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Credit Rationing and Signalling Effects of Trade Credit: Theory and Evidence from Korean Firms*

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Abstract We examine interaction among bank credit, trade credit and internal wealth. Our theoretical model derives borrowers' optimal patterns of credit uses depending on internal wealth levels, subject to credit rationing. In particular, the model incorporates signalling effects of and nonlinear interest schedules for trade credit to account for stylized facts from Korean data that are at odds with previous models. Our empirical results are broadly consistent with presence of signalling effects as well as theoretically predicted interaction patterns. The results could be interpreted as a rough estimate of the extent of credit rationing among sample firms.

Keywords trade credit, credit rationing, signalling, simultaneous equations, endogenous threshold

JEL Classification G32, G21, G14

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1. INTRODUCTION

In the wake of recent financial turmoil across the world, it is important to ensure that businesses in need of funds have adequate access to external financing. How significant are the major sources of external financing for firms? Which source is more heavily used by a particular class of firms? Are businesses subject to credit rationing and if so, to what extent? These are some of the questions facing policy makers and economists, and this paper attempts to make a contribution towards answering them, focusing on two financing sources (bank credit and trade credit).

In this paper, we first present some empirical "anomalies" found in our data on Korean firms' credit uses. These are anomalies in the sense that they cannot be reconciled with standard theoretical models (e.g. Burkart and Ellingsen, 2004) in the literature. We argue that a model incorporating signalling effects of trade credit (Biais and Gollier, 1997) and nonlinear interest schedules for trade credit can provide a framework that fits better with our data. We then draw further empirical predictions from the proposed model and proceed to examine them in our data.

In Section 2, we discuss some relevant literature for our topic, in relation to a few stylized facts from our data on Korean firms. Section 3 outlines a theoretical model informed by the anomalies in our data and draws further empirical implications. In Section 4, based on the theoretical model, we set up a system of two equations for estimation and describe variables and data to be used for empirical analysis. Section 5 reports and discusses the estimation results.

The major empirical findings are: (1) signalling effects do exist and help improve the estimation and (2) the sample firms can be divided into wealth groups that show different interaction patterns between financing sources. The results could be interpreted as suggesting that the bottom 10% to 15% of the sample firms were subject to bank credit rationing for the sample period, because complementary interaction between trade credit and bank credit and strong presence of signalling effects are detected for this group.[1]

[1]In contrast, Kim (2009), using a similar dataset but employing a more simplistic model, suggested that the bottom 10% were subject to severe rationing (in both instruments) and as much as the half could be subject to bank credit rationing.

2. REVIEW OF LITERATURE AND STYLIZED FACTS FROM KOREAN DATA

Bank credit and trade credit are arguably the two most important sources of short-term external financing for firms (Petersen and Rajan, 1997). Bank credit, here referring to credit extended by banks and any other financial institutions, is an obvious primary source. Trade credit refers to that offered by suppliers of goods in the form of deferred payments. In the literature, trade credit is also alternatively referred to as 'in-kind finance' (Burkart and Ellingsen, 2004) or 'vendor financing' (Brennan et al., 1988). In empirical literature, it is typically identified with 'account payables'.

It is well documented that trade credit is a significant source of external financing for firms. For example, Tirole (2005, p. 82) reports that trade credit as proportion of total assets is 10.4% for US industrial firms, 13% in Japan, 11.5% in Germany and 17% in France. For Korean firms, Kim (2009) reports this figure to be about 10%, while bank credit as proportion of total assets to be about 9%. Table 1, which is reproduced from Kim (2009, Table 2), offers overview of significance of both bank credit and trade credit in several measures. Note that in these reported figures, trade credit means 'account payables' from financial statements in the literature.

Table 1: Significance of bank credit and trade credit for Korean firms

	2001	2002	2003	2004	2005	2006
Cash credit/GDP	12.4%	11.9%	12.0%	11.6%	11.7%	12.2%
Trade credit/GDP	12.2%	12.5%	12.5%	13.1%	14.2%	14.5%
Cash credit/Sales	9.4%	9.6%	9.6%	8.5%	8.3%	8.5%
Trade credit/Sales	9.3%	10.0%	10.1%	9.6%	10.1%	10.1%
Cash credit/Total Assets	9.2%	9.4%	9.3%	8.9%	8.5%	8.5%
Trade credit/Total Assets	9.2%	9.8%	9.7%	10.1%	10.3%	10.1%

Source: Kim (2009, Table 2)

Note: Kim (2009) uses the term 'cash credit' for our term 'bank credit'.

Prevalence of trade credit may seem peculiar because suppliers are non-financial firms and presumably inferior to specialized financial institutions (banks) in conducting financial transactions. Petersen and Rajan (1997) summarize several theories explaining the role of trade credit and empirically examine them, where one prominent theory is based on financing advantages of suppliers. The financing advantage theory suggests that compared to banks who maintain 'arms-length' relationship with borrowers, suppliers are better informed of borrowing firms' financial conditions, or may be better able to salvage value in case of default by borrowers. Fabbri and Menichini (2010) is a recent paper in this literature.

An important paper by Burkart and Ellingsen (2004) makes this explanation more explicit by incorporating potential diversions by borrowers. Suppliers offering trade credit are in a better position than banks to monitor diversions and seize back the credit in case of default, hence less susceptible to the moral hazard issues. One of the main implications from Burkart and Ellingsen's (2004) model is on the interaction between bank credit and trade credit: that the two instruments can be substitutes or complements or independents depending on the level of internal wealth.[2]

In Burkart and Ellingsen's (2004) model, the possibility of diversions leads to (i) lenders' optimal contract taking the form of rationing limits and (ii) trade credit having a higher interest rate than bank credit. Hence in their model, trade credit is inherently an inferior (more expensive) instrument from borrowers' point of view, so a borrower's optimal choice is not to use trade credit unless bank credit limit is reached. In fact, most papers in the literature (with the notable exception of Giannetti et al., 2011) seem to take it for granted that trade credit has a higher interest rate, hence an inferior instrument for borrowers.

In Burkart and Ellingsen's model, borrowers are divided into three groups: the high wealth group (with low demand for credit) is not rationed with respect to bank credit hence uses bank credit exclusively, the medium wealth group is bank credit rationed and uses both bank credit and trade credit while the low wealth group is rationed with respect to both instruments (Burkart and Ellingsen, 2004, Proposition 2). Moreover, for the low wealth group, any parameter change that increases one credit limit also increases the other instrument's credit limit, implying complementary interaction between the two instruments (Proposition 3) while for the medium wealth group the two instruments act as substitutes (Proposition 4) because when more bank credit is available the firm's use of trade credit falls.

Based on these predictions, Cunningham (2005) attempted to empirically determine endogenous thresholds (Hansen, 2000) between these wealth groups by looking at interactions between bank credit and trade credit using Canadian data. Her estimation results identified the threshold between the low wealth group (complementary) and the medium wealth group (substitutive), but did not

[2]Their model has several other important (macro) implications that we do not consider in this paper.

successfully reveal the threshold between the medium wealth group and the high wealth group (predicted to use zero trade credit, which implies absence of interaction between the two).

However, at least for our Korean data, one prediction of Burkart and Ellingsen model is clearly rejected: Burkart and Elligsen (2004) suggest that high wealth firms would use only bank credit and the rest would use both credit instruments, but in our Korean data the exactly opposite is true. In fact, a few stylized facts stand out from Korean data summarized in Box below[3] and Table 2.[4]

Box: Stylized Facts on Korean Firms' Credit Uses (derived from Table 2)

(1) Most (about 80% or more) of the firms in all wealth groups use *both* credit instruments.

(2) Among the small number of firms that use a single instrument exclusively, the preferred instrument is trade credit, not bank credit.

(3) The proportion of firms that use trade credit exclusively is highest for the top wealth group, falls as the wealth level falls, then somewhat rises again for the lowest wealth groups.

There are a few potential explanations for these stylized facts. First, contrary to popular assumptions in the literature, trade credit may actually be the cheaper instrument than bank credit, which could explain the wealthier firms' trade credit uses. In fact, Giannetti et al. (2011) offer empirical evidence supporting this position while Kim (2009) adopts this position in interpreting his Korean data. But this view is not easily reconcilable with currently available theories (Burkart and Ellingsen, 2004; Petersen and Rajan, 1997) that explain the role of trade credit to be "secondary" to bank credit.

Second, signalling effects of trade credit could explain the use of trade credit despite its (supposedly) higher interest rate. Alphonse et al. (2006), building on Biais and Gollier (1997), focus on signalling and reputational effects of trade

[3]A related observation was made by Petersen and Rajan (1997) on US data that larger firms tend to have larger account payables (proxy for trade credit). Jain (2001) also noted Elliehausen and Wolken's (1993) finding that more than 80% of US firms used trade credit.

[4]While Table 2 is based on the year 2006 data only, results are qualitatively similar for other years. Kim (2009) also reports similar findings across several years.

Table 2: Credit uses by wealth groups (number of firms)

Wealth group	Both credits	Trade credit only	Bank credit only	No credit	Total
0%-10%	653 (75.8%)	189 (22.0%)	11 (1.3%)	8 (0.9%)	861
10%-20%	713 (82.8%)	130 (15.1%)	15 (1.7%)	3 (0.3%)	861
20%-30%	685 (79.6%)	148 (17.2%)	19 (2.2%)	9 (1.0%)	861
30%-40%	741 (86.1%)	94 (10.9%)	23 (2.7%)	3 (0.3%)	861
40%-50%	785 (91.2%)	51 (5.9%)	10 (1.2%)	15 (1.7%)	861
50%-60%	753 (87.5%)	54 (6.3%)	13 (1.5%)	41 (4.8%)	861
60%-70%	759 (88.2%)	20 (2.3%)	14 (1.6%)	68 (7.9%)	861
70%-80%	736 (85.6%)	22 (2.6%)	20 (2.3%)	82 (9.5%)	860
80%-90%	766 (89.1%)	28 (3.3%)	30 (3.5%)	36 (4.2%)	860
90%-100%	707 (82.2%)	104 (12.1%)	17 (2.0%)	32 (3.7%)	860
Total	7,298 (84.8%)	840 (9.8%)	172 (2.0%)	297 (3.5%)	8,607

Note: The table is based on observations for the year 2006 from our main sample to be described in Section 4. Firms were divided into decile groups from top (0% -10%) to bottom (90%-100%) in wealth. See Section 4 for how wealth is defined.

credit. Succinctly put, they argue that the ability of a firm to obtain trade credit may act as a positive signal to (relatively uninformed) banks, leading previously unavailable bank credit to be offered. From a two-equation system, Alphonse et al. (2006) obtain estimation results showing both a negative effect of bank credit on trade credit (substitutability) and a positive effect of trade credit on bank credit (complementarity), the latter especially for firms with shorter banking relationships. Antov and Atanasova (2008) also develop a theoretical model based on signalling effects and draw dynamic implications that they find to be consistent with empirical evidence from UK and Irish data. One of their predictions is that borrowing firms will choose an interior solution, i.e. will use both trade credit and bank credit. They interpret a negative coefficient of trade credit on bank credit as supporting this prediction, as well as citing Miwa and Ramseyer's (2008) findings on Japanese firms.

While the signalling theory can explain the wide use of both instruments (interior optimum) and complementary interaction between them, it also falls short in accounting for the stylized facts outlined above. The signalling theory still presumes trade credit to be an inferior instrument, and cannot explain why some firms, especially the wealthier ones, would use trade credit exclusively.

One notable fact is that the existing theories typically assume *constant* interest rates and hence linear interest schedules for credit, presumably for analytical convenience. But a model with constant interest rates is bound to yield a corner solution where high wealth firms use the cheaper instrument exclusively while other firms use both. It is clear that our attempt to account for the stylized facts will be futile if we retain linear interest schedules within the theoretical framework where trade credit is a secondary (hence inferior) instrument. Moreover, we will argue in the next section that typical trade credit contracts actually show distinctively non-linear schedules.

The literature is very scarce when it comes to specifically Korean setting. Kim (2009) uses a similar dataset to that used in this paper, but adopts a very simple theoretical model following Burkart and Ellingsen (2004). Kim's (2009) empirical analysis is also quite limited compared to ours as it ignores endogeneity issues between bank credit and trade credit. Song and Ahn (2010) use a much smaller sample drawn from the same source as ours to examine agency-theoretical implications. Chong (2010) offers an empirical comparison between Korean firms and Australian firms in trade credit financing.

While we use exclusively Korean data in our empirical analysis, our theoretical analysis doesn't rely on Korea-specific assumptions.[5] It is our conjecture that similar empirical anomalies as noted above may stand out in data from other countries. The recent survey reported in Giannetti et al (2011) in fact seems to be in agreement with our position.

3. THEORY

In light of discussions in the previous section, we now develop a theoretical model that can account for the stylized facts we noted. Our model simplifies the situation by omitting why and how credit rationing may occur. (We take such questions to have been extensively and successfully handled by previous works.) Instead, we take the perspective of a borrowing firm who faces credit limits already set by lenders. Our model tries to capture the wide use of both instruments and the seemingly preferred status of trade credit by incorporating signalling effects of trade credit and nonlinear interest schedules for trade credit.

The model yields predictions on interaction among bank credit, trade credit and internal wealth that are superficially similar to those of Burkart and Ellingsen (2004) in appearance, but with subtle and important differences in interpretation and some additional empirical regularities to look for. It also suggests how signalling effects will be detected for different wealth groups, a question that was not pursued in Alphonse et al. (2006) or Antov and Atanasova (2008).

[5]This paragraph was inspired by an anonymous referee's insightful criticism of an earlier version.

The basic setup is similar to Kim's (2009) model. Suppose a borrowing firm has the production function $F(\cdot)$ that turns financial input I into financial return $F(I)$, with $F' > 0$ and $F'' < 0$.[6] The financial input I can come from three different sources—internal wealth w, bank credit c_B and trade credit c_T, so we have the identity $I \equiv w + c_B + c_T$ where bank credit c_B is obtained from financial institutions and trade credit c_T is obtained from suppliers of inputs.

For this setup, Kim (2009) considered the simple case of a price-taking borrower subject to constant credit limits in both credit markets. In other words, (i) both credit instruments are available at constant market interest rates, r_B for bank credit and r_T for trade credit and (ii) credit rationing takes the simple form of given upper limits[7] on the amount of credit allowed, i.e. $c_B \leq \overline{c_B}$ and $c_T \leq \overline{c_T}$. The optimum solutions can be characterized in a straightforward manner by Kuhn-Tucker first order conditions, and intuitively we can see that they will take the following form: If w is sufficiently high, then the firm will not use any credit: $c_B = c_T = 0$. If w is somewhat lower, then the firm will use only one (whichever is cheaper) instrument as long as the required credit amount is less than the rationed limit. In other words, either "$0 < c_B \leq \overline{c_B}$ and $c_T = 0$" or "$c_B = 0$ and $0 < c_T \leq \overline{c_T}$," depending on whether $r_B < r_T$ or $r_B > r_T$. Finally, if w is substantially low so that the rationed amount of the cheaper credit instrument is not enough, then the firm will use both instruments. For the case $r_B < r_T$, we will get $c_B = \overline{c_B}$ and $c_T > 0$, and vice versa for the opposite case.

Such implications are consistent with Burkart and Ellingsen's (2004) Proposition 2. If this model is literally applied, when we group borrowers according to their internal wealth levels, we should find that the medium wealth firms use the cheaper instrument exclusively while the low wealth firms use both instruments, so the boundary wealth level between these groups should be easily discernible: just search for the level of w where firms begin to use the inferior instrument!

However, we have noted earlier that this simple model is at odds with observations on our data. There are very few firms that use either bank credit or trade credit exclusively. This suggests that at least one of the two interest rates is not constant because the 'corner' optimum primarily arises from constant interest rates (rendering one instrument dominated by another).

[6]We abstract away the risky nature of the firm's financial activity. We may justify this as assuming risk neutrality of the firm and interpreting the production function in terms of expected values where other informational concerns have been incorporated into the "prices" (interest rates).

[7]A fixed credit limit is a restrictive assumption, but in later empirical analysis we will control for obvious variables that may affect credit limits (such as the asset size). We also note that by definition of rationing, the credit limit is to be imposed *regardless* of the borrowing firm's idiosyncratic characteristics.

3.1. MODEL

First, partly for simplicity, we maintain the assumption that there is a fixed limit on the amount of trade credit available.

Assumption 1 (trade credit rationing). $c_T \leq \overline{c_T}$

We keep the assumption that borrowing firms are price-takers in bank credit market with given constant interest rate r_B, which is plausible because the borrowing firm's relationship with banks is more "arms-length" compared to that with suppliers and banking market is more competitive.

Assumption 2 (bank credit interest rate). *r_B is a given constant.*

For trade credit, we assume that the interest rate is a function $r_T(c_T)$ of the size of the credit used.

Assumption 3 (trade credit interest rate). *$r_T(\cdot)$ is a sufficiently smooth function such that*

(1) $\lim_{c_T \to 0} r_T(c_T) \equiv r_T(0) < r_B$

(2) $r_T(\overline{c_T}) > r_B$

(3) $r_T'(c_T) > 0, \forall c_T$

(4) $r_T''(c_T) > 0, \forall c_T$

Assumption 3 reflects (in a roundabout way) well-known features of trade credit contracts.[8] In practice, trade credit contracts are not in terms of explicit interest rates, but take the form of "early payment discounts" from which *implicit* interest rates may be derived. The borrowing firm is allowed a specified "grace period" (e.g. 10 days or 1 month). If payment is made within this period, then the purchase price for the input is discounted than the standard list price. If payment is made after the grace period, the borrowing firm pays the list price (no discount and no formal interest). By paying the list price, the borrower forgoes the discount, hence an implicit interest rate can be computed, which is substantially higher than bank interest rates. Moreover, there may be another

[8]See Giannetti et al. (2011), Klapper et al. (2012), and Tirole (2005) for descriptions of European and American contracts. While we do not have documented evidence for Korean practice, our casual observations and conversations with some businesspersons suggest that it is not particularly different from American or European ones.

deadline for payments, beyond which the supplier may charge higher interest rates. This structure of payment periods shows that the interest schedule may not be linear.

Moreover, to insist that trade credit is inferior (because the implicit rate is quite high) is to ignore the fact that the borrower can avoid interest by paying back early. Even if the firm pays back within the grace period, the transaction could be reflected in the balance sheet as account payable. Hence, not all account payables are subject to the same high interest rate.

Assumption 3 reflects such a practice by allowing the interest rate to be an increasing function of the size of the credit used. Presumably it will be easier to pay back a small amount of trade credit within the grace period. It is also likely that as the size of trade credit gets larger, it becomes more difficult to utilize the discount or even make payments within normal payback period. In the statement of Assumption 3(1), the 'limit' appears because the interest rate may not be defined at $c_T = 0$, but we simplify the notation by calling the limit $r_T(0)$. Because such small trade credit essentially involves price discounts, it is plausible to assume that the rate is lower than bank rate r_B. Assumption 3(1) through (3) say that for a sufficiently small amount, trade credit interest rate is lower than the (constant) bank credit interest rate, making it a more attractive option for small transactions but eventually trade credit becomes more expensive than bank credit.

Assumption 3(4) renders the interest rate a convex function, which simplifies the analysis. It may be justified by observing that suppliers will not grant credit indefinitely, so for a large sum of trade credit if the firm keeps deferring payments, then the supplier may seize back or take other legal actions. Smoothness is assumed for convenience.

Finally, we assume that the bank credit limit is an *increasing* function of trade credit used $\overline{c_B}(c_T)$. This reflects positive signalling effect of trade credit. If a firm is able to acquire trade credit, it sends positive signals to banks, leading to increased bank credit limits. We also assume that signalling effect diminishes as the amount of trade credit gets larger.

Assumption 4 (bank credit rationing)**.** $\overline{c_B}(\cdot)$ *is a sufficiently smooth function such that*

(1) $\overline{c_B}(0) \geq 0$

(2) **[signalling effect]** $\overline{c_B}'(c_T) > 0$

(3) $\overline{c_B}''(c_T) < 0, \forall c_T$

With these four assumptions, a borrowing firm's problem is stated as follows:

$$\begin{aligned} \max_{c_B, c_T} \quad & F(w + c_B + c_T) - r_B c_B - r_T(c_T) c_T \\ \text{subject to} \quad & 0 \leq c_B \leq \overline{c_B}(c_T) \\ & 0 \leq c_T \leq \overline{c_T} \end{aligned}$$

3.2. OPTIMUM

We can form the Lagrangian function as $L(c_B, c_T, \lambda_B, \lambda_T) = F(w + c_B + c_T) - r_B c_B - r_T(c_T)c_T + \lambda_B[\overline{c_B}(c_T) - c_B] + \lambda_T[\overline{c_T} - c_T]$ and Kuhn-Tucker first-order conditions are given below as equations (1) through (4), with complementary slackness for each (i.e. at least one of the two inequalities in each condition must be binding).

$$F'(w + c_B + c_T) - r_B - \lambda_B \leq 0, \quad c_B \geq 0 \tag{1}$$

$$F'(w + c_B + c_T) - (r_T(c_T) + r'_T(c_T)c_T) + \lambda_B \overline{c_B}'(c_T) - \lambda_T \leq 0, \quad c_T \geq 0 \tag{2}$$

$$c_B \leq \overline{c_B}(c_T), \quad \lambda_B \geq 0 \tag{3}$$

$$c_T \leq \overline{c_T}, \quad \lambda_T \geq 0 \tag{4}$$

Trade credit interest schedule is not linear, so we introduce a notation for "effective" interest rate $\widetilde{r_T}$ (as a function of credit size c_T) as follows:

$$\widetilde{r_T}(c_T) \equiv r_T(c_T) + r'_T(c_T)c_T \tag{5}$$

It is easily checked that $\widetilde{r_T}'(\cdot) > 0$ (effective rate increases with credit size) under the given assumptions. We can then denote the unique threshold level c_T^* that equates the effective trade credit interest rate with bank interest rate:

$$c_T^* \quad : \quad \widetilde{r_T}(c_T^*) \equiv r_B \tag{6}$$

Obviously, we have that $c_T^* > 0$ and that $\widetilde{r_T}(c_T) < r_B$ for $c_T < c_T^*$ (trade credit is cheaper than bank credit for small c_T) and vice versa (trade credit becomes more expensive for larger c_T).

It will be helpful to define a number of thresholds on the level of w using the following equations:

$$w_1 \quad : \quad F'(w_1) \equiv r_T(0) \tag{7}$$

$$w_2 \quad : \quad F'(w_2 + c_T^*) \equiv r_B \tag{8}$$

$$w_3 \quad : \quad F'(w_3 + \overline{c_B}(c_T^*) + c_T^*) \equiv r_B \tag{9}$$

$$w_4 \quad : \quad F'(w_4 + \overline{c_B}(\overline{c_T}) + \overline{c_T}) \equiv \frac{\widetilde{r_T}(\overline{c_T}) + \overline{c_B}'(\overline{c_T}) r_B}{1 + \overline{c_B}'(\overline{c_T})} \tag{10}$$

The following lemma establishes that these equations give us well-defined thresholds. (Proofs of theoretical results are collected in Appendix 1.)

Lemma 1. *(7)∼(10) uniquely define thresholds on w such that $w_1 > w_2 > w_3 > w_4$.*

Notice that the right-hand sides of (7) through (10) are all constants (with (8) and (9) having the same value), hence we can denote three different levels of total investment as follows:

$$\begin{aligned} I^* &= w_1 \\ I^{**} &= w_2 + c_T^* \quad (= w_3 + \overline{c_B}(c_T^*) + c_T^*) \\ I^{***} &= w_4 + \overline{c_B}(\overline{c_T}) + \overline{c_T} \end{aligned}$$

It is easily checked that $I^* > I^{**} > I^{***}$. These are optimum levels of I with the best available interest rates depending on the level of c_T used. The thresholds just defined help us to tabulate the optimum solutions to the borrower's problem as follows.

Lemma 2. *Five cases of optimum solutions (c_B, c_T) are possible depending on the level of w as in the following table where the thresholds w_1, w_2, w_3 and w_4 are defined by (7) through (10).*

	(a′) $c_T = 0$	(b′) $0 < c_T < \overline{c_T}$	(c′) $c_T = \overline{c_T}$
(a) $c_B = 0$	$w_1 \leq w$	$w_2 \leq w < w_1$	impossible
(b) $0 < c_B < \overline{c_B}$	impossible	$w_3 < w < w_2$	impossible
(c) $c_B = \overline{c_B}$	impossible	$w_4 < w \leq w_3$	$-(\overline{c_B}(\overline{c_T}) + \overline{c_T}) < w \leq w_4$

The following theorem gives a complete characterization of the optimum credit uses depending on the parameter w. Proofs are straightforward given Lemma 2. (Brief intuitive comments are given for each case within the theorem's statement.) Figure 1 gives an illustration of optimum choices by charting I, c_T and c_B as functions of w. (Several defining values in Figure 1 are arbitrarily set for visual convenience. For example, the c_B curve is arbitrarily set to be strictly below the c_T curve.)

Theorem 1 (optimum uses of credit)**.** *Depending on the level of internal wealth w, the optimum uses of credits are as follows.*

(1) *If $w \geq w_1$, then $c_B = c_T = 0$ and $I = I^*$. (If the internal wealth is sufficient for the first-best level of investment, then the firm need not use any credit.)*

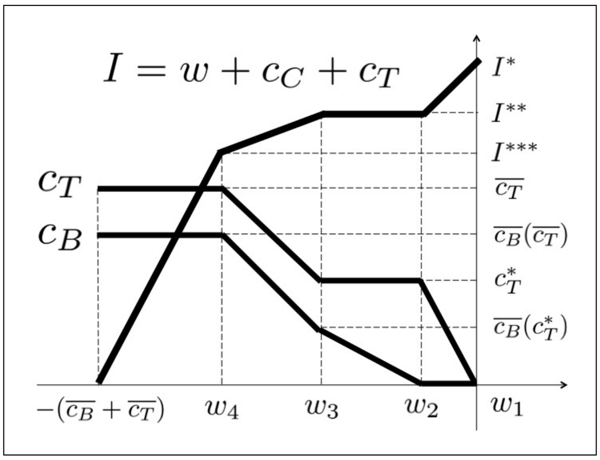

Figure 1: An illustration of optimum credit choices

(2) *If* $w_2 \leq w < w_1$*, then* $c_T = I^{**} - w$*,* $c_B = 0$ *and* $I = I^{**}$*. (For a small amount of credit, trade credit is cheaper, so is used exclusively.)*

(3) *If* $w_3 < w < w_2$*, then* $c_T = c_T^*$*,* $c_B = I^{**} - w - c_T^*$ *and* $I = I^{**}$*. (Trade credit is used up to the level* c_T^* *where its effective rate equals the bank rate and bank credit is used for the remaining needs.)*

(4) *If* $w_4 < w \leq w_3$*, then* $c_B = \overline{c_B}(c_T)$*,* $c_T^* \leq c_T < \overline{c_T}$ *and* $I = I^{***}$*. (If bank credit limit is reached, the firm returns to trade credit which allows the firm to get even more bank credit.)*

(5) *If* $-(\overline{c_B}+\overline{c_T}) < w \leq w_4$*, then* $c_B = \overline{c_B}(\overline{c_T})$*,* $c_T = \overline{c_T}$ *and* $I = w + \overline{c_B} + \overline{c_T} \leq I^{***}$*. (Firms with very small wealth make a sub-optimal level of investment using all three sources and are rationed with respect to both bank credit and trade credit.)*

(6) *If* $w \leq -(\overline{c_B}+\overline{c_T})$*, then* $c_B = c_T = 0$*. (Firms with negative wealth exceeding the size of total available credits do not use additional credits and do not invest at all.)*

Theorem 1 divides the firms into six groups depending on the level of internal wealth. The theorem asserts zero credit uses for both the very high wealth group (1) and the very low wealth group (6). The former group does not need credit while the latter cannot secure any. In empirical analysis, both groups will be naturally excluded from the sample. The item (5) depicts firms that are rationed with respect to both trade credit and bank credit. Because the model assumed a fixed limit for trade credit, their credit uses are constant in both instruments and represents an extreme case. The remaining three groups, characterized by items (2) through (4) of Theorem 1, describe high, medium and low wealth groups, respectively. As can be seen from Figure 1's illustration, each group exhibits distinct patterns of credit uses. The following theorem summarizes them. Interpretations and discussions will be given in the next subsection.

Theorem 2 (comparative statics of wealth on credit uses)**.** *The effect of changes in internal wealth w on optimal credit uses differs among different wealth groups as follows:*

$$-1 < \frac{dc_T}{dw}(w_h) < 0, \quad \frac{dc_T}{dw}(w_m) = 0, \quad -1 < \frac{dc_T}{dw}(w_l) < 0$$

$$\frac{dc_B}{dw}(w_h) = 0, \quad \frac{dc_B}{dw}(w_m) = -1, \quad \frac{dc_B}{dw}(w_l) < 0$$

where $w_h \in [w_2, w_1)$*,* $w_m \in (w_3, w_2)$*, and* $w_l \in (w_4, w_3]$.

Furthermore, in general we have

$$\frac{dc_T}{dc_B}(w_h) \neq \frac{dc_T}{dc_B}(w_l), \quad \frac{dc_T}{dc_B}(w_m) \neq \frac{dc_T}{dc_B}(w_l)$$

3.3. DISCUSSION OF THE MODEL AND TESTABLE IMPLICATIONS

We now seek to draw testable implications from the model. If the model were an accurate description of reality, then a straightforward comparative static analysis contained in Theorem 2 would suffice. But the model has limitations from simplifying assumptions. Instead of formally revising the model, we will argue away the limitations while trying to retain insights gleaned from it.

According to the model, high wealth firms use trade credit exclusively, hence an increase in w does not affect bank credit use ($c_B = 0$) and decreases the demand for trade credit (less than proportionately because the interest rate r_T falls as c_T falls) as noted by Theorem 2. Any change in parameters that affect c_T (including changes in w) should not affect c_B (which should remain zero). Therefore, if we regress c_B on w and c_T, we should find both coefficients to be zero.[9]

[9] Cunningham (2005) uses Burkart and Ellingsen's (2004) framework which predicts $c_T = 0$ for high wealth firms. So she regresses c_T on c_B and expects a zero coefficient for high wealth firms.

We have already observed in Table 2 that a small but sizable proportion of our sample firms use trade credit exclusively and they tend to have higher wealth. But it is also true that most of our sample firms do use both credit instruments across all wealth levels. If we restrict our attention to those firms that use trade credit exclusively, then not surprisingly we will observe no relation between their bank credit use (zero) and either trade credit use or internal wealth. On the other hand, if we examine the actual dataset in which most firms do use both, it may be unrealistic to expect a zero coefficient.[10]

Therefore we anticipate that in the data *high* and *medium* wealth groups may not show as sharp a break as the theory suggests. What we observe in the data will be a mixture of ‘theoretical’ (as opposed to ‘sample’) high wealth group and ‘theoretical’ medium wealth group. Since sample *high* wealth group contains a higher proportion of theoretical high wealth group, we may expect the effects of w or c_T on c_B to be somewhat mitigated, but not necessarily zero.

Turning next to *medium* wealth firms, one clear simplification of the model is that it prescribes a fixed level of trade credit c_T^*, hence predicts no effect of wealth on c_T. But this prediction is solely driven by our simplifying assumptions (especially Assumption 3(3)) leading to a *unique* value of c_T^* that equates effective trade credit rate $\widetilde{r_T}(c_T)$ and bank credit rate r_B. If we relax those assumptions slightly, for example, by assuming $r_T(\cdot)$ to be weakly increasing, then we would have an interval rather than a single value of c_T^*. Even in such a case, it remains true that the borrower is indifferent between the two instruments, but the borrower need not choose a fixed level of trade credit. The model then does not offer a definite prediction for each credit instrument separately. However, if we introduce random factors (due to unobservable characteristics, for example, which we will allow in an empirical model), the optimality would still require $c_B + c_T = I^{**} - w$.

Then what we expect about *medium* wealth firms is the following. The effect of wealth w on a single credit instrument (c_B or c_T) is ambiguous (but it is somewhat likely to be negative because higher wealth implies lower demand for credit, *ceteris paribus*). We have a more definite prediction for the *total* credit uses $c = c_B + c_T$: we expect it to be inversely related to the level of wealth $dc/dw = -1$. On the other hand, for any given level of w, we expect trade credit and bank credit to act as (perfect) substitutes, or the two instruments to be inversely related. If we regress c_T on c_B, the prediction is a negative relation. However, if we regress c_B on c_T, the prediction becomes ambiguous because in

[10]This might be one explanation for Cunningham’s (2005) failure to find the threshold value for high wealth group.

addition to the substitutive relation just noted we also posit a positive signalling effect. In theory, the signalling effect works on the bank credit limit $\overline{c_B}$, so it may not show up for theoretical medium wealth firms (not subject to bank credit rationing).

Finally, theoretical *low* wealth firms are rationed with respect to bank credit, but the credit limit is itself an increasing function of trade credit used (due to signalling effect). The increase in the level of wealth w will be inversely related to both trade credit and bank credit. Furthermore these coefficients will be different from those observed for high or medium wealth firms. Determining whether these coefficients will be higher or lower in magnitude than those for medium wealth group requires further parameter assumptions. On the other hand, since $c_B = \overline{c_B}(c_T)$, we have $dc_B/dc_T = \overline{c_B}'(c_T) > 0$. Since bank credit rationing is in effect, the two credit instruments will exhibit complementarity.

These testable implications are tabulated in Table 3 for convenience.

Table 3: Summary of testable implications

dependent variable	c_T		c_B		$c_T + c_B$
independent variables	c_B	w	c_T	w	w
high wealth	0^a	$(-)$	0^a	0^a	$(-)$
medium wealth	$(-)$	$?^b$	0	$?^b$	$(-)$
low wealth	$(+)$	$(-)$	$(+)$	$(-)$	$(-)$

Note: ^{a} could be negative, ^{b} ambiguous but likely to be negative

4. OVERVIEW OF EMPIRICAL ANALYSIS

4.1. ESTIMATION MODEL AND VARIABLE DEFINITIONS

In view of theoretical discussion in the previous section, we set up a simultaneous equations model as follows (random error terms are omitted):

$$TC = \beta_0 + \beta_1 BC + \beta_2 LC + \beta_3 \ln(TA) + \beta_4 \ln(AGE) + \beta_5 PR + \beta_6 CR + \beta_7 OE + \beta_8 SGdum \tag{11}$$

$$BC = \gamma_0 + \gamma_1 TC + \gamma_2 IE + \gamma_3 \ln(TA) + \gamma_4 \ln(AGE) + \gamma_5 PR + \gamma_6 CR + \gamma_7 OE + \gamma_8 SGdum \tag{12}$$

where it may be noted that TC and BC appear as endogenous variables, LC and IE are used as instruments for identification of each equation and the identical set of other control variables are included in both equations.

TC (trade credit) will be proxied by Account Payable, a sub-item of short-term liabilities in balance sheets. Another short-term liabilities sub-item, Short-term Debt, is used to measure BC (bank credit). Short-term Debt in balance sheets refers to loans with maturity of less than 1 year. Note that these proxy variables are standard in the related literature.

Two variables, LC and IE, are included for identification purposes. LC (Liquidation Cost) is computed as the ratio of finished goods inventories to the total inventories, sub-items in assets in balance sheets. Suppliers of material inputs can offer trade credit because they can seize back the sold inputs in case of borrowing firm's default. However, if those inputs have already been turned into finished goods, the creditors need to incur additional liquidation costs. Hence, LC will affect how much trade credit is offered. On the other hand, LC is unlikely to affect bank credit because whether the input has been turned into finished goods does not matter to banks in terms of salvage values. Therefore, we expect LC to identify Equation (11) with a negative coefficient.

IE (Interest Expenses) is a sub-item of expenses in income statements. By nature, trade credit transactions do not incur actual interest expenses but only implicit interests as forgone discount benefits. Hence, IE has at best indirect, if any, relations with TC, while it is directly related to BC. So we include IE to identify Equation (12) and expect a positive coefficient.

Other variables are controls for both equations and are standard in the literature. TA (Total Asset) measures the firm size. AGE is '1+firm age' in order to avoid zeros in logarithm. PR refers to Net Income, measuring the profitability. CR (Current Ratio) is computed as the ratio of Current Assets to Current Liabilities and is a standard measure of borrower's ability to repay. OE (Operating Expenses) is relevant because TC and BC are short term in nature. SGdum (Sales Growth dummy) is a binary variable with value 1 for positive sales growth. Values of TC, BC, IE, PR, and OE are divided by TA to control for scale effects. TA also enters equations directly, so nonlinear scale effects are allowed.

4.2. DATA

In estimating the model (11) and (12), we use a panel dataset drawn from a database on Korean firms. Since all variables are defined in terms of balance sheets and income statements, we use data from publicly available financial statements on externally audited firms.[11]

[11] Article 2 of Korea's ACT ON EXTERNAL AUDIT OF STOCK COMPANIES and Article 2 of ENFORCEMENT DECREE of the same ACT require an external audit for (i) any stock company with total asset exceeding 7 billion KRW, or (ii) any company listed in KSE or KOSDAQ, or (iii)

The period covered is 2001 to 2006. This period is meaningful as they fall between two recent financial crises. Korea was hit by the Asian financial crisis in late 1997 and saw its economic indicators return to pre-crisis levels by 2000. In the aftermath of the 1997 crisis, Korean banking and financial sector went through radical changes, including bailouts of major banks, M&A's among financial firms and regulatory reforms. In 2007, the global financial crisis began to affect the world economy. Hence, our sample period covers a relatively stable financial market in recent years.

We focus on non-financial firms, so discard firms classified as financial or insurance. The number of firms that are used in statistical estimation is 8,607 with 35,931 observations. Table 4 reports summary statistics. The mean of TC (as share of TA) is around 15%, while the mean of BC (as share of TA) steadily increases from 22% (2001) to 26% (2006). The mean LC (share of finished products in all inventories) is about 30% and the mean IE (as share of TA) is 2%∼3%. PR and CR show drops in 2006. Usually desired level of CR is above 200%, but our sample average is lower.

Table 4: Summary statistics for the whole sample

Variable	Year	#Obs.	Mean	Std. Dev.	Median	Min.	Max.
TC	2001	5,033	0.1519	0.1421	0.1105	1.31E-07	1.0173
	2002	5.492	0.1514	0.1407	0.1110	2.39E-05	0.9778
	2003	5,961	0.1489	0.1376	0.1110	3.54E-07	1.2552
	2004	6,280	0.1525	0.1388	0.1170	1.84E-06	1.3505
	2005	6,496	0.1547	0.1420	0.1161	2.13E-05	1.3812
	2006	6,669	0.1507	0.1417	0.1108	2.91E-06	1.3090
BC	2001	5,033	0.2197	0.1850	0.1824	1.26E-06	4.4751
	2002	5,492	0.2355	0.1829	0.2047	2.18E-07	2.8505
	2003	5,961	0.2445	0.1889	0.2161	9.98E-06	4.5065
	2004	6,280	0.2473	0.1955	0.2166	8.73E-07	4.4932
	2005	6,496	0.2457	0.1832	0.2152	1.46E-07	2.4165
	2006	6,669	0.2591	0.1937	0.2282	4.58E-08	2.2652
LC	2001	5,033	0.3153	0.2561	0.2944	0	1
	2002	5.492	0.3090	0.2592	0.2832	0	1
	2003	5,961	0.3071	0.2597	0.2755	0	1

(continued on the next page)

any company planning to be listed in KSE or KOSDAQ market. Hence, the data set excludes privately-held firms with less than 7 billion KRW assets.

Table 4: Summary statistics (*continued*)

Variable	Year	#Obs.	Mean	Std. Dev.	Median	Min.	Max.
	2004	6,280	0.3066	0.2623	0.2733	0	1
	2005	6,496	0.3117	0.2661	0.2825	0	1
	2006	6,669	0.3181	0.2706	0.2848	0	1
IE	2001	5,033	0.0305	0.0248	0.0263	7.64E-07	0.3618
	2002	5.492	0.0260	0.0246	0.0227	4.52E-07	0.8165
	2003	5,961	0.0243	0.0223	0.0210	5.77E-06	0.5247
	2004	6,280	0.0238	0.0219	0.0208	3.75E-07	0.5718
	2005	6,496	0.0223	0.0183	0.0198	7.21E-07	0.6380
	2006	6,669	0.0236	0.0170	0.0213	7.51E-07	0.2205
ln(TA)	2001	5,033	16.7409	1.3971	16.5005	12.7019	23.8522
	2002	5.492	16.7403	1.3287	16.4850	13.0584	23.8034
	2003	5,961	16.7827	1.2833	16.5191	12.8090	23.8964
	2004	6,280	16.8523	1.2285	16.5740	12.9888	23.9187
	2005	6,496	16.9448	1.1936	16.6544	12.3225	24.0065
	2006	6,669	17.0429	1.1450	16.7416	11.9854	23.9978
ln(AGE)	2001	5,033	2.5213	0.7563	2.6391	0.6931	4.6634
	2002	5.492	2.5079	0.7490	2.5649	0.6931	4.6728
	2003	5,961	2.5173	0.7341	2.5649	0.6931	4.6821
	2004	6,280	2.5563	0.7096	2.6391	0.6931	4.6913
	2005	6,496	2.5906	0.6846	2.6391	0.6931	4.7005
	2006	6,669	2.6351	0.6677	2.6391	0.6931	4.7095
PR	2001	5,033	0.0276	0.1469	0.0326	−4.5242	1.6906
	2002	5.492	0.0281	0.1419	0.0347	−3.2366	1.8936
	2003	5,961	0.0171	0.1606	0.0294	−4.3819	1.3040
	2004	6,280	0.0247	0.1643	0.0334	−3.4413	1.9818
	2005	6,496	0.0214	0.1489	0.0301	−4.5500	3.2341
	2006	6,669	0.0089	0.1520	0.0240	−3.2257	0.6456
CR	2001	5,033	130.81	99.45	110.46	0.9596	1610.59
	2002	5.492	126.72	89.65	108.45	0.1904	1453.89
	2003	5,961	126.97	102.30	106.89	0.6334	2006.75
	2004	6,280	126.59	97.60	107.07	0.4207	1595.32
	2005	6,496	128.29	100.97	107.21	0.7650	1773.46
	2006	6,669	125.53	103.20	104.53	0.4932	1918.25
OE	2001	5,033	0.1770	0.1577	0.1335	0.0042	2.0979
	2002	5.492	0.1861	0.1769	0.1378	0.0026	2.7548

(continued on the next page)

Table 4: Summary statistics (*continued*)

Variable	Year	#Obs.	Mean	Std. Dev.	Median	Min.	Max.
	2003	5,961	0.1924	0.1960	0.1372	0.0029	2.6861
	2004	6,280	0.1941	0.1947	0.1380	0.0067	2.4306
	2005	6,496	0.1863	0.1931	0.1312	0.0046	2.7201
	2006	6,669	0.1804	0.1855	0.1286	0.0035	2.6256
SGdum	2001	5,033	0.6742	0.4687	1	0	1
	2002	5.492	0.7340	0.4419	1	0	1
	2003	5,961	0.6808	0.4662	1	0	1
	2004	6,280	0.7373	0.4402	1	0	1
	2005	6,496	0.6416	0.4796	1	0	1
	2006	6,669	0.6465	0.4781	1	0	1

4.3. MEASURING INTERNAL WEALTH

Our analysis requires us to classify firms according to their internal wealth level w. In theory, w is meant to be a primary source for operating and investment expenses and when it falls short of firms' financial needs, they will seek to obtain external credit. But it is difficult to measure a firm's available internal wealth at any given moment accurately.

In this paper, we use the discounted sum (using GDP deflator) of net income throughout the data period (in other words, discounted sum of PR) to divide sample firms into different wealth groups. We believe that a firm's net income is at least highly correlated with the internally available resources at any given time moment. Net income is essentially the profit generated within the year and can be used either for resolution of debt, business expenses, accumulation of assets, etc.[12]

By taking a discounted sum, we are measuring the firm's accumulated net income or the wealth stock at the last sample period. This measure does not account for year-by-year variations but gives us a consistent classification scheme for sample firms. Note that PR is also included as a control variable, so we do not ignore varying profitability in each year.

In analyzing firms' credit uses, we take two approaches. First, we examine decile groups according to the discounted sum of net income, where the first decile (0%∼10%) represents the highest wealth group and the last decile (90%∼100%) represents the lowest wealth group. While the grouping is done exoge-

[12]As an anonymous referee pointed out, retained earnings, rather than net income, may be a better alternative. However, neither net income nor retained earnings are not perfect proxies for the accumulated and available internal wealth and they must be highly correlated with each other, especially when added up over the sample period.

nously and the choice of "decile" division is arbitrary, it gives us a good overview of firms' behaviors.

Second, we use Caner and Hansen's (2004) methodology[13] of *endogenous threshold estimation* to classify firms into three groups. The procedure is roughly as follows: Using the same threshold variable (discounted sum of net income), pick an arbitrary threshold level and divide the sample into two parts. Run the regression on each sub-sample and compute the squared sums of residuals. Find the threshold value that has the minimum squared sums of residuals. Candidates for threshold values are chosen from pre-specified grids.

By nature of the methodology, it cannot find several thresholds at the same time and is not suitable for panel estimation. So we limit the endogenous grouping to 2006 samples only and apply the method to the sub-sample with 35% and lower in terms of net income to find the threshold between medium wealth and low wealth groups, which turns out to be 86%. Then we apply the same method to another sub-sample (again drawn from the year 2006 only), obtained this time by discarding 86% and below (those already identified to be low wealth group) and adding 35% and above. The threshold between high wealth and medium wealth groups thus found is 31%.

Table 5 presents summary statistics on the criterion by which firms are classified, the internal wealth proxied by the accumulated net income. Among the total of 8,607 firms, 1,856 (21.6%) had negative wealth level (accumulated over the sample period). Hence, the bottom two decile groups and the low wealth group in the endogenous grouping consist of firms with negative accumulated wealth from 2001 through 2006.

Next, Tables 6 and 7 show summary statistics on TC and BC by groups. The first notable thing is that the top decile groups TC and BC (as shares of total asset) are similar, while other groups show significantly higher shares of BC. The level of TC rises from the top group down until the 7th decile (60% through 70%) group then falls significantly for the bottom two groups (note that these are firms with mean negative net income). The level of BC rises from the top down until the 9th group, then somewhat falls for the bottom group.

Examination of endogenously classified groups reveals that the level of TC is similar for high wealth and low wealth groups, and is higher for medium wealth group, while the level of BC is the lowest for high wealth group and rises significantly for medium wealth and low wealth groups.

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[13]This is an extension of Hansen's (2000) *threshold estimation*, which was employed by Cunningham (2005).

Table 5: Internal wealth by groups

Decile Grouping					
Group	# Firms	# Obs.	Mean	Std. Dev.	Median
0%-10%	861	3,647	2.08E+08	6.74E+08	6.01E+07
10%-20%	861	3,802	1.73E+07	4,295,950	1.64E+07
20%-30%	861	3,579	8,586,462	1,331,759	8,393,747
30%-40%	861	3,624	5,143,695	712,175	5,101,339
40%-50%	861	3,686	3,277,206	420,785	3,277,482
50%-60%	861	3,616	2,061,751	275,236	2,055,217
60%-70%	861	3,667	1,189,038	218,902	1,168,341
70%-80%	860	3,326	365,498	310,908	409,592
80%-90%	860	3,430	−1,941,666	1,228,607	−1,647,983
90%-100%	860	3,554	−5.14E+07	2.25E+08	−1.68E+07
Endogenous Grouping					
Group	# Firms	# Obs.	Mean	Std. Dev.	Median
0%-31%	2,685	11,460	7.26E+07	3.72E+08	1.56E+07
31%-86%	4,710	19,531	1,945,898	1,877,316	1,730,965
86%-100%	1,212	4,940	−4.00E+07	2.12E+08	−9,496,097

Table 6: TC (Account Payable = Trade Credit) by groups

Decile Grouping						
Group	# Obs.	Mean	Std. Dev.	Median	Min.	Max.
0%-10%	3,647	0.1205	0.1046	0.0916	2.91E-06	0.8620
10%-20%	3,802	0.1352	0.1179	0.1050	2.03E-05	0.7868
20%-30%	3,579	0.1362	0.1301	0.0980	3.25E-05	1.0173
30%-40%	3,624	0.1505	0.1248	0.1202	4.50E-06	0.8620
40%-50%	3,686	0.1690	0.1458	0.1314	5.35E-06	0.9117
50%-60%	3,616	0.1770	0.1583	0.1339	1.80E-05	1.3812
60%-70%	3,667	0.1755	0.1525	0.1385	4.91E-05	0.9319
70%-80%	3,326	0.1730	0.1631	0.1278	1.31E-07	1.1522
80%-90%	3,430	0.1525	0.1451	0.1111	4.27E-07	1.2552
90%-100%	3,554	0.1296	0.1406	0.0892	1.24E-05	1.3561
Endogenous Grouping						
Group	# Obs.	Mean	Std. Dev.	Median	Min.	Max.
0%-31%	11,460	0.1306	0.1178	0.0975	2.91E-06	1.0173
31%-86%	19,531	0.1686	0.1506	0.1294	1.31E-07	1.3812
86%-100%	4,940	0.1340	0.1385	0.0944	4.27E-07	1.3561

Table 7: BC (Short-term Debt = Bank Credit) by groups

Decile Grouping						
Group	# Obs.	Mean	Std. Dev.	Median	Min.	Max.
0%-10%	3,647	0.1299	0.1150	0.0999	4.58E-08	1.1081
10%-20%	3,802	0.1925	0.1369	0.1706	2.18E-07	1.0603
20%-30%	3,579	0.2008	0.1503	0.1692	3.14E-06	1.6620
30%-40%	3,624	0.2252	0.1598	0.2001	8.62E-06	2.2053
40%-50%	3,686	0.2467	0.1544	0.2288	1.27E-05	0.9012
50%-60%	3,616	0.2684	0.1696	0.2577	5.49E-06	1.5816
60%-70%	3,667	0.2815	0.1690	0.2687	9.93E-06	0.9724
70%-80%	3,326	0.2939	0.1855	0.2724	2.29E-04	1.9715
80%-90%	3,430	0.3129	0.2225	0.2872	2.93E-05	4.5065
90%-100%	3,554	0.2901	0.2923	0.2250	2.05E-05	4.4932
Endogenous Grouping						
Group	# Obs.	Mean	Std. Dev.	Median	Min.	Max.
0%-31%	11,460	0.1763	0.1415	0.1444	4.58E-08	2.2053
31%-86%	19,531	0.2690	0.1770	0.2492	5.49E-06	4.5065
86%-100%	4,940	0.2954	0.2710	0.2420	2.05E-05	4.4932

5. ESTIMATION RESULTS

We estimate (11) and (12) using two-stage least squares method. Durbin-Watson's d-statistic showed that both TC and BC have positive AR(1) serial correlation, so we applied correction for the serial correlation. After Hausman Test, we used fixed effects model in panel data estimation.

Table 8 reports the results of estimation on the *whole* sample. While we are mainly interested in results on the sub-samples to be presented later, there are a few notable points from the whole sample results as well.

The small (and statistically not significant even at 10%) coefficient of BC in TC equation (11) does not tell us much at this point. But the large and statistically significant (at 1%) coefficient of TC in BC equation (12) is a piece of evidence for the presence of signalling effects. The instruments used for identification show expected signs, although the instrument for TC equation (11), LC, has a rather small coefficient (but still statistically significantly nonzero at 1%). Most of the control variables also have expected signs.

With this evidence of the presence of significant signalling effects, the use of a simultaneous equations model is warranted and the coefficients in TC equation (11) can be interpreted in terms of the theoretical model. To further test the merits of the simultaneous equations model, we also estimated a single equation model with TC as the dependent variable, where we observe an economically and statistically significant negative coefficient on BC. In other words, if we did not use the simultaneous equations model accounting for signalling effects, we could have (wrongly) concluded that bank credit and trade credit are substitutes across the whole sample. See Appendix 2 for more details on this point.

Table 8: The whole sample estimation results

Variable	Eq (11) TC	Eq (12) BC
BC	0.00676	
	(0.42)	
LC	−0.01478***	
	(−4.84)	
TC		1.19509***
		(12.77)
IE		2.00022***
		(26.43)
ln(TA)	0.00047	−0.00770***
	(0.27)	(−2.02)
ln(AGE)	0.00043	0.05924***
	(0.12)	(8.15)
PR	−0.02714***	−0.14354***
	(−5.62)	(−18.14)
CR	−0.00010***	−0.00035***
	(−9.63)	(−19.85)
OE	0.01741***	−0.06962***
	(3.13)	(−5.62)
SGdum	0.01738***	−0.02602***
	(21.77)	(−10.70)
constant	0.14260***	0.07123
	(5.24)	(1.18)

Notes: # observations = 35,931
firms = 8,607
( ) = standard error
*** = statistically significant at 1%

Let us now examine the sub-samples results presented in Table 9. It contains both decile group results and endogenously determined group results. (For brevity, we report only the coefficients of key variables.) We shall see that the results are broadly consistent with predictions from our theory.

First, the coefficient β_1 of BC in TC equation (11), which was insignificant

Table 9: The group sub-samples estimation results

	(11) $TC = \beta_1 BC + \beta_5 PR + \ldots$		(12) $BC = \gamma_1 TC + \gamma_5 PR + \ldots$	
	β_1	β_5	γ_1	γ_5
Whole	0.00676	-0.02714***	1.19509***	-0.14354***
Decile				
0%-10%	-0.01695	-0.03722***	0.08871	-0.10227***
10%-20%	0.02461	-0.00039	-0.22324	-0.10589***
20%-30%	-0.12093*	-0.05110*	0.69670***	-0.27584***
30%-40%	-0.22673***	-0.09694***	0.64174***	-0.19851***
40%-50%	-0.73286***	-0.22894***	0.02338	-0.23420***
50%-60%	-0.61937***	-0.14200***	0.66801***	-0.25926***
60%-70%	-0.39822***	-0.06111*	0.43943	-0.20809***
70%-80%	-0.43095***	-0.06909***	0.50218*	-0.11609***
80%-90%	-0.05284**	-0.05340***	2.14210***	-0.10105**
90%-100%	0.13398***	0.00999	1.75557***	-0.14359***
Endogenous				
High (-31%)	-0.04694	-0.02395***	0.36921***	-0.13293***
Mid (-86%)	-0.20453***	-0.06998***	1.31600***	-0.19809***
Low (-100%)	0.10576***	-0.00177	1.62452***	-0.13443***

Notes: ***= statistically significant at 1%, **= at 5%, *=at 10%

for the whole sample, is not significant for the top two deciles and the endogenously determined high wealth group, significantly negative for the third through the ninth decile groups and the endogenously determined medium wealth group, and finally significantly positive for the last decile group and the endogenously determined low wealth group. These are broadly consistent with our theory's predictions. They may be interpreted as that the bottom 10%$\sim$15% firms (who on average have a negative accumulated wealth) are subject to rationing in bank credit market.

Second, the signalling effect as measured by the coefficient γ_1 of TC in BC equation (12) is zero or positive across wealth groups. Theory's unambiguous prediction is that it will be significantly positive for the low wealth group, which is confirmed at least for the bottom 20% and the endogenously determined low wealth group. Hence the findings support not only the existence of signalling effects but also their strong presence for the low wealth group who are subject to bank credit rationing. It is natural that signalling effects are not detected for wealthier firms.

In order to confirm our predictions on the effect of internal wealth on credit uses, we need some further considerations. While we used the discounted sum of net income for grouping the samples, this variable is not wholly satisfactory for our purpose here because it loses the time component. An imperfect but convenient alternative is to use the current net income (PR in the estimation equations). It is imperfect because in theory w should be the 'stock' of internal wealth but PR is the annual 'flow' into the internal wealth. However, it is convenient in that we can use the already reported estimation results. It is not enough to check signs of coefficients β_5 or γ_5 directly. Instead, we need to derive the reduced-form equation from the simultaneous equations model. We outline a simplified reduced form in Appendix 3. From the reduced form model, we may compute the coefficient of PR (as a proxy for the current internal wealth), which are tabulated in Table 10.

We observe mostly negative signs, which make sense because both trade credit and bank credit are substitutable with wealth. One curious thing is that the effect of wealth on trade credit is very small in magnitude, in comparison with that on bank credit. For some reason, bank credit is picking up most of the effects from wealth. Roughly speaking, wealth and bank credit appear to act as important substitutes while trade credit appears to be relatively inelastic to wealth changes.

The values of dc_B/dw computed from the reduced form are quite consistent with theory's predictions. For the medium wealth group, wealth exerts a clear

Table 10: Effects of wealth on credit as computed from the reduced form

	dc_T/dw	dc_Bdw
Decile		
0%-10%	−0.037	−0.102
10%-20%	0.000	−0.106
20%-30%	−0.018	−0.311
30%-40%	−0.052	−0.261
40%-50%	−0.057	−0.234
50%-60%	0.019	−0.354
60%-70%	0.022	−0.208
70%-80%	−0.019	−0.151
80%-90%	−0.048	−0.215
90%-100%	−0.019	−0.144
Engogenous		
High (-31%)	−0.024	−0.142
Medium (-86%)	−0.023	−0.228
Low (-100%)	−0.020	−0.166

and strong negative effect on the use of bank credit. The unambiguous prediction of theory for this group is that wealth and credit in general will be inversely related. For the high wealth group, theoretical prediction is zero effect but as we have already noted before, the empirical data contain a mixture of theoretical high wealth and medium wealth firms. So the negative coefficient with a smaller magnitude is consistent with our theory. Finally, for the low wealth group, again a smaller negative coefficient is obtained. This is again plausible because theoretically the effect of wealth on bank credit for this group is exerted indirectly via the effect of wealth on trade credit (plus signalling effects). From the empirical results, the small size of dc_T/dw leads to a lower value of dc_B/dw.

For the values of dc_T/dw computed from the reduced form, interpretation is more difficult because of the small magnitudes observed for all groups. The decile group figures are somewhat more consistent with theory in the sense that low wealth groups show negative signs while the high and the medium wealth groups show more mixed results. Our unambiguous prediction was limited to the low wealth group.

6. CONCLUSION

In this paper, we outlined a theoretical framework in which we can describe borrowing firms' credit choices depending on the level of internal wealth. Our model reflects insights from previous theories and adds new features. Specifically, our model describes how borrowers would choose when faced with credit rationing, signalling effects and nonlinear interest schedules for trade credit. We then brought predictions from the model against panel data on Korean firms for the period between 2001 and 2006. Using the theoretical framework, we were able to roughly identify groupings of the sample firms. Especially we could identify the low wealth group (the bottom 10% $\sim$ 15%), because those firms exhibited complementarity in their use of bank credit and trade credit and also strong signalling effects were detected for them.

Some questions for further research suggest themselves. For theory, it is notable that we used a somewhat roundabout description of nonlinear interest schedules for trade credit. Employing a more realistic description is less tractable but might yield new insights. More importantly, the fundamental question remains as to why trade credit contracts take the observed typical form. We may need an extended model of signalling effects (Biais and Gollier, 1997) using more refined game theoretic ideas.

For the empirical part, the relatively small magnitudes of coefficients (both for the identifying variable and PR) in TC equation remain somewhat of a puzzle. They can be partly explained by arguing that the identifying instrument is weak and that PR is a weak proxy for internal wealth. Even then, the puzzle remains because the coefficient of PR in BC equation is relatively large in magnitude. An improved theory (with a refinement of signalling effects mentioned in the previous paragraph) might be able to cast us new lights.

There are also many important issues not directly addressed in this paper, partly to focus on our immediate concern but also partly due to limitations in the available data. For example, macroeconomic considerations such as monetary policy have been suppressed. We can note that the period covered in our dataset (from 2001 through 2006) represents relatively stable years in recent financial history in Korea, as the impact of 1997 Asian financial crisis had been effectively dissipated by the year 2000 and the global financial turmoil began to affect Korea in late 2007.

Our model posits a common production function for analytic convenience, while clearly firms are heterogeneous. The industry characteristics might be an important factor in credit choices. In fact, we have tried different specifications of estimation that included industry classification dummies, but such analysis did not yield any meaningful results hence were omitted in this paper.

We considered only two credit instruments (trade credit and bank credit), which are the two most important ones, but firms use a more diverse set of credit instruments (e.g. promissory notes, notes payable and other trade payables), some of which have intermediate properties between bank credit and trade credit, because they can be securitized. The theoretical extension in this direction should not be too difficult but has not been done yet in the literature. In addition, the challenge remains in securing a more detailed dataset because the dataset we used does not have much information on such refined credit instruments. In other words, in financial statements, many firms report only on the category 'account payables' and do not offer detailed information on refined credit instruments. This is one of the reasons that most existing papers use account payables as proxy for trade credit.

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APPENDIX 1: PROOFS

Proof of Lemma 1. Because F is strictly concave, from (7) and (8), we have $w_1 > w_2 + c_T^* > w_2$ since $r_T(0) < r_B$. From (8) and (9), we have $w_2 + c_T^* = w_3 + \overline{c_B}(c_T^*) + c_T^*$, hence $w_2 > w_3$. Because $\widetilde{r_T}(\overline{c_T}) > r_B$ and the right-hand side of (10) is a weighted average of r_B and $\widetilde{r_T}(\overline{c_T})$, it is greater than r_B. So $w_3 + \overline{c_B}(c_T^*) + c_T^* > w_4 + \overline{c_B}(\overline{c_T}) + \overline{c_T}$, which leads to $w_3 > w_4 + [\overline{c_B}(\overline{c_T}) - \overline{c_B}(c_T^*)] + (\overline{c_T} - c_T^*) > w_4$ since $\overline{c_B}(\overline{c_T}) > \overline{c_B}(c_T^*)$ and $\overline{c_T} > c_T^*$. ∎

Proof of Lemma 2. Each of the nine cells represents a possible solution of the first-order conditions. We shall examine them in some detail, as they provide useful intuitions for the firm's behavior.

(aa′) $c_B = c_T = 0$: Both rationing constraints (3) and (4) are slack, hence $\lambda_B = \lambda_T = 0$. From (1) and (2), $F'(w) - r_B \leq 0$ and $F'(w) - r_T(0) \leq 0$, but $r_T(0) < r_B$ by Assumption 3(1). Hence, for this case to obtain we want $F'(w) \leq r_T(0)$. This condition is satisfied for $w \geq w_1$, where w_1 is defined by (7). The interpretation is that the internal resource w is sufficiently large, so the firm can obtain the first-best return $F(w_1)$ without using any credit.

(ba′) $0 < c_B < \overline{c_B}(0)$, $c_T = 0$: Both rationing constraints (3) and (4) are slack, so $\lambda_B = \lambda_T = 0$. In addition, $c_B > 0$ implies $F'(w + c_B) - r_B = 0$ from (1). We also have $F'(w + c_B) - r_T(0) \leq 0$ from (2). In sum, we have $F'(w + c_B) = r_B \leq r_T(0)$, which is inconsistent with Assumption 3(1). Since a small amount of trade credit is cheaper than bank credit, it is not optimal to use a positive amount of bank credit without using any trade credit.

(ca′) $c_B = \overline{c_B}(0)$, $c_T = 0$: We need not spell out the details, as it is obvious from the previous case that this is inconsistent with Assumption 3(1).

(ab′) $c_B = 0$, $0 < c_T < \overline{c_T}$: Both rationing constraints (3) and (4) are slack, so $\lambda_B = \lambda_T = 0$. In addition, $c_T > 0$ implies $F'(w + c_T) - \widetilde{r_T}(c_T) = 0$ from (2), and (1) becomes $F'(w + c_T) - r_B \leq 0$. Hence, we have $\widetilde{r_T}(c_T) = F'(w + c_T) \leq r_B$. In the limiting case $c_T \to 0$, we are back to case (aa′) with $\widetilde{r_T}(0) = F'(w_1)$, hence for $0 < c_T$, $F'(w_1) = \widetilde{r_T}(0) < \widetilde{r_T}(c_T) = F'(w + c_T)$, which implies $w < w_1$ (not enough internal wealth leading to use of credit).

The amount c_T cannot go up to the limit $\overline{c_T}$ (since $\widetilde{r_T}(\overline{c_T}) > r_B$ by Assumption). For $c_T \leq c_T^*$ where c_T^* is defined in (6), we have $\widetilde{r_T}(c_T) \leq r_B$. We can check that the first conditions hold for $w \geq w_2$, where w_2 is defined in (8). The firm uses trade credit only up to the point where its (marginal) interest rate equals bank credit interest rate.

(ac′) $c_B = 0$, $c_T = \overline{c_T}$: Rationing constraint (4) is binding, but (3) is slack, so $\lambda_B = 0$ but $\lambda_T \geq 0$. The condition (2) is now binding, as the non-negativity constraint on c_T is slack. So we have $F'(w + \overline{c_T}) - r_B \leq 0$ and $F'(w + \overline{c_T}) - \widetilde{r_T}(\overline{c_T}) - \lambda_T = 0$. Combine the two to obtain $\widetilde{r_T}(\overline{c_T}) \leq F'(w + \overline{c_T}) \leq r_B$, which is inconsistent with Assumption 3(3). Bank credit becomes cheaper before the firm reaches the limit on trade credit, so it is not optimal not to use bank credit while exhausting trade credit limit.

(bc′) $0 < c_B < \overline{c_B}(\overline{c_T})$, $c_T = \overline{c_T}$: As in case (ac′), rationing constraint (4) is binding, but (3) is slack, so $\lambda_B = 0$ but $\lambda_T \geq 0$. Both (1) and (2) are binding, as both non-negativity constraints are slack. So we have $F'(w + c_B + \overline{c_T}) - r_B = 0$ and $F'(w + c_B + \overline{c_T}) - \widetilde{r_T}(\overline{c_T}) - \lambda_T = 0$. Combine the two to obtain $\widetilde{r_T}(\overline{c_T}) \leq F'(w + c_B + \overline{c_T}) = r_B$, which is again inconsistent with Assumption 3(3).

(bb′) $0 < c_B < \overline{c_B}(c_T)$, $0 < c_T < \overline{c_T}$: All constraints are slack, hence we have equality first-order conditions with $\lambda_B = \lambda_T = 0$. So $F'(w + c_B + c_T) = r_B = \widetilde{r_T}(c_T)$. For this to hold, we need $c_T = c_T^*$. Then it is easy to check that we need $w_3 < w < w_2$.

(cb′) $c_B = \overline{c_B}(c_T)$, $0 < c_T < \overline{c_T}$: This is the most intricate case because the bank credit limit is not a constant but changes as c_T changes.

First, we have $\lambda_T = 0$, but $\lambda_B \geq 0$. The first two FOCs reduce to $F'(w + \overline{c_B}(c_T) + c_T) = r_B + \lambda_B = \widetilde{r_T}(c_T) - \lambda_B \overline{c_B}'(c_T)$. From the latter equality we can solve for λ_B to obtain $\lambda_B = (\widetilde{r_T}(c_T) - r_B)/(1 + \overline{c_B}'(c_T))$, which correctly measures the shadow price of the bank credit limit. Putting this value back into the FOC, we have an equation

$$F'(w + \overline{c_B}(c_T) + c_T) = \frac{1}{1 + \overline{c_B}'(c_T)} \widetilde{r_T}(c_T) + \frac{\overline{c_B}'(c_T)}{1 + \overline{c_B}'(c_T)} r_B \tag{13}$$

The right-hand side of (13) is a weighted average of r_B and $\widetilde{r_T}(c_T)$, hence falls (strictly) between them.

We have observed in cases (ab′) and (bb′) that $c_T \leq c_T^*$, hence we know $c_T > c_T^*$, which implies $\widetilde{r_T}(c_T) > r_B$ so we have $r_B < F'(w + \overline{c_B}(c_T) + c_T) < \widetilde{r_T}(c_T)$. Under certain conditions, the equation (13) can implicitly define c_T as function of w and we can sign this function as $dc_T/dw < 0$ with the assumption $\overline{c_B}'' \leq 0$ (diminishing signalling effect, Assumption 4(3)).[14]

Now $w = w_3$ and $c_T = c_T^*$ together satisfy (13) because $\widetilde{r_T}(c_T^*) = r_B$. For w lower than w_3, c_T increases and reaches the upper limit $\overline{c_T}$ when $w = w_4$. Hence, this case obtains for $w_4 \leq w \leq w_3$.

As the firm reaches its first limit on bank credit at $\overline{c_B}(c_T^*)$, it obtains some trade credit which allows it to obtain further bank credit.

(cc′) $c_B = \overline{c_B}$, $c_T = \overline{c_T}$: This is the opposite extreme of (aa′) and obviously the remaining condition is for $w < w_4$. The firm has little internal resources and using up both kinds of credits are not enough. Such a firm may be said to face severe credit rationing. In addition, we also need $-(\overline{c_B}(\overline{c_T}) + \overline{c_T}) < w$, otherwise $I < 0$, in which case the optimum choice would be $c_B = c_T = 0$. In other words, if the firm's internal wealth is negative (i.e. accumulated previous debt) whose size is greater than the size of

[14]From (13), let $\psi(c_T, w) = (1 + \overline{c_B}'(c_T))F'(w + \overline{c_B}(c_T) + c_T) - \widetilde{r_T}(c_T) - r_B \overline{c_B}'(c_T) = 0$. Then

$$\frac{dc_T}{dw} = -\frac{\partial \psi/\partial w}{\partial \psi/\partial c_T} = -\frac{(1 + \overline{c_B}'(\cdot))F''(\cdot)}{(F'(\cdot) - r_B)\overline{c_B}''(\cdot) + F''(\cdot)(1 + \overline{c_B}'(\cdot))^2 - \widetilde{r_T}'(c_T)} < 0$$

because $\overline{c_B}' > 0$, $\overline{c_B}'' \leq 0$ and $F'' < 0$ by assumptions, and also $F' > r_B$ from the FOC.

available credits, then it is pointless to get additional credit which can only be used for paying back the previous debt. ∎

Proof of Theorem 2. Let us first consider the sign of dc_T/dw for each wealth level. Theorem 1 characterizes the optimal level of c_T as follows:

(i) $[w_h]$ For $w_2 \leq w < w_1$, $F'(w+c_T) - \widetilde{r_T} = 0$

(ii) $[w_m]$ For $w_3 < w < w_2$, $c_T = c_T^*$

(iii) $[w_l]$ For $w_4 < w \leq w_3$,

$$F'(w+\overline{c_B}(c_T)+c_T) - \frac{1}{1+\overline{c_B}'(c_T)}\widetilde{r_T}(c_T) - \frac{\overline{c_B}'(c_T)}{1+\overline{c_B}'(c_T)}r_B = 0$$

From (i), let $\phi(c_T, w) \equiv F'(w+c_T) - \widetilde{r_T} = 0$. Then

$$\frac{dc_T}{dw}(w_h) = -\frac{\partial\phi/\partial w}{\partial\phi/\partial c_T} = -\frac{F''(w+c_T)}{F''(w+c_T) - \widetilde{r_T}'(c_T)} < 0$$

because $F'' < 0$ and $\widetilde{r_T}'(c_T) > 0$.

From (ii), since c_T^* is a constant, it is obvious that $\frac{dc_T}{dw}(w_m) = 0$.

From (iii), let $\psi(c_T, w) \equiv (1+\overline{c_B}'(c_T))F'(w+\overline{c_B}(c_T)+c_T) - \widetilde{r_T}(c_T) - r_B\overline{c_B}'(c_T) = 0$. Then

$$\frac{dc_T}{dw(w_l)} = -\frac{\partial\psi/\partial w}{\partial\psi/(\partial c_T)} = -\frac{(1+\overline{c_B}'(\cdot))F''(\cdot)}{(F'(\cdot)-r_B)\widetilde{c_B}''(\cdot) + F''(\cdot)(1+\overline{c_B}'(\cdot))^2 - \widetilde{r_T}'(c_T)} < 0$$

because $\overline{c_B}'(\cdot) > 0$, $\overline{c_B}''(\cdot) \leq 0$ and $F'' < 0$ by assumptions, and also $F'(\cdot) > r_B$ from Equation (13) in proof of Theorem 1. It is obvious that $\frac{dc_T}{dw}(w_h) \neq \frac{dc_T}{dw}(w_l)$ in general.

Let us now consider dc_B/dw. From Theorem 1,

$$c_B = \begin{cases} 0, & w \geq w_2 \\ I^{**} - w - c_T^*, & w_3 < w < w_2 \\ \overline{c_B}(c_T), & w_4 < w \leq w_3 \end{cases}$$

Then we have $\frac{dc_B}{dw}(w_h) = 0$, $\frac{dc_B}{dw}(w_m) = -1$ and $\frac{dc_B}{dw}(w_l) < 0$. The last inequality holds because $\frac{dc_B}{dw}(w_l) = \overline{c_B}'(\cdot)\frac{dc_T}{dw}(w_l)$ where $\overline{c_B}'(\cdot) > 0$ by assumption and $\frac{dc_T}{dw}(w_l) < 0$ from above. ∎

APPENDIX 2: DISCUSSION ON THE SIMULTANEOUS EQUATIONS APPROACH

Suppose the true model is the following system of two equations:

$$TC = \beta_1 BC + \beta_2 LC$$

$$BC = \gamma_1 TC + \gamma_2 IE$$

where LC and IE are the instrumental variables for identification of each equation and other common control variables are dropped for simplicity.

Suppose also that $\beta_2 < 0$ (the coefficient of LC is negative from estimation results), $\gamma_1 > 0$ (signalling effect) and $\gamma_2 > 0$ (the coefficient of IE is positive from estimation results). Note that the "true" sign of β_1 differs depending on the wealth level.

If we solve the above system, we obtain

$$\begin{pmatrix} TC \\ BC \end{pmatrix} = \frac{1}{1-\beta_1\gamma_1} \begin{pmatrix} \beta_2 LC + \beta_1\gamma_2 IE \\ \beta_2\gamma_1 LC + \gamma_2 IE \end{pmatrix}$$

$$TC = \frac{\beta_2 LC + \beta_1\gamma_2 IE}{\beta_2\gamma_1 LC + \gamma_2 IE} BC \equiv k \cdot BC$$

If we regress TC on BC in a single equation, then k_1 will be the estimated coefficient of BC. If β_2 is negative but the magnitude is small (as was found to be the case in estimation), then the denominator of k_1 will be positive, in which case we can sign k_1 with its numerator.

(1) If the true $\beta_1 \approx 0$ (high wealth group), then $\underbrace{\beta_2}_{(-)} LC + \underbrace{\beta_1}_{\approx 0} \underbrace{\gamma_2}_{(+)} IE < 0$, so the coefficient of BC in the single equation model will be a (relatively small) negative number, while that in the two equation model will be close to 0.

(2) If the true $\beta_1 < 0$ (medium wealth group), then $\underbrace{\beta_2}_{(-)} LC + \underbrace{\beta_1}_{(-)} \underbrace{\gamma_2}_{(+)} IE < 0$, so coefficients of BC in both single equation model and two equation model will be negative.

(3) If the true $\beta_1 > 0$ (low wealth group), then $\underbrace{\beta_2}_{(-)} LC + \underbrace{\beta_1}_{(+)} \underbrace{\gamma_2}_{(+)} IE$, so the sign in the single equation model is ambiguous while that in two equations model will be positive.

For comparison, we estimate the following single equation model (using OLS) with the decile group samples:

$$TC = k_0 + k_1 BC + k_3 ln(TA) + k_4 ln(AGE) + k_5 PR + k_6 CR + k_7 OE + k_9 SGdum$$

The estimated results are more or less consistent with the above story as shown in Table 11, where β_1 is from the two equations system (reproduced from Table 9) and k_1 is from the single equation model.

APPENDIX 3: EFFECTS OF WEALTH ON CREDIT USES FROM THE REDUCED FORM

Extending the discussion in Appendix 2, let us suppose the true model to be

$$TC = \beta_1 BC + \beta_2 LC + \beta_5 PR$$

Table 11: Comparison of two equations model and one equation model

	β_1	k
0%-10%	-0.01695	-0.1424^{***}
10%-20%	0.02461	-0.2377^{***}
20%-30%	-0.12093^{*}	-0.2496^{***}
30%-40%	-0.22673^{***}	-0.2588^{***}
40%-50%	-0.73286^{***}	-0.3580^{***}
50%-60%	-0.61937^{***}	-0.2775^{***}
60%-70%	-0.39822^{***}	-0.2482^{***}
70%-80%	-0.43095^{***}	-0.2365^{***}
80%-90%	-0.05284^{**}	-0.1547^{***}
90%-100%	0.13398^{***}	-0.0221^{***}

Notes: Values of β_1 are from Table 8.
***: statistical significance at 1%, **: at 5%, *: 10%

$$BC = \gamma_1 TC + \gamma_2 IE + \gamma_5 PR$$

where LC and IE are the instrumental variables for identification of each equation and other common control variables (other than PR) are dropped for simplicity.

If we solve the above system, we obtain

$$\begin{pmatrix} TC \\ BC \end{pmatrix} = \frac{1}{1-\beta_1\gamma_1} \begin{pmatrix} \beta_2 LC + \beta_1\gamma_2 IE + (\beta_5 + \beta_1\gamma_5)PR \\ \beta_2\gamma_1 LC + \gamma_2 IE + (\beta_5\gamma_1 + \gamma_5)PR \end{pmatrix}$$

The estimated coefficients (to the third decimal digit) from the endogenous group case are presented in Table 12 (the statistically not significant coefficient is set to be zero).

Table 12: Estimated coefficients (endogenous groups)

	β_1	β_5	γ_1	γ_5
High	0	-0.024	0.369	-0.133
Medium	-0.205	-0.070	1.316	-0.198
Low	0.106	-0.002	1.625	-0.134

Then the coefficients of PR from the reduced form may be tabulated as in Table 13. Similar computations can be carried out for the decile group figures and are reported in the main text.

Table 13: Coefficients of PR from the reduced form

	TC on PR $(\beta_5 + \beta_1\gamma_5)$	BC on PR $(\beta_5\gamma_1 + \gamma_5)$
High	-0.024	-0.142
Medium	-0.023	-0.228
Low	-0.020	-0.166