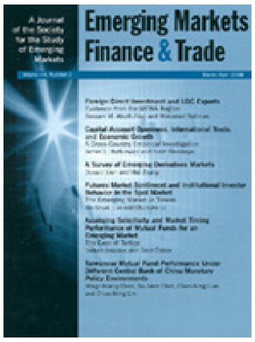

Emerging Markets Finance and Trade

ISSN: 1540-496X (Print) 1558-0938 (Online) Journal homepage: http://www.tandfonline.com/loi/mree20

Fuel Intensity, Access to Finance and Profitability: Firm-Level Evidence from China

Lingbing Feng, Tong Fu & Ali M. Kutan

Fuel intensity, access to finance and profitability: Firm-level evidence from China

Lingbing Feng

International Institute for Financial Studies
Jiangxi University of Finance and Economics
Nanchang, China, 330013
Email: fenglb88@gmail.com

Tong Fu*

Institute of Industrial Economics/Center for Regulation and Competition
Jiangxi University of Finance and Economics
Nanchang, China, 330013
Email: canjianft@hotmail.com

Ali M. Kutan
Department of Economics and Finance
Southern Illinois University Edwardsville, Edwardsville, 62016-1102, USA
Email: akutan@siue.edu

* The corresponding author acknowledges financial support by the National Natural Science Foundation of China (Project No. 71763009).

Abstract

Sustainability and energy economics together as a field has rapidly developed in recent years. However, it is still limited of the literature regarding the effect of energy on firm performance. This paper fills the gap by providing empirical evidence from China on the fuel intensity-performance link at the firm level. Our findings are summarized as follows: (i) firms' fuel intensity significantly constrains the firms' profitability and the constraint effect is significantly greater for firms with no access to finance; (ii)an increase in fuel intensity reduces profitability by intensifying the financial constraint effect; and (iii) financial access moderates the constraint effect of fuel intensity on firm's performance. The policy implications of the findings are discussed.

Key words: Fuel intensity; access to finance; profitability

1. Introduction

Energy is widely perceived to be a key to sustainable development. With the United Nations Climate Change Conference opened in 2009, many governments have promised to develop a low-carbon economy. In particular, the Chinese government in 2005announced to reduce the carbon intensity by 40% - 45% before 2020.While there is an active literature on the issue of energy economics and finance, much less scholars study the microeconomic effects of energy intensity on firm performance. Since firms are an important engine of economic growth and fuel is an essential input in production process, identifying how a firm's fuel intensity affects its profitability is not only crucial for firm managers but also for designing effective energy policies in low-carbon-targeted economies.

We argue that a higher level of fuel intensity reduces a firm's profit. Using data from China, we first confirm the profit-reduction effect of fuel intensity. Given that firms' finance channel tends to be constrained in China (Cull et al., 2015), we further confirm that the reduction effect is larger for firms without an access to finance. Our findings offer policy applications for governments. Specifically, our empirical findings suggest that governments should support fuel-consumed firms with financial incentives to enable a low energy economy.

It is interesting to study the fuel intensity-firm performance in China for several reasons. First, energy saving has become one of the most important issues in the agenda of the Chinese government as China has been the largest carbon emitter since 2006 according to the World Bank (2017). China is therefore under a pressure to reduce their level of fuel-intensity.[1] Second, China has been the largest consumer of energy products with a heavy reliance on energy imports (Song and Zheng, 2012). Thus, China is included in a list of countries with a significant concern of energy security. Third, China is one of the fastest-growing economies in the world, but its finance structure is underdeveloped (Allen et al., 2005). The low level of financial development is representative of most developing countries. Finally, this study employs the Investment Climate Survey undertaken by the World Bank in 2012, which provides a rich sample of firms with fuel expenditure, which are subject to various degrees of micro-financial development. Such a rich sample enables us to explore whether access to finance affects the relationship between fuel intensity and firm profitability.

The existing literature has explored macro issues in energy intensity for Latin America (Jimenez and Mercado, 2014), OECD countries (Liddle 2012), transition economies (Cornillie and Frankhauser, 2004), China (e.g., Song and Zheng, 2012; Wu, 2012; Ye et al., 2013; Zhao et al., 2010) and other regions. Following Fisher-Vanden et al., (2004), an increasing number of scholars have also explored the determinants of firm-level energy intensity (Adom, 2015; Andreoni and Galmarini, 2016; Gamtessa, 2017). However, studies with a focus on energy intensity at the firm level are still

[1] Note that although China aims to reduce its energy consumption, it refers to the reduction of fuel consumption. As the most important component of energy, fuel tends to be nonrenewable and is basically the source of carbon. Thus, in this paper, we do not distinguish fuel from energy in later discussions when China's policies are discussed.

relatively limited. Specifically, until Ma et al., (2010)'s survey in China's energy economics, no research explores the impact of energy intensity at the firm level. Some studies have recently started to investigate the impact of firm-level energy intensity (Abeberese, 2016; Wei and Li, 2017), however, to the best of our knowledge, this paper offers a first attempt to examine whether access to finance determines the micro effect of fuel intensity on firm performance in China.

The rest of the paper is organized as following. Section 2 designs an institutional framework to explain how a firm's fuel intensity reduces its profit due to the financial constraint effect. Section 3 presents the methodology for the moderation effect of access to finance to examine the impact of fuel intensity on firm performance. Section 4 reports our empirical results while Section 5 provide robustness tests. Section 6 concludes.

2. Institutional background and hypothesis development

As described by Allen et al., (2005), China has one of the fastest-growing economies in the world, but its financial system is underdeveloped for several reasons. First, the financial system is unsound; its bond and venture capital markets are young and inaccessible for most Chinese firms (Linton, 2006). Even when its equity market has been fast expanding, it is still not comparable to financial loans (Allen et al., 2005). Consequently, most Chinese firms rely solely on loans for financing.

Second, China's financial system is inefficient (Qian and Young, 2015). A large number of studies confirm that China's financial institutions provide favorable loans to state-owned enterprises (hereafter SOEs), which are not as efficient as private ones because of the weak state entrepreneurship (Hart et al., 1997) and/or red tape (Duvanova, 2014). Given that China's fast and continuous growth derive from the informal sector (Allen et al., 2005), which has a clear obstacle to access formal financing (Cull et al., 2009), Chinese firms that consist of the large share of the informal sector have to seek informal financing (Ayyagari et al., 2010;Guariglia et al., 2011).

The above two problems clearly indicate that most Chinese firms face financial constraints (Guariglia et al., 2011; Héricourt and Poncet, 2009; Poncet et al., 2010). Considering that the fuel intensity of a firm is rigid in the short run, a larger level of fuel intensity is likely to deteriorate a firm's finance and hence reduces its performance; hence, we argue that a higher level of fuel intensity will reduce firm profits due to the financial constraint effect.

It is also important to note that the government intervention in economic activity intensifies the financial constraint effect on fuel-consumed firms for several reasons. First, the Chinese central government adopts a series of intervention policies to require its local governments and corresponding officials to reach the goal of energy reduction. Precisely, the Chinese government designs appraisal programs for regional economic and social development. Local governments or energy-consumed firms that do not meet compulsory targets for energy reduction will not pass any governmental evaluations. Specifically, major officials in the local government or energy-consuming SOEs will have little chance to keep their positions, not to mention promotions. At the same time, the unqualified firms will be suspended from the jurisdictions' new high-energy consumption projects or they will be disapproved from gaining land for industrial use. Therefore, Chinese local governments and the relevant firms have high incentive to implement energy-reduction policies.

Second, local governments can incentivize energy-consumed firms to save energy with the control over financial institutions. In fact, the local governments form strategic alliances with financial institutions and firms (Wang 2007) and have been empowered to control over financial intermediaries (Boisotand Meyer, 2008) in addition to stock, bond and venture capital markets (Ayyagari et al 2010). Firms therefore have an incentive to seek government support or connection for access to finance (Cull et al., 2015) and produce better performance (Li et al., 2008). Thus, the local governments control the financial system and hence firms' access to finance to strategically support energy-saving firms.

Third, the local governments adopt financial policies to directly incentivize firms to replace the backward production facilities for energy-saving (Zhang et al., 2011). Financial policies include special funds and compensation programs for energy-saving firms decided by local governments.

Overall, most Chinese firms face financial constraints and have an incentive to seek government-controlled access to finance. When Chinese local governments aim to reduce firms' fuel consumption, a firm's increasing fuel intensity will reduce firm performance. In summary, we argue that there is reduction effect of fuel intensity on firm profit due to the financial constraint effect. Accordingly, our first hypothesis can be stated as following:

H1: a higher level of fuel intensity reduces firm profits.

Based on H1, this paper further explores why fuel intensity worsens profitability due to the financial constraint effect. The existing literature has confirmed that a financial constraint impedes the performance of firms in developed economies (Hubbard, 1998; Stein, 2003) and developing countries (Cull et al., 2015; Dethier et al., 2011). In principle, a larger level of fuel intensity is more likely to generate financial constraints. According to the pecking order theory, financially constrained firms prefer internal financing because of the high cost of external financing; as such, financial constraints force the firms to select low-risk and low-profitable investments (Hobdari et al., 2009). Therefore, a larger level of fuel intensity, which is rigid in the short run, enlarges the firm's financial demand for investments and then the financial constraint effect. Given the impact of financial constraints, we posit that a firm's fuel intensity reduces the firm's profitability.

We attempt to identify the financial constraint effect with a moderation effect. Considering how to precisely measure financial constraints is a hot debate in the existing literature (see Cull et al., 2015), we develop our hypothesis with reference to access to finance. As mentioned before, when firms have an access to external finance, they have smaller financial constraints. Thus, we predict the impact of fuel intensity on profitability is smaller for firms with an access to finance. Hence, our second hypothesis is formulated as the following:

H2: the negative effect of a firm's fuel intensity on its profits should be smaller (in absolute value) for firms with an access to finance and be larger (in absolute value) for firms without an access to finance.

It is worth pointing out that our arguments here may be generalized to other countries because the financial constraint effect is a common problem for most developing countries (Dethier et al. 2011).

3. Methodology

As mentioned before, this study employs the Investment Climate Survey undertaken by the World Bank in 2012. The survey selects the non-agricultural economy of firms with at least 5 employees and positive amounts of private ownership. Thus, the survey is conducted to cover small, medium, and large companies. The survey data cover all of China's manufacturing industries and large cities. As such, the data are used to create indicators that benchmark the investment climate across firms. In particular, the large cities are selected on the base of the number of establishments, contribution to employment, and value added.

This following first explains the model used to test the relationship between fuel intensity and profitability (for Hypothesis 1). Considering the potential reverse causality issue, we also conduct reduced-sample estimates to justify that the potentially endogenous bias in our estimations is negligible. We second describe the model for our reduced-sample estimates. Finally, we examine the mechanism of access to finance for capturing the impact of fuel intensity on profitability at the firm level.

3.1 Baseline equation

To test the hypothesis 1, we conduct estimations according to the following equation:

$$\Pr ofit_{i,j,k} = c + aFuel_i + bZ_i + u_j + v_k + e_i \tag{1}$$

where $\Pr ofit$ denotes profitability, which is measured by three alternative variables. First, we measure the return on investments with the percentage of profit relative to the cost. Second, we measure the net profit margin with the percentage of profit relative to sales. Considering that some firms' net profit margins are negative, we transform the net profit margin according to inverse hyperbolic sine (IHS) function as a third measure. In particular the HIS transformation is introduced by Johnson (1949). It not only corrects for skewness in the data and non-positive data as to retain the size of sample but also avoids the excessive sensitivity at the zero-value point. In fact, this transformation has been generally applied in the literature investigating wealth issues (e.g., Frideline et al., 2012). Although different versions of IHS function, we adopt the following simplest version of IHS because it is closer to the natural log (Frideline el at., 2012).

$$ihs(x) = \log(x + \sqrt{x^2 + 1}) . \quad (2)$$

In Equation (1), *Fuel* is fuel intensity, measured by the percentage of the surveyed firm's fuel expenditure relative to its sales. In addition to accounting for fixed-city, u_j, and fixed-industry effects, v_k, we also control for exogenous firm characteristics, Z. First, we control for firm age and firm size. We use the log of employee number to measure firm size (e.g., Cai et al., 2011; Lin et al., 2010). Second, we also control for the ratios of government shares in the ownership structure. State shares represent the degree of the relationship of the firm with the government, which promotes firm performance (Li et al., 2008). Third, we control for whether the firm has export sales because the Chinese government aims to support exports (Lemoine, 2000). However, export firms may also have smaller profits due to the reliance on government supports (Kueh, 1992). Fourth, we control for whether a surveyed firm belongs to a group firm because such a firm has an advantage to conduct firms' key business operations (e.g., Zhao, 2006). Fifth, we control for the political environment of surveyed firms as the survey requires the firm to assess the adverse effect of political instability. Finally, we control for whether the firm is listed in the stock market because the listed firm always are sensitive to governments' fuel policies (Lyon et al., 2013; Ye et al., 2013).[2]

3.2 Reduced-sample estimates

Equation (1) may be subject to reverse causality issue. Specifically, given fuel intensity is constructed as the fuel expenditure relative to sales, it must be closely related to firm profits. In this case, it is very difficult, if not impossible, to find some instrument variables that are exogenous for profits but are related to fuel intensity. Moreover, the one-year data disallow us to test a lagged relationship. It may be worthy pointing that we have used the average (i.e., medium/mean value) of fuel intensity in the industry as an instrument to obtain the same finding as the baseline estimates do. Considering that an average-instrument is not strictly exogenous, we do not report the estimates using an average instrument (available upon requests). However, we use reduced-sample estimations to confirm that the potentially endogenous bias is negligible as follows.

We conduct reduced-sample estimates to test the possibility of the endogenous bias using the following equation:

$$\Pr ofit_{i,j,k} = c + aFuel_i + bZ_i + u_j + v_k + e_i, i \in I \tag{3}$$

where we only include particular firms for reduced-sample estimates. First, we include firms whose sale of the main product accounts for at least 50% of total sales.

[2]We do not control for other relevant variables such as firm leverage with the consideration of the endogeneity issue. To include firm leverage tends to enlarge the potentially endogenous bias. Because firms can use their leverages on the base of their profitability and then firm leverage is not exogenous. We select to undertake the variable-omitting issue that tends to be lessened out by the city and industry fixed effects.

As Abeberese (2013) reports, firm performance can motivate firms to adapt energy consumption in the long run; however, the adaptation is conditional on the goods production. When firms' main product generates the majority of sales, the firms' adaptation is limited at least in the short run.[3]

Similarly, if the surveyed firm keeps or enlarges its sales, due to the reliance of fuel consumption on goods production, it is difficult for firms to reduce their fuel consumption. Thus, we only include firms whose profits are in an upward trend. The 2012 survey requires the firm's sales to be reported in 2009 and 2011. We collect data for inflation levels in 2009 and 2010 and then transform the sales in 2009 into one in 2011. Then, we only include firms whose sales in 2011 reaches the sales in 2009 but at the 2011 price level. Alternatively, considering that 5% difference is negligible, we include firms whose sales in 2011 reaches 95% of sales in 2009 (after transformed with inflation rates in 2009 and 2010).

3.3 The mechanism of access to finance

To examine whether access to finance affects the impact of fuel intensity on firm profitability, we estimate the following equations.

$$Profit_{i,j,k} = c_1 + a_1 Fuel_i + b_1 Z_i + u_j + v_k + e_i,\ if\ \ AF_i = 1 \quad (4)$$

$$Profit_{i,j,k} = c_2 + a_2 Fuel_i + b_2 Z_i + u_j + v_k + e_i,\ if\ \ AF_i = 0 \quad (5)$$

where AF is the dummy of access to finance which is captured by two variables.

[3] Note that the 2012 survey only involves one year data across firms.

First, we use the self-assessment of responders.[4] The survey requires managers to report whether the firm has an obstacle in access to finance. Second, we measure the objective establishment of the firm's access to finance. Precisely, the access to finance is objectively verified if the firm has an overdraft facility, a line of credit or a loan from financial institutions (Ayyagari et al., 2010). By contrast, the firm has no access to finance if the firm fully relies on its internal finance.

We hypothesize that a_1 is significantly smaller than a_2 (see Hypothesis 2). To test the significance of the difference between a_1 and a_2, we conduct the Chow (1960) test as follows:

$$\frac{(S_t - S_1 - S_2)}{k} / \frac{S_1 + S_2}{N_1 + N_2 - 2k} \tag{6}$$

where S_t represents the sum of squared residuals from the full data (Equation (1)), S_1 is the sum of squared residuals from the group of firms with access to finance (Equation (4)), and S_2 is the sum of squared residuals from the group of firms without access to finance (Equation (5)). N_1 and N_2 are the number of observations in each group. The test statistic follows F distribution with k and $N_1 + N_2 - 2k$ degrees of freedom.

[4]Given that we also use an objective measure of access to finance (whether the firm has a loan, credit or overdraft from financial institutions), the self-assessment indicator complements the information on a firm's ability for access to finance. Specifically, if the self-assessment indicator captures similar information to the objective measure and the empirical findings are similar too, which later estimates will show, the indicator is valuable and reliable.

4. Empirical results

Empirical findings reported in Table 3 show that a firm's fuel intensity is negatively and significantly related to its profitability. Precisely, one percentage increase of fuel intensity will reduce the return on investments by 23.831% or 1.619% for net profit margin. At the same time, one percentage increase of fuel intensity will still reduce net profit margin by 19.083%.[5] Generally, one percentage increase of fuel intensity will reduce return on investments or net profit margin by about 20%.

To test whether the potential reverse causality bias is negligible, we include firm samples with heavy reliance on fuel consumption. Considering that our three profitability variables obtain the same relationship with the variable of interest (see Table 3), to save space, we only report reduced-sample results for the transformed net profit margin. As mentioned before, we use two options for the sample inclusion. Columns 1-2 of Table 4 report results for firms whose main product account for at least 50% of total sales, whereas Columns 3-6 of Table 4 report results for firms who are in the profit-increase trend. In particular, Columns 3-4 presents results for firms whose sales in 2011 gain at least sales in 2009 (in the 2011 price) while Columns 5-6 allows the former sales to be at least 95% of the later sales.

As Table 4 shows, reduced-sample estimates obtain similar findings as reported before. Precisely, here we only include the firms with difficulty adapting to its fuel

[5] As shown by Table 3, one percentage increase in fuel intensity reduces 0.192 IHS value of net profit margin, or 19.083% of net margin profit.

consumption, but a firm's fuel intensity is still found to be negatively and significantly related to its profitability. Moreover, the coefficient of fuel intensity in Table 4 is still very close to the one in Table 3, i.e., -0.186~-0.192.

To test the effect of access to finance, we conduct the heterogeneity tests. Columns 1-4 of Table 5 report results when access to finance is measured by the surveyed firm's self-assessment indicator, while Columns 5-8 of Table 5 presents results when access to finance is measured by the objective existence of access to finance. As Table 5 shows, using either measure of access to finance, the firm sample with access to finance (Sample 1 or Sample I in Table 5) has a significantly smaller coefficient of fuel intensity than the firms without access to finance (Sample 2 or Sample II in Table 5). All of the corresponding Chow test statistics are significant at 1% level.

5. Robustness tests

We have so far confirmed that access to finance moderates the effect of fuel intensity on the firm's profitability. To further justify the robustness of our estimates, we now conduct a more detailed heterogeneity test. Our survey requires managers to report why they did not apply for loans in 2011 and provide reasons for it. The latter is useful to distinguish among types of non-access to finance.[6] Precisely, we conduct heterogeneity tests between firms with access to finance in 2011 (Sample 1 in Table

[6] Besides loans, the firm may access to equity; however, in our estimation we control whether firms go public. Thus, the access to loans captures only firms' access to finance.

6)[7] and with firms without access to finance due to; (i) complex application procedures (Sample 2 in Table 6), (ii) unfavorable interest rates (Sample 3 in Table 6), (iii) very high collateral requirements (Sample 4 in Table 6) and (iv) insufficient size of loan and maturity (Sample 5 in Table 6).

Given that the different types of non-access to finance have a small size, some coefficients of fuel intensity are insignificant for firms without an access to finance. To visualize the detailed comparison, we also report the results in Figure 1. Due to the smaller size for some samples, Chow tests are not used here. However, Table 6 (or Figure 1) clearly shows that the coefficient of fuel intensity on the firm's profitability is smallest (in the absolute size) for firms with access to access. This confirms that access to finance weakens the constraint effect of fuel intensity on profitability; put differently, the reduction effect of fuel intensity on profitability is positively determined by access to finance.

Moreover, the survey requires manager to answer the question: "what is the biggest obstacle for the firm's operation and growth?" One of the obstacles is the issue access to finance; others include transport, informal practice and so on. We conduct a detailed heterogeneity test to compare the effect of access to finance with the effect of other obstacles. In particular, we do not compare it with the effect of electricity because it is endogenously related to the firm's fuel consumption. We also combine some variables together, for example, corruption, tax administration and tax

[7] The measure of access to finance in 2011 is the same as the one of access to finance that is used in the last section. Precisely, the firms have access to finance in 2011 if they get a loan in 2011 or it has overdraft facility or credit in rent recent years.

rates are combined together as “corruption and tax” because tax is always used to measure corruption (Hopkin and Rodriguez-Pose, 2007). Considering this heterogeneity test involves more detailed comparison (7 categories), we only report the comparison results in Figure 2. As Figure 2 shows, the issue of access to finance has the largest coefficient of energy intensity. This further validates the significance of access to finance for the fuel intensity-firm performance link.

6. Conclusions and policy implications

Energy conservation or emission reduction has been a hot topic across both developed and developing counties in the last decade. Central governments have set fuel reduction goals for local governments that, in turn, have set rigid requirements for local firms forcing them to be more environmentally friendly. However, whether this requirement is effective or not is still debatable. From a micro perspective, this paper has examined the effect of energy intensity on firm performance, investigating the link between firm’s fuel intensity and its profitability. Understanding the existence and economic magnitude of this relationship provides deeper insight regarding the incentives of firms in reducing fuel intensity and thus reaching environmental goals, thereby enabling policy makers to design energy policies.

We first have hypothesized that a firm’s fuel intensity reduces its profitability. Employing the survey data undertaken by the World Bank in 2012 in China, we have confirmed that there is a significantly negative relationship between firm’s fuel intensity and profitability. We have found that a one percentage increase in a firm's fuel intensity will approximately reduce return on investments or net profit margins by 20%. We have further argued that this relationship is due to the financial constraint effect, i.e., the negative effect is smaller when the firm has an access to finance and is larger otherwise. This argument, which is also supported by our empirical analysis, indicates that the reverse pull effect of fuel intensity on firm's profit performance is determined by firms' access to finance. Although access to finance may be relatively exogenous in the short run, governments can strategically control access to finance gradually for energy-reduction achievement. To overcome the potential endogeneity issue, we have also conducted reduced sample estimates and our findings are robust and consistent.

This paper offers a first attempt to show how fuel intensity affects firm profitability. Given that our estimates show that fuel intensity is negatively related to profitability and then the negative relationship is severe for firms who have a comparative disadvantage in access to finance. Thus, we identify fuel intensity functions to reduce profitability due to the financial constraint effect. This finding contributes to the literature by opening the black-box on the micro impact of fuel intensity, which is overlooked by the prior literature (see the review by Ma et al., 2010). Moreover, the finding is in line with the wisdom of the existing literature. Because China's financial system is underdeveloped (Allen et al., 2005) and its financial resources are misallocated (Qian and Young, 2015), most Chinese firms face financial constraints (Guariglia et al., 2011; Héricourt and Poncet, 2009; Poncet et al., 2010). Considering that the fuel intensity of a firm is rigid in the short run, a larger level of fuel intensity will tighten the firm' financial constraint condition and then worsen its performance.

The findings of this paper have policy implications for both firms and local governments. Firstly, firms should strategically strive to reduce their fuel intensity, not only because of the increasing environment requirements from the local governments or upper regulators, but also because of the findings that reducing fuel intensity will lessen the financial constraint effect, thereby bringing more profits. Local governments may encourage firms to become more environmentally friendly by providing financial support to firms who have less fuel intensity in their production. However, firms normally cannot realize the benefit of becoming more environmentally friendly, or if they do, they are typically passive in setting up detailed strategies and plans to become so. Moreover, firms in different industrial sectors should be treated differently by the local government in setting up environmental requirements, as well as financial supports. It is common practice that small size companies or start-up companies are more eager for financial support, so governments should pay more attention to those firms and devise financial support plans linking fuel intensity performance to particularly form them. For state-owned or large private enterprises, as they care less for financial support, local governments may need to find another ways as to encourage them to become more environmentally friendly.

In this paper, we have focused on the financial constraint channel. It is likely that there are additional channels acting in the relationship between fuel intensity and profit performance. We hope that the initial findings in this paper can generate further researches and provide a yardstick for future work.

References

Abeberese, A. B., 2016. Electricity Cost and Firm Performance: Evidence from India. Review of Economics and Statistics, Vol. 0, No. ja (doi: 10.1162/REST_a_00641).

Adom, P. K., 2015. Asymmetric impacts of the determinants of energy intensity in Nigeria. *Energy Economics*, 49(C): 570-580.

Allen, F., Qian, J., Qian, M., 2005. Law, finance, and economic growth in China. *Journal of Financial Economics* 77, 57–116.

Andreoni, V. and Galmarini, S., 2016. Drivers in CO2 emissions variation: A decomposition analysis for 33 world countries. *Energy*, 103, 27-37.

Ayyagari, M., Demirguc-Kunt, A., Maksimovi, V., 2010. Formal versus Informal Finance: Evidence from China. *Review of Financial Studies*23(8), 3048-3097.

Boisot, M. and Meyer, M.W., 2008. Which way through the open door? Reflections on the internationalization of Chinese firms. *Management and Organization Review*, 4(3): 349–365.

Cai, H., Fang, H.,Xu, L.C., 2011. Eat, drink, firms, government: An investigation of corruption from entertainment and travel costs of Chinese firms. *Journal of Law and Economics* 54, 55-78.

Chow, G. C., 1960. Tests of Equality Between Sets of Coefficients in Two Linear Regressions. *Econometrica*, 28 (3):591–605.

Cornillie, J. and Frankhauser, S., 2004. The energy intensity of transition countries. *Energy Economics* 26, 283 – 295.

Cull, R., Xu, L. C. and Zhu, T., 2009. Formal finance and trade credit during China's transition. *Journal of Finance Intermediaries*, 18 (2): 173 –192

Cull, R., Li, W., Sun, B., Xu, L. C., 2015. Government connections and financial constraints: Evidence from a large representative sample of Chinese firms. *Journal of Corporate Finance*, 32, 271–294.

Dethier, J-J., Hirn, M., Straub, S., 2011. Explaining enterprise performance in developing countries with business climate survey data. World Bank Research Observer. 26, 258–309.

Duvanova, D., 2014. Economic Regulations, Red Tape, and Bureaucratic Corruption in Post-Communist Economies. *World Development*, 59, 298–312.

Fisher-Vanden, K., Jefferson, G. H., Liu, H. and Tao, Q., 2004. What is driving Chinas decline in energy intensity. *Resource and Energy Economics*, 26(1): 77–97

Friedline, T., Masa, R. D. and Chowa, G.N., 2012. *Transforming wealth: Using the Inverse Hyperbolic Sine (IHS) and Splines to Predict Youth's Math Achievement*. Lawrence, KS: The University of Kansas.

Gamtessa, S. F., 2017. The effects of energy price on energy intensity: evidence from Canadian manufacturing sector. *Energy Efficiency*, 10(1): 183-197.

Guariglia, A., Liu, X. and Song, L., 2011. Internal finance and growth: microeconometric evidence on Chinese firms. *Journal of Development Economics*, 96 (1): 79 –94.

Hart, O., Shleifer, A. And Vishny, R. W., 1997. The proper scope of government: theory and an application to prisons. *Quarterly Journal of Economics*, 112 (4):1127-1161.

Héricourt, J., Poncet, S., 2009. FDI and credit constraints: firm level evidence in China. *Economic Systems* 33, 1–21.

Hobdari, B., Jones, D. C. and Mygind, N., 2009. Capital investment and determinants of financial constraints in Estonia. *Economic systems*. 33(4): 344–359.

Hopkin, J.,Rodriguez-Pose, A., 2007. “Grabbing hand” or “helping hand”?: Corruption and the economic role of the state. *Governance: An International Journal of Policy, Administration, and Institutions* 20(2), 187–208.

Hubbard, R.G., 1998. Capital market imperfections and investment. *Journal of Economic Literature*. 36 (1): 193–225.

Jimenez, R., Mercado, J., 2014. Energy intensity: A decomposition and counterfactual exercise for Latin American countries. *Energy Economics* 42, 161 –171.

Johnson, N. L., 1949. Systems of frequency curves generated by methods of translation. *Biometrika* 36(1/2): 149-176.

Li, H.B., Meng, L.S., Wang, Q. and Zhou, L.A., 2008. Political connections, financing and firm performance: evidence from Chinese private firms. *Journal of Development Economics*, 87 (2): 283 –299.

Linton, K., 2006. Access to capital in China: Competitive conditions for foreign and domestic firms. SSRN Working Paper Series.

Kueh, Y. Y. 1992. Foreign investment and economic change in China. *China Quarterly* 131:637-90.

Lemoine, F., 2000.*FDI and the opening up of China's economy*. Paris: Centre d'Etudes Prospectives et d'In-formations Internationales (CEPII).

Li, H.B., Meng, L.S., Wang, Q. and Zhou, L.A., 2008. Political connections, financing and firm performance: evidence from Chinese private firms. *Journal of Development Economics*, 87 (2): 283 –299.

Liddle, B., 2012. OECD energy intensity: Measures, trends, and convergence. *Energy Efficiency*5, 583 – 597.

Lin, C., Lin, P., Song, F., 2010. Property rights protection and corporate R&D: Evidence from China. *Journal of Development Economics* 93, 49–62.

Lyon, T., Lu, Y., Shi, X. and Yin, Q., 2013. How do investors respond to Green Company Awards in China?. *Ecological Economics* 94, 1–8.

Ma, H., Oxley, L., Gibson, J., 2010. China's energy economy: A survey of the literature. *Economic Systems*, 34(2): 105–132

Poncet, S., Steingress, W. and Vandenbussche, H., 2010. Financial constraints in China: firm-level evidence. *China Economic Review*, 21 (3): 411–422.

Qian, M., Young, B., 2015. Bank financing and corporate governance. *Journal of Corporate Finance* 32, 258–270.

Song, F. and Zheng, X., 2012. What drives the change in China's energy intensity: Combining decomposition analysis and econometric analysis at the provincial level. *Energy Policy* 51, 445–453.

Stein, J., 2003. Agency, information and corporate investment. In: Constantinides, George, Harris, Milton, Stulz, Rene (Eds.), *Handbook of the Economics of Finance*. Elsevier.

Wang, Y., 2007. Interlinking markets, relational contract and economic transition. *Studies of Regional Development* 39(1): 161-187.

Wei, C. and Li, C., 2017. Resource misallocation in Chinese manufacturing enterprises: evidence from firm-level data. *Journal of Cleaner Production*. 142, 837–845.

World Bank, 2017. CO2 emissions. Available from http://data.worldbank.org/indicator [accessed on Jun/14/2017]

Wu, Y., 2012. Energy intensity and its determinants in China's regional economies. *Energy Policy* 41, 703–711.

Ye, D., Liu, S. and Kong, D., 2013. Do efforts on energy saving enhance firm values? Evidence from China's stock market. *Energy Economics* 40, 360–369

Zhang, D., Aunan, K., Seip, H. M. and Vennemo, H., 2011. The energy intensity target in China's 11th Five-Year Plan period—Local implementation and achievements in Shanxi Province. *Energy Policy* 39, 4115–4124.

Zhao, M.Y., 2006. Conducting R&D in countries with weak intellectual property rights protection. *Management Science*, 52(8): 1185-1199.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Return on fuel expenditure	1536	70.109	71.387	-81.481	394.560
Net profit margin (NPM)	1536	32.699	28.848	-440	79.78
IHS of NPM*	1536	11.284	3.656	-15.825	17.285
Firm age	1496	12.011	8.183	0	124
Firm size	1536	4.422	1.268	1.609	10.309
State shares	1535	0.034	0.166	0	0.95
Export dummy	1536	0.207	0.405	0	1
Group affiliation	1536	0.105	0.306	0	1
Political instability	1513	0.274	0.609	0	4
Listed company (dummy)	1536	0.018	0.134	0	1

* To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.

Table 2: Correlation matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Return on fuel expenditure	1								
(2)	Net profit margin (NPM)	0.747	1							
(3)	IHS of NPM*	0.368	0.614	1						
(4)	Firm age	0.063	0.049	0.043	1					
(5)	Firm size	0.120	0.100	0.047	0.215	1				
(6)	State shares	0.023	0.025	0.003	0.074	0.030	1			
(7)	Export dummy	0.033	0.012	-0.015	0.009	0.255	-0.084	1		
(8)	Group affiliation	0.047	-0.004	0.005	0.046	0.232	0.009	0.117	1	
(9)	Political instability	-0.038	-0.035	-0.007	0.006	0.064	-0.087	0.093	0.012	1
(10)	Listed company (dummy)	0.007	-0.050	-0.018	0.085	0.204	0.031	0.116	0.234	0.030

* To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.

Table 3: Baseline estimates

Depend var.	Return on investments		Net profit margin (NPM)		Transformed NPM[#]	
Fuel intensity	-23.831***	-23.831***	-1.619***	-1.619***	-0.192***	-0.192***
	(5.993)	(5.716)	(0.289)	(0.337)	(0.052)	(0.060)
Firm age	2.741	2.741	0.135+	0.135	0.019**	0.019**
	(2.456)	(2.677)	(0.082)	(0.098)	(0.009)	(0.009)
Firm size	-6.829	-6.829	0.636	0.636	-0.037	-0.037
	(32.828)	(36.792)	(0.684)	(0.665)	(0.080)	(0.075)
State shares	220.866**	220.866*	11.748**	11.748	1.256*	1.256+
	(100.707)	(108.322)	(5.056)	(8.841)	(0.704)	(0.758)
Export dummy	-86.488	-86.488	0.345	0.345	-0.085	-0.085
	(83.242)	(92.093)	(1.486)	(1.336)	(0.257)	(0.210)
Group affiliation	319.860	319.860	2.380	2.380	0.284	0.284
	(231.491)	(246.279)	(3.416)	(3.584)	(0.352)	(0.321)
Political instability	-29.013	-29.013	-0.364	-0.364	-0.063	-0.063
	(38.206)	(38.961)	(1.058)	(1.382)	(0.200)	(0.213)
Listed company	224.958	224.958	-1.378	-1.378	0.010	0.010
	(431.502)	(434.814)	(5.127)	(5.496)	(1.083)	(1.079)
Constant	280.090	280.090	34.418***	34.418***	11.079***	11.079***
	(269.759)	(250.142)	(5.764)	(6.105)	(0.646)	(0.519)
City	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
SE	Robust	Cluster	Robust	Cluster	Robust	Cluster
R^2	0.06	0.06	0.21	0.21	0.12	0.12
N	1,415	1,415	1,415	1,415	1,415	1,415

To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.+ $p<0.15$; * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 4: Reduced-sample estimates#

Sample firms:	The main product accounts for at least 50% of total sales		The sales in 2011 reaches the sales 2009 (also in the 2011 price)		The sales in 2011 reaches 95% of the sales 2009 (also in the 2011 price)	
Energy intensity	-0.192***	-0.192***	-0.191***	-0.191**	-0.186***	-0.186**
	(0.052)	(0.060)	(0.060)	(0.072)	(0.067)	(0.078)
Firm age	0.019**	0.019**	0.023*	0.023*	0.032**	0.032**
	(0.009)	(0.009)	(0.012)	(0.012)	(0.014)	(0.013)
Firm size	-0.039	-0.039	-0.061	-0.061	-0.060	-0.060
	(0.081)	(0.076)	(0.086)	(0.106)	(0.097)	(0.098)
State shares	1.260*	1.260+	0.975	0.975	0.802	0.802
	(0.705)	(0.757)	(0.801)	(0.877)	(1.005)	(1.073)
Export dummy	-0.093	-0.093	0.080	0.080	-0.094	-0.094
	(0.258)	(0.210)	(0.275)	(0.224)	(0.291)	(0.212)
Group affiliation	0.286	0.286	0.506+	0.506+	0.546+	0.546+
	(0.352)	(0.322)	(0.325)	(0.298)	(0.366)	(0.321)
Political instability	-0.058	-0.058	0.000	0.000	-0.011	-0.011
	(0.206)	(0.212)	(0.186)	(0.200)	(0.197)	(0.217)
Listed company	0.019	0.019	0.882	0.882	1.018	1.018
	(1.083)	(1.080)	(0.791)	(0.820)	(0.867)	(0.901)
Constant	11.090***	11.090***	12.048***	12.048***	12.274***	12.274***
	(0.647)	(0.518)	(0.587)	(0.554)	(0.671)	(0.573)
City	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
SE	Robust	Cluster	Robust	Cluster	Robust	Cluster
R^2	0.12	0.12	0.14	0.14	0.16	0.16
N	1,411	1,411	1,036	1,036	878	878

the dependent variable is the transformed net profit margin. To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.+ p<0.15; * p<0.1; ** p<0.05; *** p<0.01.

Table 5: Effect of access to finance[#]

	The self-assessment indicator				The existence of access to finance			
Sample:	Sample 1	Sample 2	Sample 1	Sample 2	Sample I	Sample II	Sample I	Sample II
Energy intensity	-0.045	-0.326***	-0.045+	-0.326***	-0.190***	-0.381	-0.190***	-0.381**
	(0.038)	(0.073)	(0.028)	(0.080)	(0.053)	(0.263)	(0.060)	(0.150)
Chow test[a]	9.70***		6.32***		6.36***		8.95***	
Firm age	0.027*	0.017	0.027+	0.017+	0.020**	0.028	0.020*	0.028*
	(0.014)	(0.013)	(0.017)	(0.011)	(0.010)	(0.026)	(0.010)	(0.013)
Firm size	-0.125	0.008	-0.125+	0.008	-0.065	-0.133	-0.065	-0.133
	(0.124)	(0.113)	(0.083)	(0.140)	(0.085)	(0.327)	(0.077)	(0.166)
State shares[b]	0.714+	-6.954	0.714+	-6.954	1.280*		1.280+	
	(0.487)	(6.245)	(0.422)	(7.782)	(0.709)		(0.758)	
Export dummy	-0.800+	0.389+	-0.800*	0.389+	-0.232	0.310	-0.232	0.310
	(0.522)	(0.265)	(0.433)	(0.241)	(0.288)	(0.332)	(0.229)	(0.292)
Group affiliation	0.070	0.456	0.070	0.456	0.229	1.171	0.229	1.171+
	(0.627)	(0.380)	(0.677)	(0.514)	(0.397)	(0.870)	(0.358)	(0.705)
Political instability	0.179	-0.062	0.179	-0.062	-0.055	0.010	-0.055	0.010
	(0.313)	(0.228)	(0.305)	(0.234)	(0.216)	(0.238)	(0.226)	(0.191)
Listed company	-1.509	1.587+	-1.509	1.587	-0.371	2.562	-0.371	2.562**
	(2.631)	(1.071)	(2.787)	(1.077)	(1.309)	(2.044)	(1.305)	(1.105)
Constant	11.873***	11.200***	11.873***	11.200***	11.296***	8.574***	11.296***	8.574***
	(0.925)	(0.788)	(0.709)	(0.743)	(0.742)	(2.414)	(0.520)	(1.994)
City	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE	Robust		Cluster		Robust		Cluster	
R^2	0.15	0.20	0.15	0.20	0.12	0.41	0.12	0.41
N	583	832	583	832	1,279	136	1,279	136

the dependent variable is the transformed net profit margin. To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.

Sample 1: firms without an obstacle in access to finance; sample 2: firms with an obstacle in access to finance. Sample I: firms with access to external finance; Sample II: firms with no access to external finance. a: Chow test is used to examine the significance of coefficient difference between different subsamples. b: there are no firms with state shares in Sample II. + $p<0.15$; * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 6: Effect of access to finance (a detailed comparison)[#]

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Energy intensity	-0.120***	-0.657***	-0.169+	-0.155	-0.646***	-0.120**	-0.657*	-0.169+	-0.155**	-0.646***
	(0.043)	(0.241)	(0.108)	(0.127)	(0.068)	(0.047)	(0.324)	(0.106)	(0.068)	(0.092)
Constant	10.831***	21.058***	11.742***	9.921***	13.400***	10.831***	21.058***	11.742***	9.921***	13.400***
	(0.734)	(3.318)	(1.354)	(1.745)	(1.813)	(0.497)	(4.233)	(1.701)	(1.534)	(1.286)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE	Robust	Robust	Robust	Robust	Robust	Cluster	Robust	Cluster	Cluster	Cluster
R^2	0.11	0.62	0.05	0.05	0.95	0.11	0.62	0.05	0.05	0.95
N	1,042	78	114	94	63	1,042	78	114	94	63

the dependent variable is the transformed net profit margin. To retain the size of sample and also avoids the excessive sensitivity at the zero-value point, we transform the net profit margin according to Inverse Hyperbolic Sine (IHS) function.

Sample 1: firms with access to finance. Sample 2: firm without access due to complex application procedures. Sample 3: firm without access due to unfavorable Interest rates Sample 4: firm without access due to too high Collateral requirements. Sample 5: firm without access due to insufficient size of loan and maturity. a: Chow test is used to examine the significance of coefficient difference between different subsamples. + p<0.15; * p<0.1; ** p<0.05; *** p<0.01.

Figure 1: with vs. without access to access

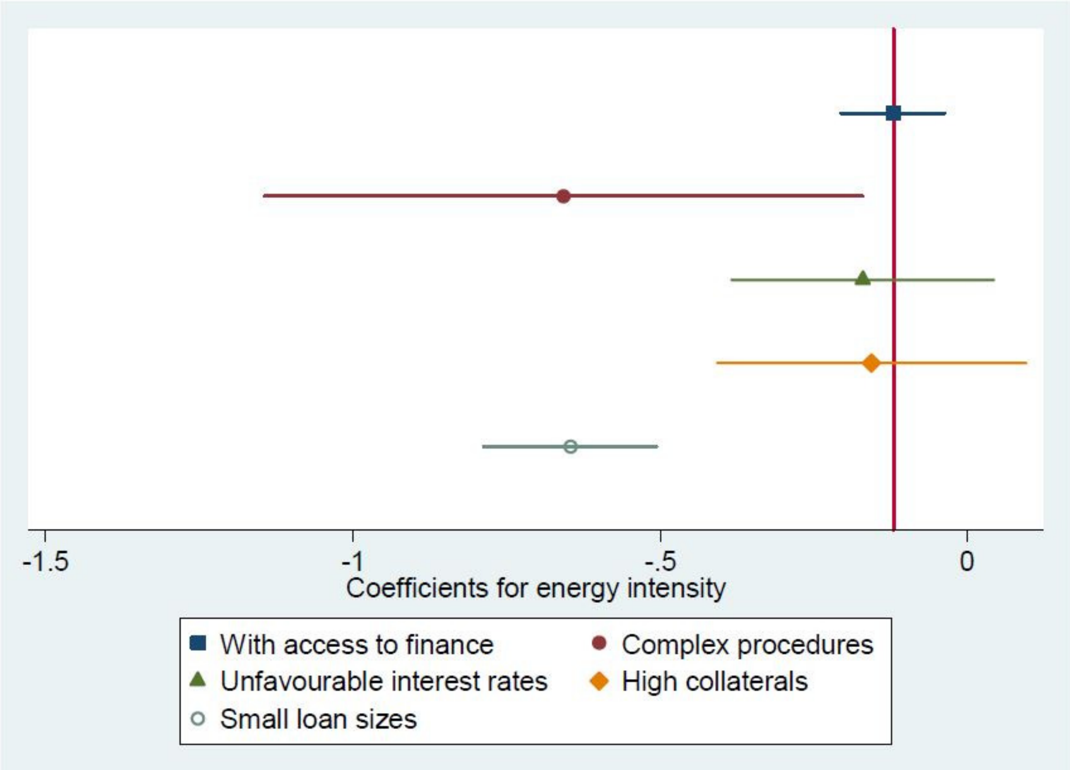

Figure 2: Access to finance vs. other obstacles