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STRUCTURAL MODELLING OF INVESTMENT AND FINANCIAL CONSTRAINTS: WHERE DO WE STAND?

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Abstract

This paper surveys issues with respect to the structural modelling of econometric tests of investment facing financial constraints, to their link with firms data and assets prices, and to their impact in macroeconomic modelling. The key issue is to ground much more the interpretation of the sensitivity of investment to liquidity variables such as cash flow as a measure of financial constraints. The structural modelling of investment facing financial constraints is also limited by the structural modelling of the force driving investment dynamics such as adjustment costs, which has not been so successful empirically.

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TABLE OF CONTENTS:

1. __INTRODUCTION__

This paper is intended to stimulate ideas on the interplay between theory and data when estimating investment facing financial constraints, a subject of applied econometric research during more than forty years (since at least Meyer and Kuh [1957]), and probably a pervasive feature of business financing during centuries. As there exists several excellent surveys dealing with these issues (e.g. Chirinko [1993], Schiantarelli [1996], Hubbard [1998], Bond and Van Reenen [1999]), I will focus on specific issues related to theoretical modelling and data and to their macro-economic consequences.

In 1993, Chirinko's view was that empirical evidence of financial constraints was found in many papers but was broadly unconclusive, being too distant from an explicit framework. The challenge relies on the interpretation of the sensitivity parameters of investment with respect to liquidity variables: it is not clear that they are fully related to financial constraints. Some progress have been made in explaining more precisely how structural parameters are "hidden" in those reduced form parameters. However, it may be the case that the problems in structural modelling of investment are not only due to financial constraints but also to the modelling of investment dynamics and adjustment process. Nonetheless, in the recent years, the use of microdata broadly expanded and many papers documented financial constraints through effects of liquidity variables on investment in several countries. It is useful to point out what are the current caveats in these works.

In a first section, I review three groups of testable investment equations without capital market imperfections: non structural models using auto-regressive distributed lags, often transformed in error correction models; Q model of investment, where investment depends on the market value of the firm divided by the value of the capital stock (average Q ratio) - Euler investment equations, which estimates that the marginal product of capital is equal to the marginal cost of capital. Then, I mention how these models are modified by the addition of four types of financial constraints. 1 also mention a few examples where alternative distortions, such as taxation and irreversibility interact with capital market imperfections.

In a second section, I mention some recurrent problems in empirical tests of financial constraints on investment. First of all, the interpretation of investment cash flow sensitivies or of the investment cash flow excess sensitivities in the general case is investigated. Second, I deal with problems related to the Q and Cash Flow model of investment. In this model, imperfect competition and decreasing returns to scale may blur the signals of financial constraints. Measurement errors and capital market short run valuation errors affects results. Third, I investigate the results and pitfalls found on financial constraints effects in the investment Euler equation.

In a third section, 1 point some difficulties related to micro-economic accounting data and to asset prices. Finally, I discuss some recent macro-economic modelling taking into account the behaviour of firms facing financial constraints. A last section concludes.

2. <u>TESTABLE THEORETICAL MODELS</u>

2.1. *Three Groups of Investment Equations*

Since Jorgenson's works, traditional estimations of investment are related to the Marshallian condition equating the marginal product of capital with its marginal cost, which builds on the arbitrage between the return from investing inside the firm and the opportunity cost of investing cash outside of the firm. It is then followed by a parameterization of the production function as a constant elasticity of substitution one. The stock of capital is then a function of sales and of the cost of capital, with elasticities related to structural parameters, e.g. the elasticity of substitution between capital and labour and the parameter of returns to scale. The higher the elasticity of substitution between capital and labour, the higher the elasticity (in absolute value) of the stock of capital with respect to the cost of capital. This intertemporal neo-classical theoretical model without adjustment costs does lead to identical results than a static model (Jorgenson [1963]). To compensate this lack of dynamics, econometricians add usually auto-regressive distributed lags, which takes into account dynamics which are not directly derived from intertemporal optimisation. Lagged variable in this approach are subject to the Lucas critique in the sense that they are not exactly related to parameters of the theoretical "structural" model. This auto-regressive distributed lag models are often parameterized again in the error correction form. A recent example of this approach has been the papers related to firms investment in the Monetary Transmission Network of the European System of Central Banks (Butzen, Fuss and Vermeulen [2001] and other papers)

Standard investment model grounding structural dynamics on intertemporal optimization assumed convex adjustment costs (Lucas [1967], Treadway [1968]). Alternative models include fixed adjustment costs which are able to deal with lumpy investment. In the convex adjustment cost case, the empirical literature splits into Q models (test on the marginal condition on investment) and Euler equation tests (test on marginal condition on the stock of capital). In the first case, the market value of the firms divided by the stock of capital (Tobin's Q ratio) summarizes all the expected determinants of investment under technology conditions derived by Hayashi [1982].

In the Euler equation case, the production function is parameterized as an homogeneous function of capital and labour, i.e. a more general assumption than the constant elasticity of substitution production function used in error correction models, which is a particular case of homogeneous function. The parameterization allows to compute the marginal product of capital so that

investment appears only as a component of the marginal cost of investing. The higher the growth of capital of the firm, (or the investment ratio), the higher the cost of investing due to convex adjustment costs. The parameterisation of the production function as an homogeneous function of capital and labour and the fact that the investment ratio appears in the cost of capital leads to specific properties of the estimated Euler equation in the perfect capital market case. The investment ratio is a negative function of EBITDA (earnings before interest, taxes and depreciation allowances) which show up usually from the parameterization of the marginal productivity. It is no longer granted that the investment ratio decreases with the opportunity cost or interest rate included in the entrepreneur discount factor.

2.2. Four Major Types of Financial Constraints

The microeconomic foundations of financial. constraints are found in the economics of asymmetric information. But, if there is only one way to know everything, there is lots of ways for outsiders to have an incomplete knowledge, on, for example, the investment of a specific firm. As a consequence, there is a broad variety of auxiliary assumptions describing various types of asymmetry of information leading to a variety of micro-economic models. Getting an agreement on these auxiliary assumptions is difficult. This could require to test auxiliary assumptions of theoretical models and not only their consequences, which are sometimes similar among those different models. This research strategy is not often chosen, but Himmelberg, Hubbard and Love [2002] provide an example. It implies a quest for organizational data and measures of information disclosed by the firms, in their case, measures of investors protection. But more generally, applied work and macro-economic modelling turned to use simplified versions of financial constraints.

The literature focuses on four major "simplified" capital market imperfections. Important features are the distinction between retained earnings and new share issues, which both accumulate into equity and the distinction between various types of new debt. First, one can consider that dividends cannot be negative. Second, one can consider that new share issues incur a cost premium with respect to internal funds: this cost premium can be a fixed cost (Bond and Meghir [1994]), or can be increasing with the amount of new share issues (Cooley and Quadrini [2001]), or can consist of both of these costs (Gomes [2001]). Third, one can consider that external debt is related to an exogenous bankruptcy (or monitoring) cost (Bernanke, Gertler and Gilchrist [1998]) which implies a cost premium with respect to internal funds. This cost premium can be increasing with the amount of debt or of leverage (Cooley and Quadrini [2001]) and also include a fixed cost. Fourth, one can consider that the firm is facing credit rationing and new share issues rationing (or face a fixed cost of new share issue sufficiently high so that it is not sound to issue new shares with respect to the firm demand for capital). An example is found in Kiyotaki and Moore [1997].

Credit rationing differs from an increasing cost of debt as leverage increases due to a Lagrange multiplier related to credit rationing. This Lagrange multiplier measures the gap between desired investment and realized investment. It alters marginal conditions (an explicit expression of this Lagrange multiplier can be found in Chatelain [2000]). Jaramillo, Schiantarelli and Weiss [1996] tested the opposition between an increasing cost of debt as leverage increases versus credit rationing in an Euler equation context, where negative dividends remains a possibility. More precisely, a credit rationing regime implies that investment and leverage are always complement: they both increases or both decreases. Conversely, the regime with an increasing cost of debt as leverage increases allows the possibility that investment and leverage can be substitute or complement. It depends on the relative shifts from one period to the next one of capital demand curve (due to e.g. productivity shocks or demand shocks) with respect to the capital supply curves (retained earnings, credit and new share issues curves)[1].

For example, consider the case for the capital demand curve is unchanged (e.g. no productivity shocks from this year to next year) and for the firm accumulate retained earnings, which shifts the credit supply curve, rising with the interest rate, to the right. It turns out that the share of debt in the means of finance decreases whereas capital increases. Leverage and investment are "substitute". In the case of constant returns to scale, capital increases, the amount of debt remains constant, equity rises so that leverage decreases. In the case of decreasing returns to scale, capital increases and the amount of debt decreases (not only leverage!): it turned to be rational to decrease debt and, as a consequence, the cost of capital in order to match a lower marginal return on capital related to a larger size of capital. Then, investment and debt are "substitute".

Conversely, consider now that a rise of productivity shifts the capital demand curve upwards relatively more than the accumulation of internal equity shifts the credit supply to the right. In this alternative case, investment and leverage both increases. They are "complement" as in the credit rationing regime. A theoretical investigation of this phenomenon, where the hypothesis of a positivity constraint on dividends turned to be crucial, and a preliminary empirical test was proposed in Chatelain [2000]. This example shows, that in these investment models of financial constraints, the question of the adjustment of the debt or dynamic capital structure is related to investment demand. It then interacts with the theoretical and applied econometrics literature explaining leverage and the variation of debt (e.g. Anderson and Nyborg [2001]).

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[1] The capital demand curve can be inelastic to the cost of capital in the constant return to scale case (e.g. Kiyotaki and Moore [1997] and Bernanke, Gertler and Gilchrist [1999]) or decreasing with respect to the cost of capital in the decreasing return to scale case (Kaplan and Zingales [1997], Gomes [2001], Gooley and Quadrini [2001]. In both cases, this curves shifts upwards following a rise in productivity.

2.3. *Financial Constraints and Other Features of Firms' Investment*

The interaction between financial constraints and other specificities of business investment are fruitful ways to improve the accuracy of our modelling of investment behaviour of firms. In particular, taxation is crucial for means of finance, as it creates large cost distortions between equity and debt, as debt service is deducted from corporate income tax, and large cost distortions between dividends and capital gains, as well as between new share issues and retained earnings in most of tax systems (See Auerbach [1983], King and Fullerton [1984]). Let us consider a well known example, the weighted average cost of capital presented in corporate finance textbooks such as Brealey and Myers [1999], where the cost of capital is a weighted mean of the opportunity cost of equity and the marginal cost of debt. It can be derived from the tax distortion between debt and equity and the capital market imperfection "number 3" alone, i.e. a rising marginal cost of debt as leverage increases. The arbitrage between the taxation gain and the costs of bankruptcy leads to an optimal debt/equity ratio which provides the optimal weights in the weighted average cost of capital (Auerbach [1983]). This optimal debt/equity ratio can always be reached instantaneously following shocks on capital demand or on the costs of the means of finance of capital, with the help of negative dividends or new share issues who do not face tax and/or asymmetric information distortions of their cost with respect to the cost of retained earnings. This example suggests that assuming only one of the four major capital market imperfections alone leads to focus on one among several financial regimes that can face firms in the real world.

Financial constraints can also interact with irreversibility and uncertainty effects (see e.g. Arrow [1968], Dixit and Pyndick [1994] and Trigeorgies [2002]). As mentioned above, financial constraints can increase the fixed costs sometimes related to investment irreversibility. As well, outside investors can take into account the cost of the real option involved in investing now a in specific project, i.e. the loss incurred by losing the option to invest *later* on in other projects (Dixit and Pyndick [1994]). Similarly, a high uncertainty on demand or costs can foster asymmetric information, which is related to moral hazard. The higher the economic uncertainty, the more difficult it is to assess ex post what is due to failures of management related to moral hazard or to economic uncertainty. Financial constraints and uncertainty effects are likely to be simultaneous. Investigating such a joint effect is proposed by e.g. Gérard and Verschueren [2002].

3. <u>AN OUTLINE OF SORNE RECURRENT PROBLEMS IN EMPIRICAL TEST</u>

3.1. *Investment Cash-Flow Excess Sensitivity*

One finds two different interpretations of investment cash flow sensitivities in the literature of financial constraints, which are put forward for any of the testable model currently used (non

structural reduced form, Q model, Euler equation). To avoid confusion, 1 precise both of them separately.

The first one is as follows. Since at least Meyer and Kuh [1957] empirical work on investment, it has been debated whether the investment cash-flow sensitivity is a signal of financial constraints or merely a signal of expected profit. In this former case, cash flow is correlated with components Tobin's Q numerator, which is the discounted sum of future cash-flow of the firm. Cash flow may turn to be a significant explanatory variable of investment due to the omission of the Q ratio in non structural models or due to measurement errors in Q and Cash Flow model of investment (Bond and Cummins [2001], Whited [2000], Gomes [2001]). In fact, alternative specifications of the neo-classical model such as the Euler equations as well as common sense suggests that both effects play a role in panel data due to the heterogeneity of the finance regime for firms. An attempt to isolate these two components inside observed cash flow has been made by e.g. Gilchrist and Himmelberg [1996] using Vector AutoRegressive techniques on panel data. This general problem is widely acknowledged and the isolation of these two effects inside the investment cash-flow sensitivity remains a difficult task.

The second point has been put forward by Fazzari, Hubbard and Petersen [1988] and combines two features. First, they assessed that even if investment cash-flow sensitivity does not necessarily reflect financial constraints, the excess sensitivity of investment cash flow for some firms with respect to a benchmark group is more likely to reflect financial constraints. Second, these groups of financially constrained firms have to be found using sample separation criteria which measure the extent of asymmetric information problems or the extent of difficulties to get external finance (size, size of intangibles, long term relationship with banks, high trade credit, and so on). In more general terms, the higher the financial constraints and/or the asymmetric information problems, the higher the investment cash-flow sensitivity.

The hypothesis that investment cash flow excess sensitivities is rising with the extent of financial constraint has been refined by Kaplan and Zingales [1998]. They proposed an inverted U-shape curve (rising then decreasing) for the investment cash flow sensitivity as a function of the extent of financial constraints. When firms are facing financial distress and a serious threat of bankruptcy, then, the investment cash flow sensitivity fall. A likely explanation is that the firm probably drops investment much more that its cash-flow fell, because it needs to use this cash for debt repayments. Kaplan and Zingales critique can be viewed as a useful extension of Fazzari, Hubbard. and Petersen [1988], adding a new financial regime labeled "financial distress", measured by a specific sample split indicator. They do not reject the method of investigating excess sensitivities with relevant sample separation criteria.

An important econometric problem is faced by these sample separation criteria. Most of the ones used in the recent literature are likely to be endogenous. This would imply a specific econometric

treatment for this endogenous selection problem. For example, the sample separation criteria can be explicitly estimated using probit or tobit estimation. Then switching regression techniques can be used (Hu and Schiantarelli [1998]). 1 now turn briefly to specific problems related to Q models and Euler equations.

3.2. Q Model and Financial Constraints

3.2.1. IMPERFECT COMPETITION AND DECREASING RETURNS TO SCALE MAY BLUR FINANCIAL CONSTRAINTS SIGNALS

The link between investment, marginal Q (ratio of a marginal change of the value of the firm divided by a marginal change of capital) and average Q has been stated by Hayashi [1982] under the assumption of convex costs of adjustment for investment. Marginal Q and average Q are equal for a competitive firm with a constant return to scale production provided that the adjustment cost function is linearly homogeneous in the rate of investment and the level of the capital stock. Recent theoretical papers considered firms facing imperfect competition and/or decreasing return to scale to challenge the interpretation of the investment cash flow sensitivity as a signal of financial constraints. They focus on the applied econometric model where investment is estimated as a function of average Q and of cash flow. It turns out that decreasing returns to scale for a firm facing uncertainty implies that the investment ratio is a reduced form linear function of average Tobin's Q and of the ratio of cash flow over capital, even without financial constraints. These demonstrations complement the initial Lucas' critique that the parameter related to cash flow in the Q cash flow reduced form model of investment is not derived from a structural model of financial constraints[2].

Abel and Eberly [2002] remove the assumption of adjustment costs and do not consider financial constraints, but assume uncertainty. To introduce time series variations of the investment ratio, they had to introduce uncertainty on the growth rate of the productivity factor, which implies uncertainty on average Q. To introduce time series variation of the cash flow/capital ratio (cash flow is the revenue function before paying the cost of capital) i.e. variation of average productivity, itself related to marginal productivity, they assumed uncertainty on depreciation, which implies uncertainty on the marginal cost of capital (the marginal product of capital is equal to the marginal cost of capital). The existence of decreasing returns to scale and/or monopoly power in an uncertain framework leads to a non linear dependence of the expected investment ratio with respect to average Q and to cash-flow. Both linearized coefficients are function of the cash flow over capital ratio (average productivity). Under some conditions on the uncertainty parameters, firms with a high average productivity (and related to a high cost of capital, hence small firms with respect to

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2   Note that these demonstrations do not invalidate the existence of a cash flow channel of monetary policy. But they found its source in uncertainty, imperfect competition and/or decreasing returns to scale instead of financial constraints.

capital, as they face decreasing returns to scale or high market power) exhibit a higher investment cash flow sensitivity and a lower investment Q sensitivity than other firms. Hence, sample separation criteria such as average productivity, the cost of capital, the size of capital or market power indicators lead to investment cash flow excess sensitivities[3]. Finally, in their setting, the uncertain growth rate of productivity is exogenous and is not necessarily connected to size. Abel and Eberly also show that fast growing firms exhibit a higher investment cash flow sensitivity and a lower investment Q sensitivity than other firms. As a consequence, uncertainty and decreasing return to scale are able to generate investment cash flow excess sensitivity when using growth as a sample separation criteria without assuming financial constraints.

However, if the sample separation criteria are financial variables such as dividend payouts, leverage, interest coverage, bond ratings (Whited [1992], Gilchrist and Himmelberg [1995]) or the composition of external finance (Kashyap, Stein and Wilcox [1993]) which are unrelated to the real characteristics of the firm (size, expected growth rate), then evidence using these variables to identify financial constraints is not subject to the confounding of financial effects and firm characteristics in the Q-cash flow model of investment. What is more, the case of a higher cost of capital may be due not that much to a high scrapping rate leading to a high investment ratio but rather to a risk premium related to financial constraint included in the financial cost of capital. If one was adding some of the four major financial constraints in Abel and Eberly setting, uncertainty and decreasing returns are likely to sharpen the effects of financial constraints on investment with respect to the certainty model with constant return to scale.

Similar findings are found by Cooper and Ejarque [20011 using another research avenue. Using simulations of a model with structural paraneters and indirect inference based on the method of moments, they are able to replicate the reduced form results of a Q cash flow model of investment estimated on a panel data set by Gilchrist and Himinelberg [1995]. They found that firms with identical market power or identical (decreasing) returns to scale but with a higher adjustment cost parameter (using quadratic adjustment costs) and a higher autocorrelation of productivity shocks exhibit a higher investment cash flow sensitivity and a higher investment Q ratio sensitivity. They indirectly infer that small firms are likely to exhibit higher adjustment costs parameter and higher persistence of productivity shocks.

This result is slightly different from Abel and Eberly [2002] where an increase of the investment cash flow sensitivity goes hand in hand with a decrease of investment Q ratio sensitivity. Both approaches point that the investment Q ratio sensitivity is no longer exactly the inverse of the quadratic adjustment cost parameter, so that the low values of this sensitivity found in applied studies do not necessarily reflect extremely high adjustment costs in the context of decreasing returns to scale. With respect to financial constraints, the observed persistence of productivity

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[3]   Their model does not take into account an industry equilibrium of firms with large or small capital as in Gomes [2001] but deals with a monopoly in partial equilibrium.

shocks may not necessarily be only a a technological phenomenon. Financial constraints may create persistence in output due to internal equity accumulation or due to the persistence of informational asymmetry characteristics. They are likely to decrease regularly with time when outside investors learn more about about the firm.

3.2.2. MEASUREMENT ERRORS AND CAPITAL MARKETS SHORT RUN VALUATION ERRORS

Several papers investigate how measurement errors in marginal Q lead to significant cash flow effect. For example, Chirinko [1992] and Gomes [2001] point that, depending on circumstances, average Q capitalizes the impact of some or all finance constraints. Gomes [2001] explores measurement errors on the price of capital goods (often taken at a sectorial level and not at the individual level), which value the stock of capital at the denominator of the Q ratio as well as measurement error in average q. Simulating his industry model removing financial constraints, he finds that significant cash flow effects can be found due to measurement error. Moving on real data and a moment estimator robust to measurement errors, Erickson and Whited [2001] confirms empirically the findings that Q can explain investment once measurement error are taken into account.

Plots of time series of variations of Q with respect to variation of investment may show that the changes of Q are often much larger than the changes of investment, so that the investment Q ratio sensitivity has to be small. Depending on circumstances, it seems that capital market may present short run valuation errors. In Cummins, Hassett and Oliner [1999], the response of investment rates to variation in average Q are quite small and cash flow is a significant regressor. However, when they replace average Q with their measure of Q based upon earnings expectations, financial variables are no long significant. A similar finding is found by Bond and Cummins [2001]. They consider to what extent the empirical failings of the Q model of investment can be attributed to the use of share prices to measure average q. They show that the usual empirical formulation may fail to identify the Q model when stock market valuations deviate from the present value of expected net distributions in ways that are consistent with weak and semi-strong forms of the Efficient Markets Hypothesis. They show that the structural parameters of the Q model can still be identified in this case using a direct estimate of the firm's fundamental value, and implement this using data on securities analysts' earnings forecasts for a large sample of publicly traded US firms in the nineties. Their empirical results suggest that stock market valuations deviate significantly from fundamental values. Controlling for this, they find no evidence that the Q model of investment is seriously misspecified.

The recent renewal of interest in Q model should not hide that more and more data set are available for firms which are not traded on the equity market. For those firms, which are more likely to financially constrained, the market value is not available so that the traditional estimation of the

market value Q model simply cannot be run. Applied econometrician would have to find analyst's earnings forecast for these non traded firms or built themselves their market value indicator. The valuation of firms can be made with the help of a few retrospective balance sheet and income statement. However, this requires assumption on forecasted firm demand. But the evaluation proposed by analysts can be roughly made in order to extend Q testing to non traded firms.

Due to the overall confusion on how to track financial constraints precisely in the Q-Cash flow model, the Euler equation was thought to renew structural estimation in the early 1990's. Let us investigate now why applied econometricians are not so enthusiastic with this alternative approach.

3.3. Euler Equations and Financial Constraints

On one hand, Q has the virtue to capture some, if not all, of the profit expectations. On the other hand, as seen in the preceding section, the Q and Cash Flow model of investment faces difficulties due to non-linear or non-structural parameter in the estimated reduced form where both sensitivities may depend or not on the extent of financial constraints, measurement errors, short run valuation error on the equity market, and the lack of data for the value of non traded firms at the microeconomic level. Using the Euler equation has been seen as an alternative for structural tests of investment which avoids several of the problems faced by the Q model. It estimates the equality between the marginal product of capital and the cost of capital including marginal adjustment costs of investment now and marginal costs of investing next period. The marginal productivity of capital is usually computed under the assumptions of homogeneity of capital and labour and of imperfect competition or decreasing return to scale.

This marginal condition has been estimated taking into account the financial constraint designed as an increasing cost of debt as leverage increases (e.g. Bond and Meghir [1994], Estrada and Valles [1995], Jarainillo, Schiantarelli and Weiss [1996], Gilchrist and Himinelberg [1998], Chatelain and Teurlai [2000]). For example, Kaplan and Zingales [1997] proposed a similar model without adjustment costs as an alternative of the Q Cash flow reduced form model, so that these Euler equation estimations avoids some of their critique. The parameter related to the cost of debt can be directly estimated. It provides a measure of the financial constraints related to leverage. It has the same status than a structural parameter. However, if Euler equation estimations were relatively successful to integrate leverage in investment equation, they turn to be disappointed with respect to the role of cash-flow. Cash flow are often introduced in Euler equations taking into account credit rationing. The Lagrange multiplier related to the credit rationing constraint is parameterized as a linear function of cash flow and other liquidity variables (e.g. Whited [1992]). But the new parameter related to cash flow is not a structural one. It is a combination of individual variables and of other parameters of the model (Chatelain [2000]). On the other hand, omitting cash flow in the Lagrange multiplier lead regularly to a misspecification of the Euler equation (Whited [1998], Chatelain and Teurlai [2000]). The need to alter the specification of cash flow in the neo-classical

Euler equation without financial constraints may be related to the fact that it constrains the investment ratio to be a negative function of EBITDA, a feature that the Lagrange multiplier add-on corrects (this problem was noticed by Bond and Meghir [1994]). If EBITDA was to be correlated with future cash flow, then the Q result would favor an opposite sign (positive) for the relationship between the investment ratio and cash flow.

Another major problem with Euler equations is related to the quadratic adjustment costs assumption. Estimation of the adjustment cost parameter are sometimes very small and not significant (whereas the size of the adjustment cost parameters are usually too large in the Q model, assuming Hayashi's [1982] conditions). An example on Belgium data is given by Barran and Peeters [1998]. As the production function is parameterized assuming homogeneity with respect to capital and labour, marginal productivity is substituted for by a function of average productivity where capital appears only at the denominator. Investment then appears only via marginal adjustment costs. If the marginal adjustment cost is not significant, investment behaviour is no longer explained by the Euler equation. Proposals have consisted to remove the assumption of quadratic adjustment cost to a polynomial specification (Whited [1998], Chatelain and Teurlai [2000]) or to another specification which allows a higher number of lags of the investment ratio (Gerard and Verschueren [2002]) or by assuming non-convex costs of adjustment (e.g. Cooper and Haltiwanger [1999]) .

It turns out that those problems have maintained alive and well the alternative traditional auto-regressive distributed lags (ADL) specification of the neo-classical Jorgensonian model (Hall, Mairesse and Mulkay [2000]), because of the flexibility of the distributed lag structure. What is more, the effect of the cost of capital is not easy to isolate properly in the Euler equation. On the other hand, the ADL structure allows attempts to isolate the cost of capital channel of monetary policy from the broad credit channel or the cash flow channel. This specification has been chosen in the monetary transmission network of the European System of Central Banks (2001). As seen above, structural models of investment stop half way in the structural modelling of financial constraints. The interpretation of the parameters of cash flow or of other liquidity variables faces the Lucas critique in these models as much as in the traditional autoregressive distributed lags models.

3.4. Private Accounting Data

In this section, I focus on the use of private accounting data. The fact that these data are not aggregated should not hide that accounting data are also fragile. Accountants can choose optimistic or pessimistic valuations for several items related to future cash inflows or cash outflows. However, it is possible to improve our use of accounting data for understanding investment. 1 provide two examples:

Off balance sheet information in some countries such as leasing and discount could be taken into account. Discount is a short run mean of finance by firms where they give property rights to some of their trade credit on the asset side to banks. As a counterpart, the banks provide them liquidity charged with interest. For financially distressed firms, this can be a mean of finance which is accepted by banks because they have the collateral which consists on the claims on other firms. Taking into account off balance sheet discount amounts to increase the amount of trade credit on the asset side and to decrease the amount of liquid debt on the liabilities side.

Similar collateral argument holds for leasing. Leased capital remain the property of the "lender", who receives rents from the firm. The collateral consist of the leased capital itself, which faces mostly accelerated scrapping. In this context, leasing may bc an opportunity for some firms which are financially constrained. However, if it is easy to add leased capital on the gross asset side, there exist several manners to split renting contract flows between depreciation flows and debt flows as if this capital good have been bought instead of renting it. On the one hand, one can find the equivalent interest rate for a debt contract (IASC recommendation) and consider that the remaining value of the good is depreciated, but the depreciation scheme does not fit standard accounting depreciation rule. On the other hand, one can apply a standard depreciation accounting rule and consider that the remaining flows are related to a debt contract. In this case, the interest payments do not fit existing debt contracts (this rule is used in Chatelain and Teurlai [2000]).

3.5. Asset Prices

Trying to isolate the cost of capital channel of monetary policy from the broad credit channel or the cash flow channel has been one of the goals of the firm studies in the monetary transmission network of the European. System of Central Banks (2001). The credit channel emphasize that credit availability is a function of collateral. The cyclical movement of asset prices can modify the value of collateral. It is then useful to investigate the asset price channel as a particular channel of the broad credit channel. Before going further, it is worth mentioning that monetary policy faces more difficulties to influence asset prices than the consumer price index. Asset prices expectations driving speculative bubbles are not systematically affected by monetary policy shocks or central bankers declarations. Unfortunately when speculative bubbles go bust, central banks sometimes have to provide liquidity to some financial intermediaries. Then, after over-investment, the decline in asset price can be long lasting.

A problem is related on how to adapt asset prices indexes, when they exist, to micro-economic data. Asset prices matter on the asset side for e.g. buildings, which are partly taken into account by sectoral investment price index for computing real investment. Asset prices also matter for the valuation of financial assets owned by the firm and for the valuation of equity liabilities of the firm. As financial assets are valued at the cost of acquisition, one may reevaluate the price of financial. assets with the equity price index. In principle, those reevaluation may be anticipated by

accountants and put on the liability side for provisions, as the market value of assets decrease. Then, the share of financial assets may reflect that a firm is more sensible to asset price fluctuations. It may also reflect a firm which can obtain finance from a group. It is also possible to reevaluate equity taking into account the shifts in asset prices. Finally, it leads to investigate the trade-off between financial investment and real investment, taking into account the risks of asset price fluctuations of financial investment.

4. FINANCIAL CONSTRAINTS ON INVESTMENT AND MACROECONOMIC MODELLING

Once some of the four major financial constraints are taken into account, specific intertemporal dynamics emerged as accumulation into equity of retained earnings, obtained from profits. This dynamics modifies reactions of firms to shocks with respect to the standard convex adjustment cost models. Without asset prices fluctuations, the accumulation of internal funds of credit rationed firms smooth capital accumulation after a rise of productivity (or a fall of the cost of capital) with respect to the neo- classical model with convex adjustment costs (Chatelain [1997]). As a consequence, additional features are usually taken into account for explaining a financial accelerator, where financial constraints are supposed to amplify productivity or demand shocks and exacerbate fluctuations. These additional features can be asset prices fluctuations, the removal of the hypothesis of adjustment costs or of its convexity, shifts in the allocation of savings towards private productive investment along the business cycle, and so on. These features are more developed in recent business cycles theory based on models of intertemporal investment facing financial constraints. Hence, econometric evidence of financial constraints on investment ground some of the four simplified assumptions of financial constraints affecting investment behaviour used in those models.

In the recent years, internal funds accumulation have been investigated in business cycles theory. This economic literature is highly indebted with the ideas developed into details by Irving Fisher's [1933] seminal article on the debt deflation episode of the 1930's. Heterogeneity of the current year equity or current year debt/equity ratio leads to different accumulation path for firms in the certainty case (Kiyotaki and Moore [1997]). This heterogeneity can be increased taking into account uncertainty on profits next period due to productivity or demand shocks, which alters the amount of retained earnings, hence of equity of the next period. Research started with constant returns to scale technology. This assumption allows capital aggregation so that the distribution of equity and of capital is not necessary for studying the cycle (Kiyotaki and Moore [1997], Bernanke, Certler and Gilchrist [1998], Carlstrom and Fuerst [1997], Aghion, Banerjee and Piketty [1998]). In Kiyotaki and Moore [1997], asset prices fluctuations are endogenous but there is no focus on monetary policy. In Bernanke, Gertler and Gilchrist, asset price fluctuations are not endogenous.

The cycle is driven by exogenous productivity shocks. But they consider a monetary policy rule, which alters the economic cycle.

Further research considered decreasing return to scale technology (once one removes the fixed costs in some models) (Gomes [2001], Cooley and Quadrini [2001], Cooley and Quadrini [1999], Barlevy, G. [1998], Caballero, R. and M. Hammour [1998], Den Haan, W. G. Rainey and J. Watson [1999]). Those recent papers have examined the general equilibrium compositional effects of shocks if financing constraints are present. It is necessary to know the distribution of equity (firm net worth) to compute or simulate the aggregate dynamics of capital. In those models, the heterogeneity of equity is fully taken into account but the investigation of the heterogeneity of other characteristics of financial constraints is not yet so developed. An attempt to deal with the consequences of the heterogeneity of financial constraints for monetary policy has been proposed recently by Beau, Larsen and Nikolov [2001]. A key question is how to adapt monetary policy rules to the heterogeneity of firms reactions to monetary policy shocks.

Finally, the accumulation of retained earnings in the equity dynamics can also affects long term growth, as well as business cycle. This can happen under three conditions: if equity growth limits the tangible and intangible capital growth of individual firms, if the share of firms facing this growth limit is large in the economy, and if the growth of intangible capital (for example research and development) and of intangible capital is one of the driving forces of the economic growth of GDP (e.g. Romer [1986] and the subsequent literature assuming constant returns to scale for the aggregate of all types of capital in the economy). A recent theoretical model is proposed by Amable, Chatelain and Ralf [2002] and recent empirical evidence on the relationship between financial structures and growth can be found in Dernirgunc-Kunt and Levine [2001].

5. <u>CONCLUSION</u>

This paper reviewed problems related to the estimation of investment facing financial constraints. A central question is the interpretation in applied work of the sensitivities of investment with respect to cash flow and other liquidity variables, which still continues to face the Lucas critique. It is not easy to isolate the component of these sensitivities related to financial constraints with respect to components related to other features of investment such as technology, imperfect competition, expectations, and so on... Many progress have been made in using new data sets and digging more and more useful information out of them. Sophisticated panel data econometric estimates dealing with endogeneity and endogenous selection problems have been used extensively. On the one hand, theory made more and more precise objections against direct interpretations of these sensitivities as measures of financial constraints. On the other hand, theory brought new results on financial constraints, being, for example, able to handle the heterogeneity of

firms. However, the answers to the Lucas critique are not yet provided. One of the reasons is that some other characteristics of investment than financial constraints present also testable difficulties (e.g. adjustment costs). Another reason may be the diversity of financial regimes faced by firms.

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