CURRENCY CRISIS, FINANCIAL IMPERFECTION AND INVESTMENT BEHAVIOUR
An Estimation Based on Korean Firms Balance Sheet Data

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Abstract

Some third generation crisis models, based on the assumption of asymmetric information in the credit market, provide a mechanism by which a monetary depreciation affects domestic firms investment. This paper proposes to validate empirically this theoretical prediction. With this intention, we study the investment behaviour of 477 Korean manufacturing firms, particularly during the 1997 Asian crisis. However, contrary to many studies in which *cash flow* variable is usually used as *proxy* of entrepreneurs net worth, our analysis privileges a more relevant variable, the *cash stock*, to measure these internal funds. We find that firms balance sheet in the aftermath of the asian crisis, are more relevant in explaining investment than before the crisis. It is further shown that this relationship is largest for small firms.

Key words : Asymmetric information, Financial imperfection, Third generation currency crisis model, Panel dynamic data, *Cash stock*

JEL classification : D21, E22, E44, F30

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Introduction

In response to the 1997 Asian currency crisis, theoretical literature offers different *scénarii* to explain this phenomenon. Contrary to the first and the second generation theorical models, there is not consensus on the mechanism of release and spread of the crisis. Therefore three families of models are regrouped under the "third generation" naming :

1. models based on moral hazard and overinvestment (Corsetti, Pesenti, Roubini [1999])
2. bank's run models based on the Diamond & Dybvig approach adapted to the open economy (Chang and Velasco [1998])
3. models based on balance sheet and investment approaches (Krugman [1999], Aghion, Bacchetta & Banerjee [2000]) which emphazise the importance of financial imperfections in credit market.

Although they knew important developments after the asian episode, the first two models are the object today of less attention than the third. Under the influence of Krugman [1999] notably, numerous models of financial crisis privilege *balance sheet channel approach.* According to this analysis, financing investment of a firm is conditioned by its financial position *ie* the quality of his balance sheet. They are agency theories which offer to this search a relevant frame of analysis by removing the hypothesis of perfection of financial markets. The will to control asymmetric information in the mechanism of obtaining loans brings then the lenders to impose rationing on the supply of credit, according to the quality of the balance sheet of firms. Imperfections of the financial market condition therefore, the level of investment in firm's financial position : a better financial position of the company authorises a more important self-financing of the investment, what reduces the conflicts of interests with the lenders. The importance of the rationing is then weaker.

This severity in the conditions of capital supply puts in evidence the central role of the balance sheet : by the modifications in the conditions of access to funds, any real or monetary shock who leads to a decrease of the guarantee, reduces the capacity of loan and affect to the final the production process.

This econometric estimate joins this balance sheet logic. The specificity of work is based on the description, at the time of the crisis, of the aggravation of korean firms credit constraints. In an empirical point of view, a vast literature stress on firm financial position to explain its investment level. Precursory work of Gertler & Hubbard [1988], Fazzari, Hubbard & Peterson [1988], Bernanke & Gertler [1989] opened the way with many research in which various components of the balance sheet are set as explanatory variables of firm investment. In the majority of the cases, these studies seek to validate the "*credit channel of monetary policy transmission*" : effects of monetary policy are amplified by the changes cause by interest rates variation on firm financial position.

The logic of *credit channel* is thus identical to that of *balance sheet currency crisis channel* which we propose to test. It based on the firms conditions access to credit in the presence of asymmetric information. In both cases, the entrepreneur pays an additional agency cost to finance his future investments. However, the nature of the shock at the origin of this mechanism discriminates the two approaches : increase in the interest rate for

the credit channel approach *versus* currency depreciation for the balance sheet currency crisis channel. The objective is not to analyze the effect of a monetary policy variation on the firm financial condition, but to study the modifications of this last one following a currency crisis. The balance sheet channel can therefore be activated independently of any decision of monetary policy.

In addition, credit channel studies reveal that firm size constitutes a relevant information for the sensitivity of firm internal funds to investment. Indeed, small firms offer low guarantee and are therefore more credit constrained that large firms : banks lend in priority to large particularly in monetary restriction period. It is the *flight to quality* phenomenon initially defined by Bernanke, Gertler & Gilchrist [1996]. By analogy, one thus expects in our study that investment of small firms is more sensitive to their net worth than that of large. This mechanism must also be subject of change in time, *ie* become more significant when the balance sheet channel is opened by a currency crisis.

Having presented some specifications of the investment function to estimate, the definition of a relevant variable to measure firm internal funds will be studied. Contrary to many studies, *cash flow* is not the account variable used to detect financial constraint in the credit market (**section 1**). In a second step, Arellano & Bond [1991] dynamic panels data procedure is briefly exposed. This technique is founded on the generalized method of moments (GMM), *ie* on the instrumentation of explanatory variables by their lagged values (**section 2**). In final, after having presented the data base characteristics, the result of the estimates are presented according to differences in the economic context (crisis *versus* absence of crisis) and according to the type of firm (**section 3**).

1 Characteristics of the investment function

According to balance sheet channel crisis model, the dependence of firms investment to their net worth is more relevant in the event of a strong monetary depreciation. To test this prediction, it is advisable to retain an investment function makes it possible to establish a link between the financial side and the real side of the economy. It is the reason why firm financial ratios are incorporating in conventional investment models : a dependence between the investment rate and the accounting variable is likely to reveal the presence of asymmetric information on credit market.

Firms liquidity indicators as investment explanatory variable find its origin in works of Tinbergen [1939], Klein [1951] or Meyer & Kuh [1957]. Nevertheless, these first attempts which do not include any theoretical component, have been swept aside by the major result of Modigliani & Miller [1958] on the neutrality of firm financial position in investment decisions. It is only during 1970's with the emergence of agency theories, that a new attraction for the question of the influence of financial constraints on investment demand appears (Stiglitz [1974], Jensen & Meckling [1976], Ross [1977]).

Based on individual data, econometric modeling of firm investment behaviour are generally articulated around four types of models : the neo-classic model (Jorgenson [1963]), approach by the accelerator (Clark [1917]), analysis derived from the q-theory (Tobin [1969])

and the model based on Euler equation (Jump & Menghir [1994]). In each one of these models, the financial constraint is usually modeled by taking the *cash flow* as indicative variable of firm net worth.

Various arguments guide our choice in favour of the accelerator-profit equation : in addition to its simplicity, the literature recognises to this specification the best performances in an empirical point of view (Oliner, Rudebush & Sidel [1995]). In addition, we replace the traditional *cash flow* by a new variable which allowing to apprehend in a more relevant way the firm net worth. Indeed, it is possible to obtain a relation between *cash flow* and investment without asymmetric information on the credit market. This variable is therefore a poor indicator to detect financial constraint existence. In order to mitigate this limit, our study based on the firm's availabilities (or *cash stock*) as predictive variable of the difficulties encountered by the entrepreneur to obtain loans.

1.1 The choice of an accelerator-profit specification

Investment accelerator-profit specification relies the firm investment rate to :
– its investment rate (I/K) lagged one period because of time adjustment of capital,
– its profit perspective *via* the lagged ratio of sales to capital (S/K),
– its financial position by the lagged ratio of *cash flow* to capital (CF/K).
In a formal way, the expression for this specification is :

$$\left(\frac{I}{K}\right)_{it} = \alpha_i + \alpha_1\left(\frac{I}{K}\right)_{it-1} + \alpha_2\left(\frac{S}{K}\right)_{it-1} + \alpha_3\left(\frac{CF}{K}\right)_{it-1} + \varepsilon_{it} \qquad (1)$$

where I is the amount of investment and ε_{it} the error term.

This equation is based on the sensitivity of investment rate to *cash flow* to detect asymmetric of information in the credit market. Nevertheless, when *cash flow* is used as firm net worth, the significativity of α_3 does not mean necessarily that firms are credit constraint. Indeed, cash the flow also exerts an influence on the future profitability of capital. Thus, as Kaplan and Zingales [1997] underline it, the firms the least constraint can be those having the strongest sensitivity to cash the flow. It is indeed probable that the entities with a high *cash flow* are also those which produce goods which are sold better or support low production costs. These firms are then strongly incited to increase their production, and thus to invest (Romer [1997]). It is therefore impossible to establish a clear distinction between the informational contents of the *cash flow*, in terms of future profits, and its predictive character in terms of asymmetric information.

In short, the empirical failures generally associated with investment relations based respectively on the Euler equation, the neo-classic model and the q-theory, lead us naturally to turn towards the accelerator-profit model. The choice of this specification remains coherent to evaluate the importance of internal funds and financial constraints in firms investment. The analysis is however improved by privileging *cash stock* instead of *cash flow*. Thus, there is not difficulty to interpret a positive relation between this variable and the investment.

1.2 Relevance of *cash stock*

In response to insufficiencies associated with the lack of *cash flow* relevance, the credit channel literature offers many alternative variables. However, in the absence of a true consensus it seems judicious to retain one which reveals financial market imperfections through an established theoretical framework. It is for this reason that the *cash stock* variable is selected in our analysis. This indicator of internal funds is built by taking the sum of firm's treasury availabilities.

This variable is not subject to many applications in empirical credit rationing studies. To our knowledge, only Kadapakkam & *al.* [1998] and Love [2001] use it. For Love, the effect of financial market development on economic growth, depends on the degree of asymmetric information on credit market. Accordingly, she evaluates through an Euler equation, the effect of *cash stock* on investment according to the country financial development. Our study follows this reasoning but the influence of *cash stock* on investment now measures the real effect of a currency crisis. In addition, as specified previously, our study privileges another form of specification for the investment function.

Intuitively, *cash stock* can be interpreted as a "**precautionary savings**" for firm which undertake investments when external funds are expensive. Thus, in the event of an increase in the level of risk premium, this availability offers to the entrepreneurs an autonomy in his investment decision. Indeed, by holding liquidity reserves, firms are in the future assured to be able to invest without having systematically recourse to expensive loans.

It is the model of Myers & Majluf [1984] which constitutes the theoretical reference for this relationship. According to these authors, the quantity of entrepreneur's availability [1] influences directly investment in the presence of asymmetric information. Indeed, with this financial room for manoeuvre, the firm has the possibility to seize project regardless costly loans : if investment requires external finance, the project would not be undertaken. Therefore, in the presence of financial constraint, the firm systematically uses its reserves and the sensitivity of investment to *cash flow* appears significant.

This point of view is also shared by Opler and *al.* [1999] when they study American firms investment behaviour between 1971 and 1994. According to these authors, the detention of liquid assets ensures the firms the possibility of investing when external financing is expensive. They establish in addition that firms which face the weakest costs of agency are those which have less liquidity. This result is explained by the opportunity cost of availability detention. Indeed, *cash stock* do not offer any return and mobilise some of the entrepreneurial resources at non-productive ends. In this conditions, firms accumulate liquidity only in a perspective of credit constraint. In the contrary case, this "precaution cash" is not necessary. Intuitively, this concern of keeping funds to face a future obligation, joined the psychological liquidity preference developed by Keynes [1936]. According to this author :

[1] Myers & Majluf employ the term of "*financial slack*".

"There is no necessity to hold idle cash to bridge over intervals if it can be obtained without difficulty at the moment when it is actually required"

John Maynard KEYNES [1936]
General Theory of Employment Interest and Money, chap. 15, page 208

By comparison with *cash flow*, there is not any ambiguity in the interpretation, as financial constraint, of a positive relation between *cash stock* and investment : an increase in *cash stock* reveals benefit anticipation only in the presence of asymmetric information. Indeed, firms wishing to invest may find it beneficial to hoard so as to be able to have in the future a maximum of internal funds (when investment opportunity arise).

2 Econometric method and data base descriptions

Based on Arellano & Bond estimator [1991], the econometric model is a dynamic linear panel data regression, with individual fixed effects and temporal effects. The dynamic character of the specification is due to the presence of the endogenous lagged variable among the regressors. The study relates to a sample of 477 Korean manufacturing firms over the period 1994-2001.

2.1 The Arellano & Bond procedure

By nature, the behaviour of firm investment is dynamic. However, this essential characteristic cannot be consider by the traditional econometric tools of panel data. Indeed, procedure based on respectively the fixed effect model and the random effect model, do not lead to efficient and consistent estimates.

By considering only one explanatory exogenous variable (x_{it}), the equation to be estimated can be written in the following form :

$$y_{it} = \alpha y_{it-1} + \beta x_{it} + \gamma_i + \varepsilon_{it} \quad \text{With} \begin{cases} i = 1, ..., N \\ t = 1, ..., T \end{cases} \tag{2}$$

where y_{it} is an endogenous variable which represents the firm investment realised in t. The terms γ_i and ε_{it} represent respectively firm fixed effect and specification errors.

2.1.1 The non robustness of current estimators

When the parameters of the equation (2) are estimated by ordinary least squares, the coefficients are biased and non consistent. The first problem lies in the correlation between the lagged endogenous variable and the individual fixed effect : if y_{it} is correlated to γ_i, y_{it-1} is inevitably correlated too. The within transformation, which consists in eliminating the individual fixed effect by withdrawing the individual average [2], does not bring more

[2] $y_{it} - \overline{y_i} = \alpha(y_{it-1} - \overline{y_i}) + \beta(x_{it} - \overline{x_i}) + (\lambda_t - \overline{\lambda}) + (\varepsilon_{it} - \overline{\varepsilon_i})$

robustness to the estimate when the temporal dimension of the sample is reduced (T small). Indeed, the elimination of the fixed effect creates a $O(1/T)$ correlation between the lagged endogenous and the error term. The term $(y_{it-1} - \overline{y_i})$ is then correlated with $(\varepsilon_{it} - \overline{\varepsilon_i})$ [3].

Just as the within transformation, the random effect model exacerbates the sources of bias in the estimate.

2.1.2 The fixed effects dynamic model

To avoid the difficulties previously evoked, Arellano & Bond [1991] propose an extension of the generalized method of moments (GMM), elaborated by Hansen [1982], to the case of dynamic panel data. The use of instrumental variables in the equation (2) specified in first differences gives consistent estimators : there are not any correlation problems between the lagged variable and the error term [4]. In addition, GMM offers efficient estimators.

As well as within transformation, the first step of the analysis consists in eliminating the fixed effect by taking equation (2) in first difference. If we just consider to simplify the lagged endogenous as explanatory variable, one has then :

$$y_{it} - y_{it-1} = \alpha(y_{it-1} - y_{it-2}) + (\varepsilon_{it} - \varepsilon_{it-1}) \tag{3}$$

By supposing that the error terms are not autocorrelated, their first difference must be orthogonal with the lagged values of y_{it-k} for $k \geq 2$. These lagged variables constitute therefore some valid instruments to estimate equation (3).

2.1.3 Tests of specification

To confirm the model specification, Arellano & Bond suggest testing the consistency of GMM estimator from the validity of instruments choice. Two procedures of test are generally reported :

1. the reject of null hypothesis in the m_2 test validates the absence of two order autocorrelation in the errors terms of the equation specified in first difference :

$$m_2 \begin{cases} H_0 : & E\Big[(\varepsilon_{it} - \varepsilon_{it-1})\ (\varepsilon_{it-2} - \varepsilon_{it-3})\Big] = 0 \\ H_1 : & E\Big[(\varepsilon_{it} - \varepsilon_{it-1})\ (\varepsilon_{it-2} - \varepsilon_{it-3})\Big] \neq 0 \end{cases}$$

   This test robustness requires nevertheless that the errors in level are not first order correlated and that they do not follow a random walk. On this last point, it is enough to check that there is a first order negative correlation in the errors in first difference. It is the purpose of the m_1 test :

$$m_1 \begin{cases} H_0 : & E\Big[(\varepsilon_{it} - \varepsilon_{it-1})\ (\varepsilon_{it-1} - \varepsilon_{it-2})\Big] = 0 \\ H_1 : & E\Big[(\varepsilon_{it} - \varepsilon_{it-1})\ (\varepsilon_{it-1} - \varepsilon_{it-2})\Big] < 0 \end{cases}$$

   The reject of the null hypothesis is therefore necessary.

[3] By construction y_{it-1} and $\overline{\varepsilon_i}$ are correlated. Indeed, the average $\overline{\varepsilon_i}$ incorporates ε_{it-1}, and this last is correlated with y_{it-1}. By transitivity, y_{it-1} and $\overline{\varepsilon_i}$ are therefore correlated.

[4] By supposing that error terms are not correlated over time.

2. The Sargan overidentification test. As well as m_1 and m_2, the Sargan test checks the exogeneity of the instruments. In other words, the data have to satisfied the orthogonality conditions : the instruments should not be correlated with the error terms.

2.2 Data base descriptions

The sample is composed by korean firms individual balance sheet data. These informations are coming from OSIRIS (data base *Van Dijk* office). OSIRIS contains general information and financial reports of more than 22 000 companies, 1 400 banks and 200 insurance companies in more than 90 countries (including 8 000 American companies). Although the representativeness of South-East Asia firms is relatively low, Korea has a sufficiently high number of observations to undertake an econometric study on the firm investment behaviour during the 1997 asian crisis.

On a historical point of view, balance sheet crisis episodes are relatively rare. Only the Scandinavian (1990) and Asian (1997) economies present some indices, in term of investment modifications, which suggests a balance sheet phenomenon during a currency crisis. Among these economies, the choice of Korea is relevant for primarily two reasons.

Firstly, it is a country where the credit rationing due to banking balance sheets deterioration was relatively contained. Following any banking crisis, bank balance sheets degradation leads indeed to a restriction in the supply of loan (*credit crunch*). Firm activity, which depend on this type of financing, is therefore penalised. In this situation, it cannot be dissociated in the credit rationing the share due exclusively to firms balance sheet degradation. In other words, even in the absence of asymmetric information on the credit market, a fall in investment is possible through the banking balance sheet channel. In order to avoid this interference in the mechanism credit attribution, it is advisable to make sure that the banking structure functions normally after a crisis. In this way, borrowers can find financing in any time. It is this reason which guide our choice in favour of Korea. Indeed, contrary to Malaysia or Thailand, the Korean authorities intervened quickly in favour of domestic banks to avoid any collapse in credit distribution after the Asian crisis (Artus [2000]). In the same way, the " freezing " in the Indonesian credit system accentuated the recession after the crisis (Krugman [1999]). Following these reasons, Korea is the only economy where a fall of investment can be interpreted without ambiguity.

In addition, Korea is an economy where individual data are available over the crisis period. Contrary to Scandinavian countries, for which the access to this type of data is difficult, individual asian balance sheets data are relatively accessible around 1997. Korea also proposes a relatively high number of observations (3816 in our sample) : we therefore highlight the heterogeneity of investment decision as well in individual as temporal dimension.

The estimate only concerns the manufacturing sector. Financial firms, such as bank or insurance companies, is voluntarily excluded : their accounting structure comprises specificities which not reflect an industrial production logic. In addition, firms with missing or aberrant informations are also excluded : our first difference dynamic specification requires

relatively long time series. In final, the sample is composed by a panel of 477 firms over the period 1994-2001 (8 years), that is to say 3816 observations.

2.2.1 Used variables description

Four variables are used for the empirical analysis of korean firm investment behaviour :

- **Total investment** (I) which is defined like the amount of acquisitions of tangible fixed assets (*net properly, plant and equipment*) net of fixed assets cession.
- **Capital** (K) which is measured by fixed assets.
- **Turnover** (S) which is measured by the net sales.
- ***Cash Stock*** (CS) which is defined like firm availabilities (*cash or equivalent*).

From these variables, the ratios I/K, S/K and CS/K are built. Beyond the definition of these accounting indicators, it is also important to define a threshold to classify the firms according to their size (small or large). The distinction between these two categories of firms is carried out through the sales turnover (in logarithm). This easily observable criterion is regularly used in the literature to appreciate the size of a firm [5]. However, various statistical indicators of sales are available to define, in an exogenous way [6], the threshold from which a firm can be considered as large. By supposing that firms do not change size over the period, two criteria were retained in our analysis [7] :

- the sale average : any firm whose average sales over the 8 periods is lower than the sample sale average will be regarded as small. This threshold defines in our sample 288 small firms against 189 large.
- the sale median : by taking 1994 as year reference, a firm with a sale level lower than sales median calculated on the whole of the sample, will be regarded as small. This criterion has for principal advantage to providing two subsamples of similar size (239 and 238 firms).

2.2.2 Summary statistics of the variables used

The main statistical characteristics relating to the various ratios used in the regression, appear in the table 1. One observes in particular a relatively strong dispersion of the *cash stock* ratio within the Korean firms (its standard deviation equalises its average).

Moreover, the annual average evolution of I/K over the period is illustrated by the figure (1). Until the Asian crisis of 1997, the strong economic growth explains an investment rate always in expanding. Indeed, over this period the anticipation of an unceasingly stronger demand associated with relatively low coast of loan, especially abroad, encourages korean firms to invest more. After the Asian crisis, the investment rate "takes down" brutally, passing from 30 % in 1997 to 23 % after three years (2000). Intuitively one thus expects that

[5] Company's workforce is also often used. However this information is not always available in our database.

[6] The endogenous determination of a threshold is not possible for dynamic panel specification (Hansen [1998]).

[7] As temporal dimension being relatively weak in the sample, this simplifying assumption appears reasonable.

TAB. 1 – Summary statistics of the variables used

Variables	Mean	Standard deviation	Median	Minimum	Maximum
I/K	0.263	0.168	0.231	-0.577	0.932
S/K	2.407	1.874	1.954	0.049	27.4
CS/K	0.079	0.078	0.055	0	0.696

firms are subjected to financial constraints over this period, *ie* their investment decisions are function of their financial position. The latter was indeed strongly degraded after the crisis.

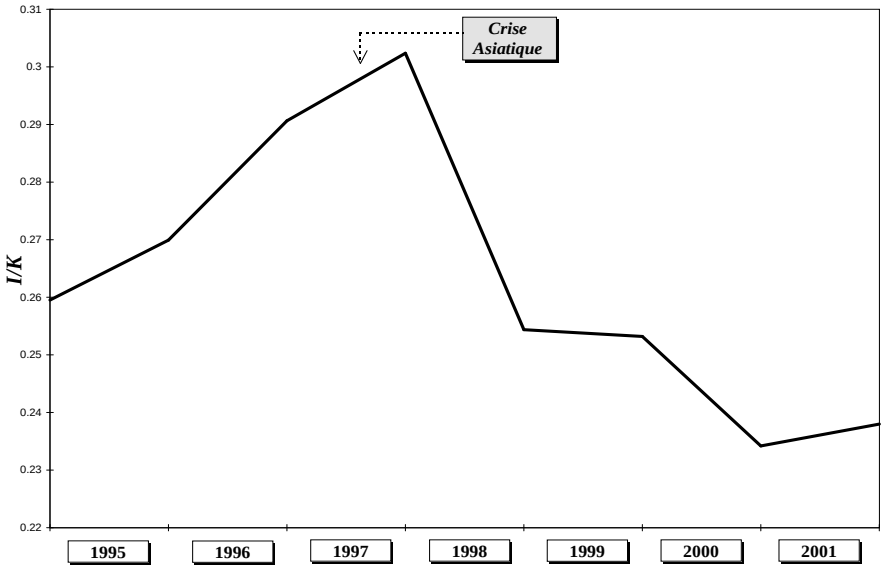

FIG. 1 – Evolution of the Korean manufacturing firms investment rate

3 Results of estimations : statistical inference and interpretation

The investment behaviour of Korean firms is initially estimated without any distinction between the firms or between the periods. The existence of heterogeneity in financial constraints, as well as individual dimension than temporal dimension, is then evaluated.

3.1 Global estimation

From an accelerator-profit specification, the Arellano & Bond procedure is used on the following investment equation :

$$\left(\frac{I}{K}\right)_{it} = \alpha_1\left(\frac{I}{K}\right)_{it-1} + \alpha_2\left(\frac{S}{K}\right)_{it-1} + \alpha_3\left(\frac{CS}{K}\right)_{it-1} + \delta_t + \mu_i + \varepsilon_{it} \qquad (4)$$

Because of the difficulty for measuring the firm investment behaviour only from the accounting ratios, equation (4) incorporates time fixed effect (δ_t) and individual fixed effect (μ_i). These indicators summarise the influence of the economic situation over the period, and the specific characteristics of firms.

TAB. 2 – **Investment sensibility to Cash Stock**

GMM estimates of first differenced equation *Dependant Variable : I/K_{it}*		
Variables	**STEP 1**	**STEP 2**
I/K_{it-1}	0.59***	0.59***
	(0.048)	(0.046)
S/K_{it-1}	0.01**	0.011***
	(0.004)	(0.0035)
CS/K_{it-1}	0.11***	0.094**
	(0.044)	(0.042)
Tests		
m1	-9.541	-9.145
P-value	0.00	0.00
m2	1.016	1.072
P-value	0.31	0.284
Sargan		13.78
P-value		0.183

**** : Significant at 1 % level, ** : Significant at 5 % level*
Standards errors are between brackets.
m1 and m2 respectively represent first order and second order serial correlation tests.
Each regression uses 3816 observations on 477 firms. Sample period is 1994-2001.
Each regression includes time dummies.

The results obtained in the two steps of the estimate are presented in table (2) [8]. The lagged of the instrumental variables go from two to three years. Whatever the estimator

[8]Estimates were performed by Gauss program *DPD98* written by Arellano & Bond.

selected, GLS (step 1) or GMM (step 2), the m_2 test reveals the absence of two order autocorrelation for the residues in first difference. In addition, we check the presence of an negative one order autocorrelation for residues in first difference. The Sargan test also validates the choice of the instruments ($p - value > 0,05$).

All the coefficients are significant and have a sign conform with the economic logic. As envisaged, the estimators obtained by GMM are more efficient (weaker variance). The aim of the study being the detection of financial constraints, it is particularly interested to focus on the coefficient α_3 (CS/K in the table). This coefficient is positive and significant, which confirms the importance of financial structure in the korean firm investment decision : before turning to external sources, the entrepreneurs finance their investments with their internal resources. This imperfect substitutability between external and internal funds translates the existence of asymmetric informations in the credit market. The extent of this rationing is function to the quality of the firm balance sheet. Therefore, any shock affecting the firm net worth is likely to modify its investment behaviour.

From a quantitative point of view, and based on GMM estimator, an increase of 1 point in the rate of *cash stock* involves an increase less than 0.1 point (0.094) in the investment rate. The order of magnitude of this value is comparable with those obtained by Loves [2001].

3.2 Firm size and investment constraint extent

Estimates realise without any distinction in the sample tend to prove the importance of korean firm self-financing as determinant of investment. Now, we are going to analyse if firm size is likely to influence the intensity of financial constraint. One can logically expect that the size constitutes a good indicator of the financial constraint dimension. The idea generally retained in the literature being that small firms, which have less guarantees to offer, are subject to more credit constraint that the large ones.

The description of size influence on financial constraint can be make by considering this following investment equation :

$$\left(\frac{I}{K}\right)_{it} = \alpha_1\left(\frac{I}{K}\right)_{it-1} + \alpha_2\left(\frac{S}{K}\right)_{it-1} + \theta\alpha_3\left(\frac{CS}{K}\right)_{it-1} + (1-\theta)\alpha_4\left(\frac{CS}{K}\right)_{it-1} + \delta_t + \mu_i + \varepsilon_{it} \quad (5)$$

where θ is a dummy variable which is equal to 1 when the firm is small, and equal 0 otherwise.

A significant α_3 coefficient combined with a coefficient α_4 nonsignificant, is interpreted as the sign that small firms are more credit constraint that the large ones. In this case, small firm investments is more dependant to internal funds. It is the "*flight to quality* " phenomenon describes by Bernanke, Gertler & Gilchrist [1996].

Table (3) presents the equation (5) estimate results. Two series of measurements are reported, according to whether the size criterion is defined compared to sale average or compared to sale median. As previously, the exogeneity instruments is confirmed respectively by tests of m_1, m_2 and Sargan.

TAB. 3 – **Firm size and investment constraint**

GMM estimates of first differenced equation *Dependent Variable : I/K_{it}*				
	Size criterion : average sale		**Size criterion : median sale**	
Variables	**STEP 1**	**STEP 2**	**STEP 1**	**STEP 2**
I/K_{it-1}	0.59***	0.59***	0.59***	0.59***
	(0.048)	(0.046)	(0.048)	(0.046)
S/K_{it-1}	0.01**	0.011***	0.01**	0.011***
	(0.004)	(0.0035)	(0.004)	(0.0035)
CS/K_{it-1}^{petite}	0.11**	0.098**	0.11**	0.096*
	(0.053)	(0.05)	(0.055)	(0.053)
CS/K_{it-1}^{grande}	0.11	0.082	0.12*	0.09
	(0.072)	(0.07)	(0.069)	(0.066)
Tests				
m1	-9.543	-9.148	-9.54	-9.148
P-value	0.00	0.00	0.00	0.00
m2	1.015	1.075	1.018	1.069
P-value	0.31	0.283	0.309	0.285
Sargan		13.79		13.78
P-value		0.183		0.183
**** : Significant at 1 % level, ** : Significant at 5 % level, * : Significant at 10 % level*				

The coefficients α_1 and α_2 are always significant and their sign is good. In the same way, the estimators of *cash stock* are close similar, in level and significativity, in the two series of estimates. Only a risk level of 7 %, instead of the 5 % generally recommended, is observed on small firms GMM *cash stock* estimator when the median determines the size. Nevertheless, the various results confirm the influence of firm size. By retaining GMM estimators (step 2), the coefficient α_3 (CS/K_{it-1}^{petite} in the table) is always the only significant one : α_4, which translates the large firm investment sensitivity to their internal funds, is statistically equal to zero. Thus, there are two types of firms :

- those which are not constraint : their investment simply depends on traditional variables.
- those which are constraint : their investment depends in addition on the level of internal funds.

In conclusion, the "*flight to quality*" phenomenon seems to be present in Korea : credit rationing does not affect firms in a similar way. Only the small ones seem subjected to the agency problems, certainly because of the weakness of their collateral in loan process.

3.3 1997 Asian Crisis and credit constraint extent

As previously, the objective is to go beyond the simple description of financial constraints. This mechanism is now connecting to change in the economic situation : the temporal stability of investment-*cash stock* relation is studied. It more precise way, we study the evolution of this connection at the time of the 1997 Asian crisis. If theoretical predictions of third generation balance sheet crisis models are exact, a monetary depreciation is likely to exacerbate the asymmetric information between lenders and borrowers. In such case, the sensitivity of investment to firm internal funds increase during the crisis.

This influence of Asian crisis on financial constraint can be highlighted from equation (4) with a dummy variable on 1997 *cash stock* value. According to this specification, any movement of this variable is likely to influence the investment ratio in the following period *ie* in 1998. Moreover, the figure (1) locates the investment ratio fall at this time.

By considering the following equation, the effects of asian crisis on korean firm investment investment are analysed :

$$\left(\frac{I}{K}\right)_{it} = \alpha_1\left(\frac{I}{K}\right)_{it-1} + \alpha_2\left(\frac{S}{K}\right)_{it-1} + \phi\alpha_3\left(\frac{CS}{K}\right)_{it-1} + (1-\phi)\alpha_4\left(\frac{CS}{K}\right)_{it-1} + \delta_t + \mu_i + \varepsilon_{it} \quad (6)$$

where ϕ is a dummy variable which equal 1 in 1997 and 0 otherwise.

Table (4) presents the estimates results. The exogeneity of instruments is confirmed through Sargan, m_1 and m_2 tests. I/K and S/K are significant in the two step of estimate. In the same way, *cash stock* continue to exert an influence on investment during the time not including the crisis. Nevertheless, contrary to the advanced predictions, the aggravation of credit constraints at the time of the crisis cannot be clearly highlighted : only the GLS estimate (first step) tends to prove, with a 10 % risk, an aggravation of the financial constraints at the time of the crisis : the coefficient α_3 increases from 0.11 to 0.12. However, this dependence is not confirmed in the second step : although being higher in level, *cash stock* GMM estimator is not significant at the moment of the crisis.

This lack of results relevance comes certainly from a bad choice of the period to consider to define the dummy variable. Indeed, although the Asian crisis took place in 1997, the figure (1) reveals that the collapse of investment is not limited to one period, but is spread out over three years. Therefore, the determinants of investment were modified during more than one year : by including a dummy variable only in 1997, one excludes systematically part of information. In the light of the graph (1), it seems more relevant to consider an economic recession period over several years. It is the purpose of the following section.

3.4 Economic recession and credit constraint extent

Figure (1) suggests two distinct periods in the evolution of korean firms investment rate :

- one period of growth which corresponds to years 1995, 1996, 1997 and 2001.
- one period of recession, in the aftermath of asian crisis which corresponds to years 1998, 1999 and 2000.

TAB. 4 – **Effects of asian crisis on investment**

GMM estimates of first differenced equation *Dependent Variable : I/K_{it}*		
Variables	**STEP 1**	**STEP 2**
I/K_{it-1}	0.59***	0.59***
	(0.048)	(0.046)
S/K_{it-1}	0.01**	0.011***
	(0.004)	(0.0035)
CS/K_{it-1}^{1997}	0.12*	0.1
	(0.073)	(0.067)
CS/K_{it-1}	0.11***	0.093**
	(0.046)	(0.044)
Tests		
m1	-9.507	-9.134
P-value	0.00	0.00
m2	0.998	1.066
P-value	0.318	0.287
Sargan		13.84
P-value		0.181
**** : Significant at 1 % level, ** : Significant at 5 % level, * : Significant at 10 % level*		

This section aims to test the relevance of balance sheet channel over these two periods. Therefore, the estimate of equation (6) is renewed but by considering $\phi = 1$ for years 1997, 1998 and 1999. This delay of one year compared to the period of recession previously definite (1998-2000) is indeed necessary to consider temporal lag between I/K and CS/K in the investment function.

Table (5) presents the estimate results. Once again, the specification of the model appears relevant since the validity of the instruments is confirmed by the various exogeneity tests. In addition, the variables I/K and S/K are always significant. As envisaged, the coefficients of *cash stock* variable reveals the presence of credit constraints only at the time of recession : in the two step of estimate, *cash stock* are significant only over this period. In period of growth, the balance sheet channel is not activated (or very little) : the dependence of firm investment to internal funds is null.

The absence of firm net worth influence to their investment behaviour, is attached in the literature with the absence of asymmetric information on the credit market. Firm can borrow as much as necessary to finance profitable investment. Nevertheless, several authors suggested that the solvency of investment project was not necessary in south-asian countries before the crisis. This characteristic is due to the presence of governmental guarantees

TAB. 5 – **Economic recession and credit constraint**

GMM estimates of first differenced equation *Dependent Variable : I/K_{it}*		
Variables	**STEP 1**	**STEP 2**
I/K_{it-1}	0.59***	0.59***
	(0.048)	(0.046)
S/K_{it-1}	0.01**	0.011***
	(0.004)	(0.0035)
CS/K_{it-1}^{97-99}	0.15***	0.11**
	(0.056)	(0.053)
CS/K_{it-1}	0.056	0.062
	(0.052)	(0.051)
Tests		
m1	-9.547	-9.161
P-value	0.00	0.00
m2	0.96	1.043
P-value	0.337	0.297
Sargan		14.19
P-value		0.164
**** : Significant at 1 % level, ** : Significant at 5 % level*		

on the investment profitability. For Corsetti, Pesenti & Roubini [1999] for example, the financial globalization of the years 1990 permits Asian investments to be financed in dollar at low cost. In addition, the efficiency of the projects has no importance since the repayment of debt is perceived as being assured : if losses appear, the government pays the deficit. Under these conditions, banks are insured to be repay and no firm guarantee is necessary. This scenario could thus explain the absence of causality between *cash stock* and investment during the economic growth [9]. In this conditions, the absence of *cash stock* significativity does not argue systematically in favour of perfect information before the crisis, on the contrary : according to Corsetti and *al.* mechanism, moral hazard phenomenon was fully since the risk of no repayment is perceived as being completely socialised by the government.

With the emergence of the crisis, the insurance against the risk of nonprofitability disappears and in the same time the firms balance sheet degrades. This is the reason why the credit rationing is not constant over time : the estimate reveals that korean firms become credit constraints only in the aftermath of the asian crisis. This result is in agreement with the theoretical predictions previously developed : the firm net worth decreasing, moral

[9]Except 2001, this period only integrates years before crisis.

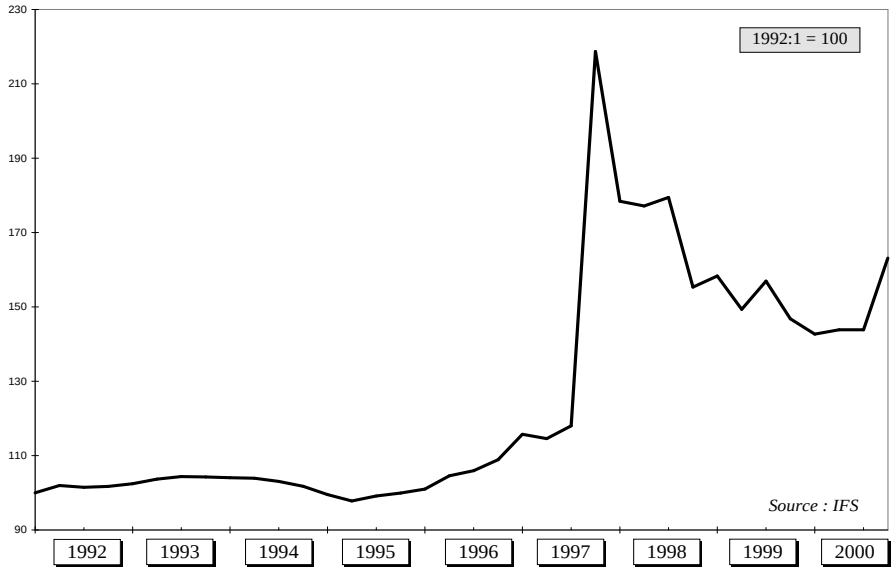

FIG. 2 – Korea : nominal exchange rate won/dollar

hazard between entrepreneurs and lenders increases. Therefore, banks limit their credit supply. This real crisis effect is captured in our function by the sensitivity of the *cash stock* to investment in recession period : the access to credit market having a cost, firm continue to invest thanks to their availabilities. For rationed firms, self-financing then becomes a necessary condition to invest. Unfortunately, the amount of own capital are insufficient to maintain a flow of raised investment. It is the reason why there is a sudden reduction of I/K since 1998 (figure 1).

Our result rests on the assumption according to korean firms balance sheet degradation is due to the exchange rate depreciation at the time of the crisis. The figures (2) and (3) argue in favour of this phenomenon. Since 1992 the stability of the won compared to the dollar, associated with low coast of credit abroad, encourages korean entrepreneurs to contract significant external loans. One notes indeed on the graph (3) a significant proportion of external debts in this country, in particular since 1995. In parallel, the fixity of exchange rate gives the contractors a too high degree of confidence with the parity : loan in dollar is perceived without exchange rate risk and firms do not protect their engagements (Agenor [2001]). In this situation, the strong 1997 monetary depreciation – in one month the Korean currency fell from 1000 won to close to 2000 won per dollar – causes a strong revaluation of the firm external debt charge. The figure (3) tends to prove this abrupt increase in interests paid at the time of the crisis.

However, another phenomenon is likely to deteriorate firm balance sheet of the firms in the presence of asymmetric information on the credit market. Indeed, the credit channel theory predicts a investment fall due to deterioration of the contractor collateral after a restrictive monetary policy. Thus, this process can also explain the sensitivity of invest-

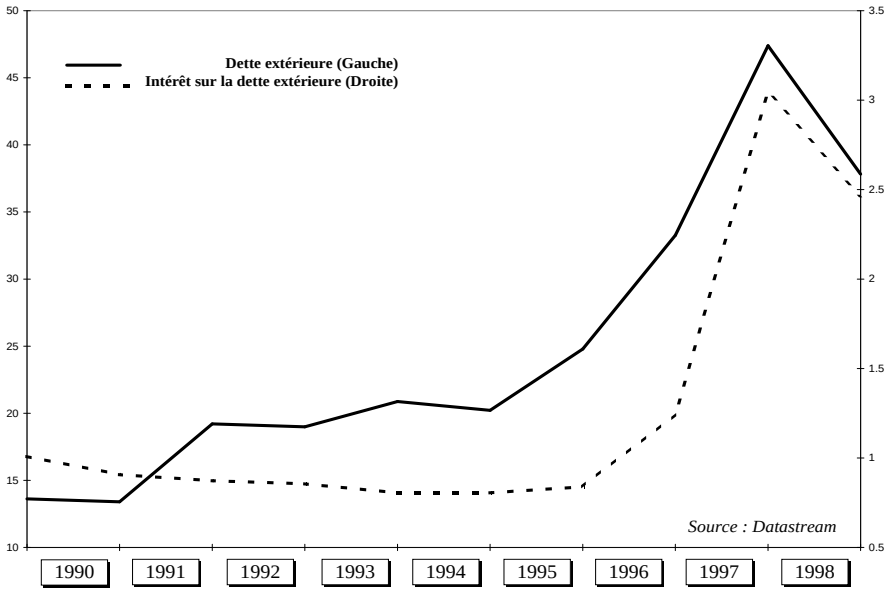

FIG. 3 – Korea : foreign debt and paid interests (% GDP)

ment to *cash stock* during the time of recession. However, we believe that this transmission mechanism remained limited in Korea. Admittedly, the crisis imposes initially a strong increase in the interest rate in order to defend the parity and limit imported inflation. Quickly however, an expansionist monetary policy take place (Artus [2000]). To prove it, the figure (4) reflects the evolution of the short term nominal interest rate in Korea : this variable increases strongly after the crisis and decreases gradually at the same time the exchange rate stabilises. The duration of the initial rise was however short. The entrepreneur net worth reduction due to increase in the interest rate was therefore limited : in a little more than two quarters after the crisis, the interest rate finds its level of mi-1996 [10]. This fall continues and Korean interest rate evolves at the beginning of 1999 below US rate. Nevertheless, in spite of this monetary expansionist policy, the Korean investment rate does not raise immediately (figure 1). Therefore, even if one cannot completely exclude a firm balance sheet degradation following the short korean restrictive monetary policy, its importance was probably limited compared to our scenario. Indeed, the interest rate mechanism functions in the two directions : at the time of a restrictive monetary policy the investment decreases, whereas the opposite occurs in an expansionist phase. If korean balance sheet deterioration were limited to interest rate channel, the restarting of investment would have taken place more quickly in Korea.

[10] In reality, the interest rates were maintained only a few days in the neighbourhoods of 25 % before returning quickly on the before crisis.

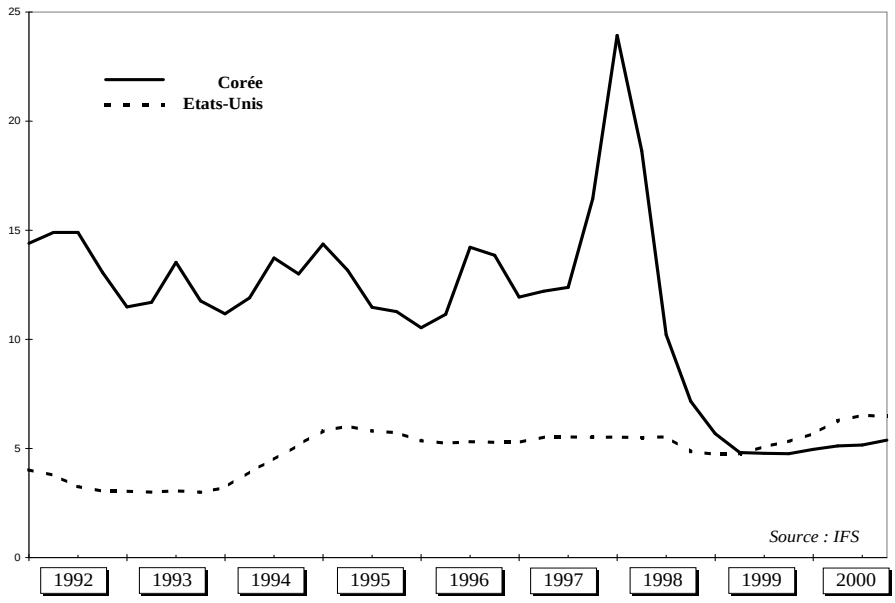

FIG. 4 – Korea : short term nominal interest rate

3.5 Size and period simultaneous effects

The previous results plead in favour of a credit constraint weighing mainly on small firms, and primarily observed in recession economic period. The last step of the analysis aims now to study the heterogeneity of investment behaviour as much as individual than temporal dimension.

As preceding estimates suggest, one intuitively expects that small firms investment is more dependent to their internal funds in recession period. To prove it, the following equation which incorporated two dummy variable is estimate :

$$\begin{aligned}\left(\frac{I}{K}\right)_{it} = \alpha_1\left(\frac{I}{K}\right)_{it-1} + \alpha_2\left(\frac{S}{K}\right)_{it-1} + \phi\left[\theta\alpha_3\left(\frac{CS}{K}\right)_{it-1} + (1-\theta)\alpha_4\left(\frac{CS}{K}\right)_{it-1}\right] \\ + (1-\phi)\left[\theta\alpha_5\left(\frac{CS}{K}\right)_{it-1} + (1-\theta)\alpha_6\left(\frac{CS}{K}\right)_{it-1}\right] + \delta_t + \mu_i + \varepsilon_{it} \qquad (7)\end{aligned}$$

with $\phi = 1$ in recession period and $\theta = 1$ for small firms [11].

Table (6) presents estimate results. The various tests prove instruments validity. As for the preceding estimates, the coefficients α_1 and α_2 are significant. In addition, whatever the type of firm, *cash stock* GLS estimator is only significant in the period of recession. Nevertheless, in the first step, this relation appears not conform to economic logic : large companies appear more constraint that small ones.

GMM estimate, which offers more efficient estimators, provides results which are more in adequacy with our predictions. It appears that the relation between investment and *cash*

[11] Firm size was defined according to sale average.

TAB. 6 – **Economic recession, firm size and investment**

GMM estimates of first differenced equation *Dependent Variable : I/K_{it}*		
Variables	**STEP 1**	**STEP 2**
$I/K_{it-1} : (\alpha_1)$	0.59***	0.59***
	(0.048)	(0.046)
$S/K_{it-1} : (\alpha_2)$	0.01**	0.011***
	(0.004)	(0.0035)
$CS/K_{it-1}^{petite(97-99)} : (\alpha_3)$	0.14**	0.10*
	(0.064)	(0.060)
$CS/K_{it-1}^{grande(97-99)} : (\alpha_4)$	0.18**	0.13
	(0.084)	(0.083)
$CS/K_{it-1}^{petite} : (\alpha_5)$	0.07	0.082
	(0.061)	(0.059)
$CS/K_{it-1}^{grande} : (\alpha_6)$	0.016	0.005
	(0.087)	(0.085)
Tests		
m1	-9.551	-9.152
P-value	0.00	0.00
m2	1.004	1.096
P-value	0.315	0.273
Sargan		14.34
P-value		0.158
**** : Significant at 1 % level, ** : Significant at 5 % level, * : Significant at 10 % level*		

stock is not uniform between firms in period of recession. If one tolerates a risk of 10 %, the constraint credit phenomenon affects in priority small firms after the 1997 asian crisis. This result seems logical : small entities present a higher risk of insolvency. The lenders are then more inclined to supply their credit towards large companies ("*flight to quality*"). The coefficient α_4 is thus no significant.

Conclusion

The crisis balance sheet channel, founded on the assumption of asymmetric information on the credit market, provides a mechanism by which a monetary depreciation affects investment in the economy. This article advances some empirical justifications with this theoretical prediction. From this point of view, we analyse from korean firms panel data

the presence of credit constraints, particularly in the aftermath of the 1997 asian crisis.

To evaluate the impact of balance sheet channel on firm activity, their investment behaviour is studied. Then we evaluate the effect of the asian crisis on these investment determinants. By substituting the traditional *cash flow* in favour of *cash stock* to proxy entrepreneur net worth, the interpretation of our results are realised without any ambiguity. The various estimates tend to consolidate the crisis balance sheet channel thesis : financial constraints were particularly significant in the aftermath of the asian crisis, *ie* during the time where firms patrimonial situation strongly worsened. In this conditions, as the evolution of the I/K attests it since 1998, investment rate significatively decreased during the recession period. The influence of financial imperfections in the propagation of a currency crisis toward the real side of economy, can therefore be proposed.

In addition, the analysis reveals a heterogeneity in financing conditions between firms. By differentiating the investment behaviour according to firm size, we show that smallest Korean entities are more credit constraint. This "*flight to quality*" phenomenon is particularly significant during the economic recession which followed the 1997 crisis.

In final, although the existence of credit constraint could be highlighted in Korea two biases, resulting from the sample composition, are likely to minimize the extend compared to historical reality :

1. the firms having been touched hard by the crisis, *ie* those having gone bankrupt, do not appear in the sample. This last one includes only firms whose activity can be measured on the whole of the period 1994-2001.
2. OSIRIS base including only quoted firms. The criterion "small firm" such as it was defined in the study, does not identify in reality the smallest Korean firms (which are not quoted by nature).

The entities potentially most exposed to financial constraints are thus, not indexed in the study. From our estimates, one cannot have a precise idea about the real dimension of the balance sheet channel in Korea after 1997. However, this insufficiency does not compromise the economic relevance of our results : the empirical arguments drawn from this sample of 477 korean firms, plead in a convincing way in favour of asian crisis real effects through firm balance sheet channel. The lack of representativeness of the sample tends just to minimize this phenomenon.

References

– *To be provided* –