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# Explaining the contract terms of energy performance contracting in China: The importance of effective financing

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ABSTRACT

Energy service company ("ESCO") uses Energy Performance Contracting ("EPC") to provide energy-saving services to its clients. Under an EPC, both ESCO and the client invest in the energy efficiency measures, according to a negotiated share of investment. Within the length of the contract, the ESCO and its client divide up the saved energy bill according to a negotiated share. Once the contract expires, the client claims all of the saved energy bills if the energy efficiency measures still last. Different EPC projects have different contract terms, including total investment, share of investment and length of contract. These contract terms directly determine the resulted energy savings. Thus it is essential and important to look at how these contract terms are formed and what are the major influencing factors. This paper first builds a theoretical bargain model between ESCO and its client to find out the structural relationship among these contract terms. Then, using the information of about 140 EPC contracts in China in 2010 and 2011, the paper empirically estimates the impacts of various factors on the contract terms and the resulted energy savings. We find that cost of capitals for ESCOs and the clients, especially for ESCOs, is a major factor influencing contract terms and the resulted energy savings. Thus providing effective financing is critical for the development of EPC in China.



## 1. Introduction

Energy service company ("ESCO") uses Energy Performance Contracting ("EPC") to provide energy-saving services to its clients. Under an EPC, an ESCO improves the energy efficiency of its client. Both sides invest in the energy efficiency measures to be used by the client, according to a negotiated share of investment. Within the period of the contract, the ESCO and its client divide up the saved energy bill according to a negotiated share. After the contract expires, the client claims all of the future savings (if any). Different EPC projects have different contract terms, such as the length of the contract, share of investment, share of benefit and total investment, which directly influence how much energy can be saved from the contract. Thus it is essential and important to look at what factors influence these contract terms as well as the resulted energy savings.

EPC has been the most effective way to conserve energy in developed countries since 1970s, compared to other conventional conservation methods (Chen and Xu, 2010). Chinese central government began to implement the policies promoting EPC in 2010. Since then, ESCOs and EPC activities began to grow rapidly in China.

Existing studies on EPC and ESCO mainly use qualitative or descriptive analysis (Goldman et al., 2005; Nakagami and Murakoshi, 2009; Okay and Akman, 2010; Sorrell, 2007; Vine, 2005). For the studies on EPC in China, Zhang et al. (2008) identified 23 critical success factors (CSFs) for the success of an EPC and then conducted surveys among EPC researchers and ESCOs on their views about these 23 CSFs. Examples of those CSFs include financing, policy and awareness. Using a similar approach, Xu et al. (2011) conducted semi-structured interviews and a questionnaire survey with practitioners and other professionals on their views of the 21 identified CSFs for the EPC of sustainable energy efficiency retrofit of hotel buildings. Gan (2009) discussed the barriers to the growth of ESCOs in China, including market, institutional, financial and technological barriers.

Very few studies have tried to explain empirically and quantitatively the underlying mechanisms of various contract terms at project or contract level based on a theoretically sound framework. This paper tries to fill in this gap. We have identified the following main contract terms which the ESCO and its client negotiate on: length of contract period, total investment, share of investment and share of energy savings. This paper builds a theoretical model to hypothesize the structural relationships among these contract terms. Then, using the information of about 100 EPC contracts in China in 2010 and 2011, we conduct econometric analysis to test the implications of the theoretical model.

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The contract problem analyzed in this paper is similar to the "sharecropping" problem in existing theoretical studies. In a "sharecropping" problem, a landlord owns the land that can produce goods. The land is cultivated by a worker, or share-cropper. The landlord can observe the amount of goods produced by the worker but not the worker's level of effort. Thus the worker's reward is made based on the amount of goods produced. The landlord seeks to maximize his residual gain by choosing an optimal reward function based on the worker's output. Hurwicz and Shapiro (1978) find that a 50–50 split is the optimal solution in a broad class of cases. Holmstrom (1979) shows that when only payoff is observable, optimal contracts will be second-best due to moral hazard. The optimal contract should balance insurance and incentives with the presence of moral hazard. Some recent studies examine this problem in the context of energy efficiency programs. Stoft et al. (1995) recommend the use of shared-savings incentive mechanisms in utility demand-side management (DSM) shareholder incentive designs. They argue that the shared-savings incentive mechanism, which "provides utility shareholders with a share of the energy savings", can "directly ensure consistency between the regulatory objective of maximizing net social benefits and the financial interests of the utility". Eom (2008) examines the shareholder incentives for utility energy efficiency programs in California. He finds that each utility "requires a minimum level of incentive rate in order to achieve the adopted energy savings target" and that "a higher-than-minimum incentive rate could achieve not only a greater net social benefit but also greater bill savings for customers".

However, the "sharecropping" problems in the existing studies differ from the EPC context in an important way. Unlike the landlord in the "sharecropping" problems in existing studies where its only source of revenue is from producing the goods on the land, in an EPC contract, the "landlord" is the client whose main source of revenue is not from the goods in the contract, namely the energy bill savings. The client's main source of revenue comes from their normal business operations. As will be discussed in Sections 2 & 3, usually the objective function of the client is not to maximize its "residual gain" from the energy bill savings. Thus this paper contributes to the existing literature by building a theoretical model to examine the "sharecropping" problem in which the landlord's objective is just to reach a minimum requirement of the "residual gain".

The paper is organized as the following: after the introduction the second section gives a brief overview about the EPC industry and related government policies in China. The third section lays out the theoretical model and its testable implications. The fourth section describes the dataset. Section 5 presents the results of the econometric analysis. Section 6 discusses policy implications and Section 7 concludes.

## 2. EPC industry

### 2.1. Development of EPC in China

In China, improvement of energy efficiency enjoys a growing demand while still having great potential (Yu, 2010). However, in the field of industrial energy efficiency, pure technical efficiency improvement in China still falls behind the world frontier and has tremendous room for future upgrading (Shi et al., 2010). From a strategic standpoint, energy efficiency is also crucial for China for its energy security and sustainability (Hübler, 2011). As a proven market-based mechanism EPC can provide low-cost channels to overcome various barriers of energy efficiency (Sorrell, 2007). Moreover, in addition to reducing the costs of transaction and implementation, EPC can effectively expand information channels about energy efficiency for the clients because the ESCO provides the client with the information on all aspects of energy efficiency improvement from the initial energy audit and a comprehensive set of measures to fit the needs of a particular facility, through long-term monitoring and verification of project savings (U.S. EPA, 2007).

Since its introduction in China in 1997, EPC has achieved tremendous development especially from 2006 to 2010 during which the number of ESCOs increased by almost tenfold and the total amount of investment for EPC projects grew by nearly fourteen times (EMCA, 2010). Though experiencing a rapid development, this momentum has not depleted EPC of its potential. In fact, EPC is likely to continue its expansion momentum in China in the foreseeable future (EMCA, 2010 ). According to the statistic data from China Energy Conservation Association (CECA), the primary focus of EPC will remain on end-use sectors, including industries, transportation and buildings.

Lack of access to capital is a major barrier for EPC to get its investment financed in developing countries like China (Less and Mcmillan, 2005). Furthermore, with relatively underdeveloped financial markets, investors tend to overestimate the risks of investment, thus leaving many otherwise profitable EPC investments unfunded (Willkins, 2002). In addition to traditional financing from banks, numerous relatively new financing methods such as equity financing and finance leasing are being experimented in China for EPC projects. However, the overall picture of EPC-financing remains limited and inefficient (Li, 2012).

### 2.2. Types of EPC contracts

There are three major types of EPC contracts: energy-saving guarantee (ESG) contract, energy-saving benefits sharing (ESBS) contract, and energy expense entrusted (EEE) contract (Chen and Xu, 2010).

In an ESG contract, the ESCO sets a guaranteed level of energy bill savings for the client. ESCO will pay the client the difference if the energy bill savings fall short of the guaranteed level. ESCO and the client bear the costs of the project according to some negotiated rate. Because the risk for client under an ESG contract is much lower, most of the EPC contracts are of this type. As an example, a thermal power plant improves its energy efficiency from an ESG contract by upgrading its condensate pumps into variable speed pumping. The contract length is 2.5 years. During the contract length, the ESCO gets 100% of the benefit from energy bill savings. Then after the contract period ends, the power plant gets all the benefit. The ESCO makes all the upfront investment. As another example, an ESCO improves the efficiency of a construction company's motors by converting the fixed-speed drive motors into ones with a variable-frequency drive. The contract length is 5 years. During the 5 years, the ESCO gets all the benefit from the energy bill savings. The ESCO makes all of the upfront investment.

In an ESBS contract, the ESCO and the client share the energy bill savings within the contract period according to some negotiated rate. ESCO does not have to guarantee a level of energy bill savings for the client. Under this type, the client assumes a larger risk than other types of contract because no guarantee is provided. As a result, this type of contract is very rare in both China and other countries. As an example, an ESCO improves the energy efficiency of a chlor-alkali chemical company through a steam pressure–relief valve system. The contract length is 6 years. During the 6 years, the ESCO and the chemical company divide the benefit from energy bill savings by a share of 50%. The ESCO makes 80% of the upfront investment and the client bears 20% of the investment.

Under an EEE contract, the client entrusts the ESCO to operate its energy system or to implement the energy-saving measures during the contract at an agreed energy saving level. The client pays the ESCO service fee. If the energy expense, after the implementation of the contract, exceeds the pre-agreed level, the ESCO will repay the difference to the client. As an example, an ESCO improves the efficiency of the oil-fired boiler of a pharmaceutical company by using biomass circulating fluidized bed boiler technology. The ESCO makes 100% of the upfront investment. The contract length is 10 years. During the 10 years, the pharmaceutical company pays the ESCO a monthly service. EEE contract is also very rare. This is because compared with an ESG contract, the potential benefit for the ESCO is lower and the risk for the ESCO still exists.