American households, these ratios were 15% (cash and deposits), 28% (insurance and pension funds), 53% (securities and stock), and 4% (others), respectively (Yoshino and Taghizadeh-Hesary 2014b). Even in Japan, which has a developed capital market, the share of cash and deposits is much larger than that of securities and stock. In other Asian economies, the situation is similar to that in Japan, i.e., banks dominate the financial system, pension funds and insurance companies are second, and the share of the capital market is small. This means that banks, insurance companies, and pension funds will be the main sources of finance for projects and businesses.

Bank loans are suitable for financing short- to medium-term projects because the resources of banks are bank deposits, which typically are short-term or medium-term resources—usually one year, two years, and at most five years (deposits longer than five years are very rare). Hence, if banks allocate their resources to long-term infrastructural projects (bridges, highways, ports, airports, etc.) and mega energy projects (such as large hydropower projects), there would be a maturity mismatch. Therefore, because banks' liabilities (deposits) are short- to medium-term, their assets (loans) also need to be allocated to short- to medium-term projects rather than to long-term projects.

Insurance and pensions are alternatives to long-term investments (10, 20, 30 years). Large projects, such as big hydropower, gas-, or coal-based power plants can be financed by insurance companies or pension funds because they are long-term (10–20-year) projects.

Having said that, electricity tariffs are often regulated by the government, and this makes it difficult for private financial institutions such as pension funds or insurance companies to finance energy projects. Hence, to increase the investment incentives, it is necessary to utilize the *spillover effects* originally created by energy supplies, and refund the tax revenues to investors in the energy projects (Figure 2). Energy supply will bring factories and businesses into the region. New residences will be constructed and property values will rise. Corporate income property, and sales taxes will rise in the area of new energy supply. All these spillover tax revenues were collected by either local governments or central governments, and they were not returned to investors in energy projects. They relied only on user charges accrued from electricity supply. If part of the spillover tax revenues had been returned to private investors, their rate of return would have increased not only for one period but also for longer periods, and their maintenance costs could have been supported.

It is possible to measure the spillover effect of an energy project based on economic growth in a specific region. To create an incentive for the private sector to invest in a particular energy project, the government should refund all or part of the spillover taxes to the private-sector investor. Yoshino and Abidhadjaev (2017) measured the spillover effects of Uzbekistan's Tashguzar–Baysun–Kumkurgan (TBK) railway connection (infrastructural project) and Japan's fast train on Kyushu island. They explained the impact of the project on growth rates of regional gross domestic product (GDP) and sectoral value added by using a difference-in-difference methodology; the same method could be used to calculate the spillover effect of energy projects.

Figure 2: Spillover Effects of Green-Energy Projects

Source: Yoshino and Taghizadeh-Hesary (2018).

3. MODELLING THE UTILIZATION OF SPILLOVER EFFECTS OF GREEN ENERGY AND APPLICATION OF HOMETOWN INVESTMENT TRUST FUNDS IN GREEN FINANCE

In Japan, the hometown investment trust (HIT) funds are a newly created source of financing for supporting solar and wind power. The basic objective of the HIT funds is to connect local investors with projects in their own locality where they have personal knowledge and interests. Individual investors choose their preferred projects and make investments via the internet (Yoshino and Kaji 2013). One of the major applications of HITs in Japan relates to wind-power and solar-power projects, which have raised money from individuals (about \$100 to \$5,000 per investor) interested in promoting green energy. Through these funds, many Japanese people invest small amounts of money in the construction of wind power and solar power. The advertisement of each wind-power and solar-power project on the internet plays an important role in pushing people to invest in these projects. Internet marketing companies provide the platforms for investment in these projects and are able to market these projects. Local banks have started to make use of the information provided by HIT funds. If these projects are done properly and are received well by individual investors, banks can then start to grant loans for those projects. In this way, renewable projects (wind and solar), most of which are considered risky, can be supported by HIT funds until they are able to borrow from banks. The use of alternative financing vehicles, such as HIT funds, has therefore assisted the growth of solar and wind projects in Japan, where the finance sector is still dominated by banks (Yoshino and Kaji 2013; Yoshino and Taghizadeh-Hesary 2014a).

HIT funds have expanded from Japan to Cambodia, Viet Nam, and Peru. They are also attracting attention from the Government of Thailand, Malaysia's central bank, and Mongolia.

Asia's finance sectors are still dominated by banks, and the venture capital market is generally not well developed. However, internet sales are gradually expanding and the use of alternative financing vehicles such as HIT funds will help risky sectors in Asia to grow.

The Hokkaido Green Fund, established in 2000 to finance wind-power projects in northern Japan, was generated by donations. As it was very difficult to raise money from banks, only 20% of total investments are financed by banks and the other 80% was obtained from individual investors and through donations. The community wind-power corporation runs wind power and sells electricity to the power company that supplies power to the region. In many cases, the price of the power produced by wind is 5% higher than that of other forms of electricity, but users are willing to pay 5% extra to save the environment. More than 19 wind-power projects were constructed in northern Japan using a similar method. There are also examples of solar-power projects in Japan where local governments put money (seed money) into the community fund as an incentive for private investors.

Another example is the revitalization of an old hydropower plant in Japan's Nara prefecture. It was constructed in 1914, but decades later it was abandoned and abolished. The local community and individual investors raised money (one unit of investment was \$300) and 274 individuals invested in the revitalization through HIT funds. The total cost amounted to \$500,000, and 184 households received electricity from the revitalized dam and money from the surplus electricity is sold to the power company in the region.

Although HITs are a form of crowdfunding, there are significant differences between HITs and conventional types of crowdfunds: i) there is a "warm feeling" behind the HIT funds because investors are sympathetic to the company/project owners, who are not solely in it for profit, and their efforts; ii) investors are ready to receive product or services generated by the project (e.g., the electricity generated by a wind-power generator) instead of a share of the profits; iii) the intermediary/assessor of HITs will monitor the project frequently to ensure that investors will not lose money and the intermediary/assessor also provides advice when the project faces some difficulty. This is unlike crowdfunding or venture capital where profit is the only purpose of investment.

3.1 Utilizing HIT funds for Green-Energy Projects

Investors' (households) utility function depends on the rate of return and risk. Equation (1) shows the utility function of investors, which is a function of rate of return and risk:

$$U = U(r_t, \sigma_t) = r_t - \beta \sigma_t^2 \quad (1)$$

where r_t denotes the rate of return, σ_t denotes the risk, and β is the weight for the risk. If an investor gives more weight to the risk, then β will be larger. A smaller β means that the investor is not so concerned about risk.

Equation (2) shows the total rate of return of households' investments. We are assuming that households are putting their money either in bank deposits or in HIT funds that will be invested into green-energy projects.

$$r_t = \alpha_t r_t^D + (1 - \alpha_t) r_t^E \quad (2)$$

In equation (2), we are assuming that α percent of the households' assets is going to bank deposits, and the rate of return on bank deposits or the deposit interest rate is r_t^D . On the other hand, $(1 - \alpha)$ percent of their assets are invested in HIT funds and r_t^E denotes the rate of return on HIT funds.

$$\sigma_t = \alpha_t \sigma_t^D + (1 - \alpha_t) \sigma_t^E \tag{3}$$

Equation (3) is the aggregated risk. There are two types of risk associated with households' investments. The first risk is for deposit (σ_t^D) and the second risk is for HIT funds investment (σ_t^E). If the deposit interest rate is fixed and not fluctuating, then σ_t^D is zero.

Table 1: Return-Risk Trade-Off for Households' Investments

| | Return | Risk |
|-----------------------|---------|--------------|
| Safer Assets | r_t^D | σ_t^D |
| Green Energy Projects | r_t^E | σ_t^E |

Source: Authors.

Table 1 shows the risk-return trade-off for the households' investments. If a household invests in safer assets (here: deposit), the return is r_t^D and the risk is σ_t^D , which we assume to be zero. If the household invests in green-energy projects that have a higher risk (σ_t^E) and expect to make a higher return (r_t^E), there is a trade-off between risk and return.

Next, in equation (4) we are looking at the dynamic welfare function and two constraints that are presented in equations (4.1) and (4.2):

$$W = \int_0^\infty e^{-\theta t} . U(r_t, \sigma_t) \tag{4}$$

$$s. t. r_t = \alpha_t r_t^D + (1 - \alpha_t) r_t^E \tag{4.1}$$

$$\sigma_t = \alpha_t \sigma_t^D + (1 - \alpha_t) \sigma_t^E \tag{4.2}$$

In the next step, we develop the Hamiltonian and present it in equation (5) in which the utility functions are shown in parentheses:

$$H = e^{-\theta t} (r_t - \beta \sigma_t^2) \tag{5}$$

$$= e^{-\theta t} [\{\alpha_t r_t^D + (1 - \alpha_t) r_t^E\} - \beta \{\alpha_t \sigma_t^D + (1 - \alpha_t) \sigma_t^E\}^2]$$

α is the ratio of allocation between deposits and HITs to green-energy projects. If $\alpha = 1$, that means households are putting all their money in bank deposits. If α becomes smaller, then the ratio of investment in HITs and green energy is increasing. In the next step, we maximize the Hamiltonian with respect to α , and the results are equation 6 and 6.1:

$$\frac{\partial H}{\partial \alpha_t} = e^{-\theta t} [(r_t^D - r_t^E) - 2\beta \{\alpha_t \sigma_t^D + (1 - \alpha_t) \sigma_t^E\} (\sigma_t^D - \sigma_t^E)] \tag{6}$$

$$(r_t^D - r_t^E) - 2\beta \alpha_t (\sigma_t^D - \sigma_t^E)^2 - 2\beta \sigma_t^E (\sigma_t^D - \sigma_t^E) = 0 \tag{6.1}$$

Equation (7) shows the α that is obtained from Hamiltonian maximization:

$$\alpha_t = \frac{(r_t^D - r_t^E) - 2\beta\sigma_t^E(\sigma_t^D - \sigma_t^E)}{2\beta(\sigma_t^D - \sigma_t^E)^2} \tag{7}$$

We can rewrite equation (7) by dividing the numerator and denominator by 2β , and we write equation (8):

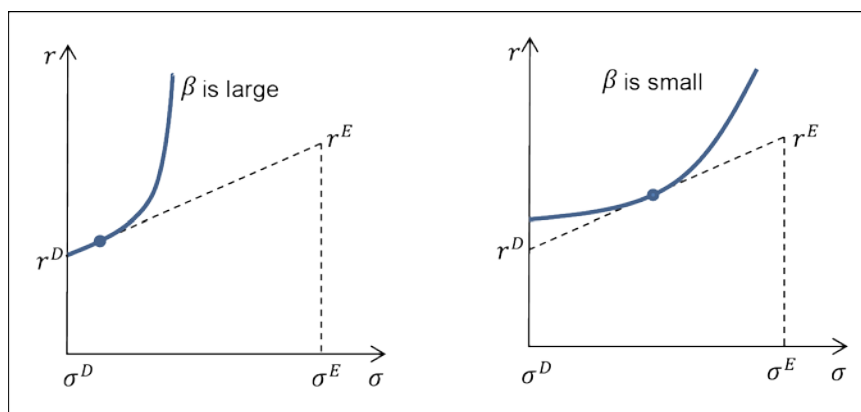
$$\alpha_t = \frac{\frac{1}{2\beta}(r_t^D - r_t^E) - \sigma_t^E(\sigma_t^D - \sigma_t^E)}{(\sigma_t^D - \sigma_t^E)^2} \tag{8}$$

Equation (9) shows changes of α_t with respect to β :

$$\frac{\partial \alpha_t}{\partial \beta} = -\frac{1}{2\beta^2} \cdot \frac{(r_t^D - r_t^E)}{(\sigma_t^D - \sigma_t^E)^2} > 0 \tag{9}$$

Equation (9) shows that if the weight of the risk (β) increases, or if the households become more risk-averse and seek safer types of assets, α_t , which is the share of bank deposits in total assets, will increase, and households will invest less in HIT funds for green-energy projects.

Figure 3: Utility Functions with Regard to Different Risk Preferences



Source: Authors' compilation.

Figure 3 shows two cases of utility functions with regard to two different levels of risk preferences. On the left side, diagram β is large, which means households are very concerned about risk and are risk-averse. Therefore, they prefer safer assets and deposit a major part of their assets in banks that have zero risk in this example and a smaller amount in HIT funds that have higher risk and higher return. On the right side, the diagram shows that β is small, which means these are risk-taking households. Households are ready to take risk, so the utility function becomes flatter compared to the first case. Hence, they are investing a significant portion of their assets in HIT funds that give them r^E return but are associated with σ^E risk.

Equation (10) shows how α_t changes when the deposit interest rate (r_t^D) goes up:

$$\frac{\partial \alpha_t}{\partial r_t^D} = \frac{\frac{1}{2\beta}}{(\sigma_t^D - \sigma_t^E)^2} > 0 \quad (10)$$

Equation (10) shows that if the deposit interest rate goes up α_t , the share of savings in bank deposits goes up.

$$\frac{\partial \alpha_t}{\partial r_t^E} = \frac{-\frac{1}{2\beta}}{(\sigma_t^D - \sigma_t^E)^2} < 0 \quad (11)$$

Equation (11) shows that if the rate of return on HIT funds for green energy (r_t^E) increases, the share of investments in deposits, or α_t , will be reduced. That means households will be reluctant to put their money in bank deposits and instead will be more interested in investing in HIT funds for green-energy projects. If spillover tax revenues are returned to investors, the rate of return (r_t^E) increases and α_t will rise. Private investors will allocate much more money to green-energy projects.

$$\frac{\partial \alpha_t}{\partial \sigma_t^E} = \frac{[-(\sigma_t^D - \sigma_t^E) + \sigma_t^E](\sigma_t^D - \sigma_t^E) - [(r_t^D - r_t^E) - 2\beta \sigma_t^E (\sigma_t^D - \sigma_t^E)](-2\sigma_t^D + 2\sigma_t^E)}{(\sigma_t^D - \sigma_t^E)^2} > 0 \quad (12)$$

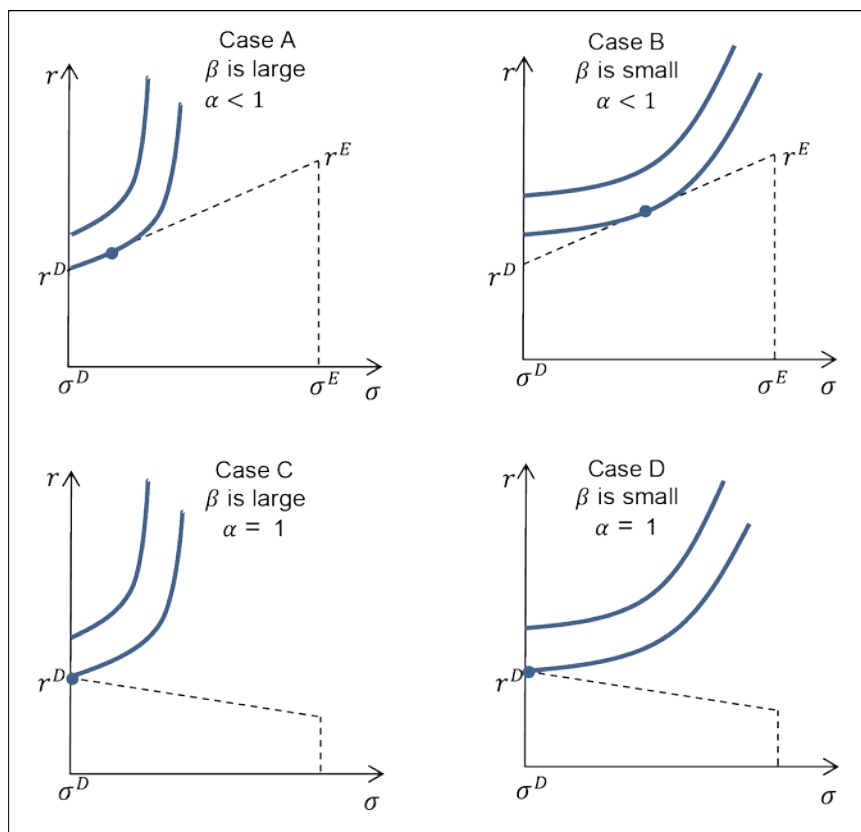
Equation (12) shows that if the risk of investment in HIT funds for green energy goes up, the share of investments in deposits or α_t increases. Figure 3 shows that the higher the rate of return on green energy ($r^E > r^D$), the larger the portion of households' investments will be in green-energy projects.

Figure 4 graphically summarizes all the mathematical equations presented in this subsection by showing the households' investment preference functions. Households' utility function depends on the rate of return and risk that are shown by r and σ , which is very typical in finance theory. Figure 4 displays four different cases. The top two diagrams show cases in which $\alpha < 1$, meaning that households are investing their assets in two forms, bank deposits and HIT funds for green-energy projects. Case A depicts risk-averse households (β is large) that prefer more risk-free types of assets (deposits) and less high-risk types of assets (green-energy projects). Case B depicts the risk-taker households (β is small) that prefer to take risk and invest more in HIT funds for green-energy projects and ultimately gain higher returns compared to Case A households. On the bottom are two cases (Case C and Case D) in which $\alpha = 1$, indicating that households keep only deposits without any investment in risky projects (green energy) when the rate of return from green energy is lower than the deposit rate of interest.

$$r = 1 \cdot r_D + 0 \cdot r_E \quad (13)$$

$$\sigma = 1 \cdot \sigma_D + 0 \cdot \sigma_E \quad (14)$$

Figure 4: Households' Investment Preferences



Source: Authors' compilation.

Equations (13) and (14) show Case C and Case D households that invest their assets only in the form of risk-free assets (bank deposits), and their investment in HIT funds for green-energy projects is zero (shown in Figure 4, Case C and Case D).

3.2 Utilizing Spillover Taxes in Development of Green-Energy Projects

As showed in section 3.1, if the rate of return on green-energy projects increases, households are more interested in investing in HIT funds for green-energy projects and reluctant to keep their assets in the form of bank deposits. Hence, it is very important to increase the rate of return on green-energy projects. In order to increase the rate of return on HIT funds for green energy, we are proposing the utilization of spillover tax revenue originally generated by energy supply.

Electricity tariffs/user charges collected by a power company are often regulated by governments because electricity, water, and other utilities are necessary goods for everyone. Therefore, if investors in green energy rely only on user charges, the rate of return will be very low. However, green energy supply creates lots of spillover effects in the region. Green energy can provide a constant supply of environmentally sustainable electricity into the region, and this could lead to the building of new apartments and new industries, as well as the entry of small and medium-sized enterprises into the region. Then property, income, sales, and corporate tax revenue from this region will increase.

$$dt = t \cdot dY \quad (15)$$

Equation (15) shows dt , which is the total increase in tax revenue from the spillover impact of regional development created by green-energy supply. t is the tax rate and dY is the increase in regional production created by green-energy supply.

$$Y = F(K, N, E) \quad (16)$$

Equation (16). shows the production function consists of private capital (K), labor (N) and green energy (E).

$$\frac{\partial Y}{\partial E} = \frac{\partial F}{\partial K} \cdot \frac{\partial K}{\partial E} + \frac{\partial F}{\partial N} \cdot \frac{\partial N}{\partial E} + \frac{\partial F}{\partial E} \quad (17)$$

Changes in Y with respect to green-energy supply are shown in Equation (17). The right side of Equation (17) consists of three components. The first component $(\frac{\partial F}{\partial K} \cdot \frac{\partial K}{\partial E})$ shows spillover effects from private capital. Green-energy supply in a region will bring restaurants, hotels and other services, small and medium-sized enterprises, and manufacturing into the region that will increase private capital (K), which will contribute to regional GDP. The second component on the right side, $(\frac{\partial F}{\partial N} \cdot \frac{\partial N}{\partial E})$, is the spillover effect through labor employment. Green-energy supply in the region will create new jobs, and an increase in jobs will increase the output. The last or third component is $(\frac{\partial F}{\partial E})$, which is energy by itself that has a direct effect in the region.

By using the trans-log production function, Japanese data and Thai data, Nakahigashi and Yoshino (2016) estimated the spillover effect of private capital and employment on the output level.

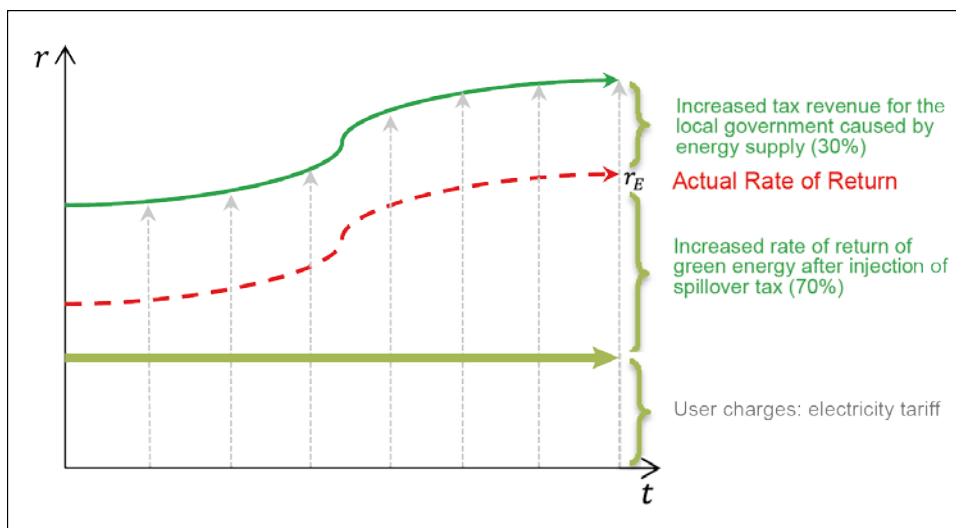
$$r_E = \left(\begin{array}{c} \text{Electricity price} \\ \text{or} \\ \text{User charges} \end{array} \right) + \gamma(tdY) \quad (18)$$

Originally, the electricity tariff was the only source of return on revenue of green-energy investors. In this case, r_E is very low when the rate of return comes only from Electricity tariff/ user charges. However, the spillover tax revenues can be returned to energy investors, in this case γ percent, for example, 60%. Then 60% of the increased tax revenue (tdY) will be returned to the private investors, and the rate of return (r_E) goes up, with the remaining 40% of the increase in tax revenue going to local government.

Equation (18) and Figure 5 show that if government returns spillover taxes to HITs that are designed for green-energy projects, the rate of return on the green-energy projects increases. This makes the projects feasible and interesting for hometown investors, and hence, the supply of investment money to these funds will increase (Figure 6).

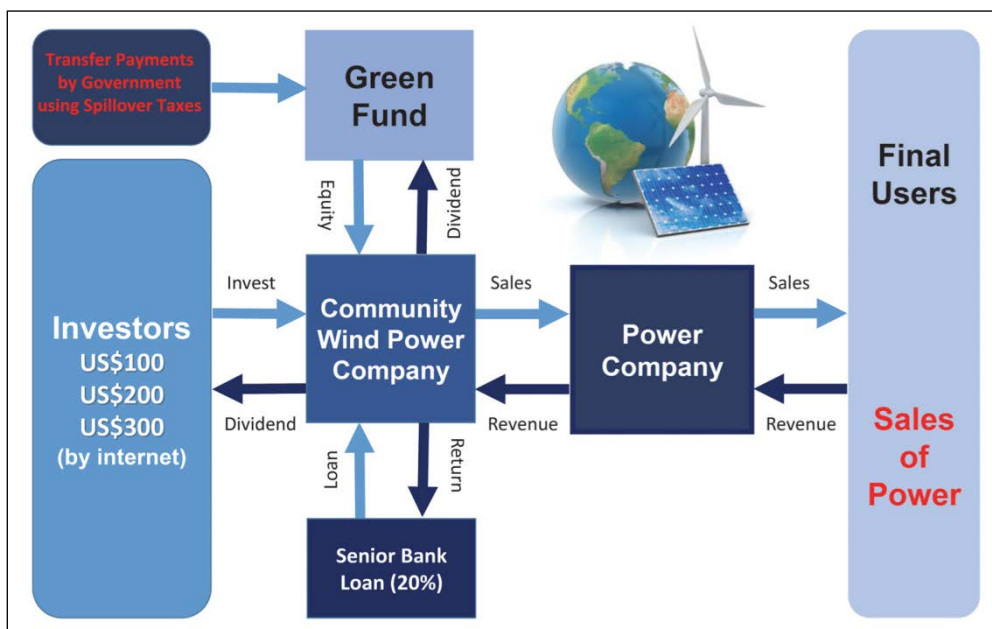
On the other hand, if HITs invest in very risky green-energy projects, this makes hometown investors reluctant to invest their money in these projects, which shrinks the supply of lending/investment to these sectors. Hence, it is crucial for fund managers to check the feasibility and creditworthiness of projects and select only projects with a high probability of success.

Figure 5: Spillover Effect of Green-Energy Supply and Rate of Return



Source: Authors' compilation.

Figure 6: Financing Scheme for Green-Energy Projects Using HITs and Spillover Tax Transfer Payments



HITs = hometown investment trust funds.

Source: Authors.

3.3 Stable Supply of Risk Capital to Renewable-Energy Sector

Due to environmental issues, and to increase energy self-sufficiency with a view to improving energy security in Asia, greater reliance on renewable energy resources is crucial. But as mentioned above, lack of access to finance is an obstacle to development of renewable-energy projects.

Asia has bank-centered financial systems, and though they offer micro credit, they loan out money at high interest rates so that risky borrowers, such as renewable-energy projects, struggle. It is essential that the HIT funds discussed here develop in Asia as investment alternatives to micro credit and venture capital.

For infrastructure investment or larger energy projects, it will in the future also be possible to put together funds in the form of infra funds (infrastructure investment trusts) and to implement project finance. When considering the establishment of HIT funds in Asia for investment projects (such as energy projects) that demand long-term funding, the question will be whether HIT funds can put together financing that will be stable for five years, 10 years, or even longer periods.

In the United States and Europe, venture capital and other funds tend to operate in the short term. Money from life insurance companies and pension funds is best suited for stable long-term funding. If private pension funds also begin to participate, demand will emerge in tandem with long-term HIT funds as places for them to invest. To engage in long-term fund management, it will be necessary for Asia to provide for an increase, on the fund-providing side, in pension funds and life insurance companies that seek long-term investments.

3.4 Fostering Sound Hometown Investment Trust Funds

HIT funds, forest investment funds for environmental protection, infrastructure funds, and other such investments are also expected to appear in areas removed from the main urban centers. When they do, it will be necessary to prevent the rise of unscrupulous investment fund companies that offer inferior projects for investment and have no commitment to the projects of the companies they are invested in and cause investors to lose.

When HIT funds are on a small scale, it is to be expected that many individual investors will consider the investment as support for the local region (i.e., solar power or wind power in a village). They can be expected to consider the investment trust will operate as a combination of contribution and investment. A variety of different regional assistance funds came into being, including HIT funds for the purpose of development of solar power and wind power in Japan, after the Great East Japan Earthquake that resulted in a nuclear disaster and people becoming more interested in non-nuclear clean energy resources (i.e., solar and wind) and starting to develop HITs for the development of their projects. HITs are expanding in Thailand, the Philippines, and Mongolia, and not only in Asia but also in many other countries outside the region, for example, in Peru.

The fund operators will have to set up a self-regulating organization that checks the activity of each fund and cultivates excellent operators who will not betray the confidence of investors. This is necessary; otherwise, the HIT funds that have finally managed to grow will lose credibility, people will not want to invest again, and HIT funds will not expand. It will be necessary to monitor the self-regulating organization as it supports excellent operators and eliminates unscrupulous operators. It will also be desirable to create a system whereby the Financial Services Agency (FSA) or other government authority monitors investment funds to eliminate unscrupulous operators.

4. CONCLUDING REMARKS

Fossil fuels, especially coal, are the main sources of fuel for Asian economies. Excessive reliance on fossil fuels, especially coal, is a major cause of greenhouse gas emissions in Asia. Renewable-energy projects are sustainable solutions for mitigating the climate-warming issues from the current critical level. Another necessity for the development of renewable projects is raising energy self-sufficiency and energy security through diversification of energy resources. Too much reliance on limited resources of energy (coal, oil, or gas) will reduce the resiliency of the economy and make it more prone to energy price fluctuations.

One of the main obstacles to development of green-energy projects is lack of access to finance. Most Asian economies are bank-dominant, and the share of the capital market in their financial systems is very small. Hence, banks are the major sources of financing projects, but they do not have long-term assets because most of their liabilities are short-term and medium-term (short-term and medium-term deposits of up to five years). After banks, in most Asian economies, insurance companies and pensions have the second largest share of the financial market. Savings at insurance companies are predominantly long-term (10 years, 20 years, or 40 years), which means insurance companies and pension funds can allocate their resources to long-term projects such as infrastructural projects or mega energy projects (large hydropower projects, gas-based power generation projects, etc.). On the other hand, electricity tariffs are regulated by the government and kept at low rates. Hence, to increase the investment incentives, *spillover effects* originally created by energy supplies need to be utilized and tax revenues refunded to investors in energy projects.

For smaller-sized projects, the paper theoretically and empirically introduced a combined model of spillover tax return HIT funds which are a form of community-based funding. There are significant differences between HITs and conventional types of crowdfunds: i) A “warm feeling” is behind the HITs because investors sympathize with the company/project owners, and they are not merely seeking to make a profit; ii) investors are prepared to accept products or services generated by the project (i.e., the electricity generated by a wind power generator in a small village) rather than insist on a share of the profit. In crowdfunding or venture capital, by contrast, profit is the only purpose of investment.

Because of the Basel capital requirements and because most green-energy projects from the point of view of financiers are considered to be risky projects, many financiers are reluctant to lend to them. Hence, project owners for developing these projects usually need to borrow from the market at very high interest rates. The paper theoretically shows that by returning the spillover tax revenue that was originally generated by green-energy supply to HITs, green-energy projects will become more feasible and more interesting to hometown investors. Hence, the supply of investment money to these funds will increase. This will help green-energy projects to address their problem of lack of access to finance. Having said that, if HITs invest in very risky green-energy projects, hometown investors will be reluctant to invest in such projects, which will reduce the supply of lending/investments to these sectors. It is crucial, therefore, that fund managers carefully assess the feasibility and creditworthiness of projects and only select those with a high probability of success.

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