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ON THE USE OF BANKS BALANCE SHEET DATA IN LOAN MARKET STUDIES: A NOTE

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On the use of banks balance sheet data in loan market studies: a note.

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Abstract: Due to the unobservability of the new credit production, most of the empirical loan market studies use, instead, the observable credit stock. This substitution has been pointed out to be likely to generate biases (e.g. see Lown and Peristiani (1996)). In this paper, we show that under quite unrestrictive conditions, this substitution does not lead to biased estimates of any log-log model coefficients, as long as banks panel data is used and fixed effects are included in the estimated equation.

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1 Introduction.

The use of individual bank data in studies devoted to banks loan supply behavior has recently increased in a significant way. Studies by Berger and Udell (1994), Elyasani, Kopecky and Van Hoose (1995), Kashyap and Stein (1994), Lown and Peristiani (1996), Peek and Rosengren (1995), etc. are recent examples of this stream. One of the common features of these studies is that they use data taken from the banks balance sheets [1]. Using individual bank balance sheets presents numerous advantages, among which one can mention the adequation between the theoretical model and the data used to check its empirical relevance and, as long as repeated observations over time are available, the possibility to deal with potential unobserved heterogeneity and/or parameter instability. Nevertheless, in the specific context of loan studies, this data source presents a drawback: while the theoretical variable appearing in most of these models is (or should be) the *new credit production,* the variable used in the empirical estimation of the model is generally either the *credit stock* or its variation because it is the only available measured variable. Obviously, the latter can hardly be considered as an accurate measure by the former[2]. One can then wonder whether this substitution is neutral with respect to the obtained coefficient estimates. As emphasized by Peristiani and Lown (1996): "Still, a major criticism of the reduced form loan equations that we (and others) have estimated is that the dependent variable - the stock of outstanding loans - does not measure new loans issued." Moreover, as is also well-known, this substitution also raises the problem of correctly correcting for inflation[3].

The aim of this note is to clarify the econometric consequences of using the credit stock instead of the new credit production in econometric models, either as the dependent variable or as a regressor. A particular focus is directed to panel data models since it appears that they allow such a substitution to be rather inocuous under quite unrestrictive conditions. The plan of the paper is as follows: in section 2, we make explicit the link that exists between the credit new production and stock. In particular, it is clearly shown that this link is much less tight for long term credit than it is for short term ones. Section 3 deals with the problem arising from the substitution of the former by the latter when the model is estimated either using the raw data or using the logarithm of this variable as the dependent variable. We also consider the case where these variables are included in the set of explanatory variables. Conditions under which this substitution is neutral with respect to the estimation of the coefficients are exhibited. Section 4 is devoted to an empirical check. Some conclusions are drawn in section 5.

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[1] An exception is a recent paper by Lown and Peristiani (1996) where data are obtained from a specific survey.

[2] See Bernanke and Lown (1991), page 209, Lown and Peristiani (1996, page 1677) and Baumel and Sevestre (1997).

[3] e.g. see Bernanke and Lown (1991), page 209.

2 The relationship between new credits and the credit stock.

The amount of credit appearing in banks balance sheets reflects the amount of credit that they have provided in the past and which remains to be reimbursed. Denoting C_{it} the amount of credit stock appearing in bank i's balance sheet at time t and NC_{it} that of new credit provided during the period ending at time t, and ignoring, for the sake of simplicity, the impact of provisions for possible payment default[4], one can write:

$$C_{it} = NC_{it} + \alpha_1 NC_{it-1} + \alpha_2 NC_{it-2} + \alpha_3 NC_{it-3} + \ ... \ + \ \alpha_p NC_{it-p}$$

which can be rewritten as:

$$C_{it} = NC_{it}(1 + \alpha_1 \frac{NC_{it-1}}{NC_{it}} + \alpha_2 \frac{NC_{it-2}}{NC_{it}} + \alpha_3 \frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p \frac{NC_{it-p}}{NC_{it}}]$$

Given that the variable of interest in most economic models is the real value of the new credit production, it is interesting to write this expression as:

$$\frac{NC_{it}}{P_t} = \frac{C_{it}}{P_t} \ / \ (1 + \alpha_1 \frac{NC_{it-1}}{NC_{it}} + \alpha_2 \frac{NC_{it-2}}{NC_{it}} + \alpha_3 \frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p \frac{NC_{it-p}}{NC_{it}}]$$

where P_t is a price index. This relationship shows that substituting the total amount of the credit stock for the new credit production will have no undesirable consequence as long as the α coefficients are close to zero; which will be the case for short term credits. On the contrary, this substitution can be quite problematic for long term credits, where the credits granted in the past have a strong influence on the current amount of credit outstandings. Moreover, this formulae shows that the relationship between new credits and the stock has no reason to be stable over time, since the ratios NC_{it-j}/NC_{it} depend on the past credit production growth. It also depends on banks but this dependence is likely to be less important given that it relies on composed past rates of growth which are more likely to depend on business conditions than on banks specificities.

One can then wonder about the consequences for the estimates of coefficients in econometric models of the usual substitution of new credit production by the credit outstandings taken from balance sheets.

3 Econometric consequences of substituting the credit stock for the new credit production.

3.1 Credit is the explained variable.

First of all, let us consider the case where the new credit production is the explained variable in the model, that is, the model under consideration can be written as:

[4] Taking these into account can be shown to affect the coefficients $\alpha_j \ j = 1, ..., p$ in the equation below.

$$\frac{NC_{it}}{P_t} = X_{it}\beta + u_{it} \qquad (1)$$

where u_{it} is assumed to have all desirable properties[5].

Then, it is obviously the case that if one estimates the model

$$\frac{C_{it}}{P_t} = X_{it}\gamma + v_{it} \qquad (2)$$

instead of model (1), the estimated γ will be a downward biased estimation of β since the expression $(1 + \alpha_1 \frac{NC_{it-1}}{NC_{it}} + \alpha_2 \frac{NC_{it-2}}{NC_{it}} + \alpha_3 \frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p \frac{NC_{it-p}}{NC_{it}})$ is obviously greater than 1. In fact, the relationship between β and γ just expresses the degree of proportionality that exists between the stock and flow of credit. Unfortunately, it is not necessarily the case that this relationship is stable over time and/or across banks, which makes it difficult to get an unbiased estimate of β whatever data is used, time-series, cross-section or panel. Nevertheless, let us assume that the logarithm of $(1 + \alpha_1 \frac{NC_{it-1}}{NC_{it}} + \alpha_2 \frac{NC_{it-2}}{NC_{it}} + \alpha_3 \frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p \frac{NC_{it-p}}{NC_{it}})$ can be correctly approximated by the following sum of time and bank dummies:

$$\ln(1 + \alpha_1 \frac{NC_{it-1}}{NC_{it}} + \alpha_2 \frac{NC_{it-2}}{NC_{it}} + \alpha_3 \frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p \frac{NC_{it-p}}{NC_{it}}) \simeq f_i + g_t,$$

then, model (1) can be rewritten as:

$$\ln(\frac{C_{it}}{P_t}) = \ln(X_{it}\beta + u_{it}) + f_i + g_t$$

which can be estimated as a non linear model or can be approximated by a log-linear model. Indeed, using the first order Taylor expansion of $\ln(X_{it}\beta + u_{it})$ around $X_{it}\beta$, it is easy to show that the previous model can be approximated by:

$$\ln(\frac{C_{it}}{P_t}) = \ln(X_{it}\beta) + f_i + g_t + v_{it}$$

where $v_{it} = u_{it}/X_{it}\beta$, which means that the linear approximation results in an heteroscedasticity of the disturbances, which can easily be taken into account by feasible-GLS.

If the model to be estimated is originally in logarithm, the advantage of using bank panel data is even more easily seen. Indeed, in that case, the model to be estimated is defined as:

$$\ln(\frac{NC_{it}}{P_t}) = \ln(X_{it})\beta + u_{it} \qquad (3)$$

[5]Assuming a possible serial correlation or heteroscedasticity of the disturbances does not change the conclusions. The only difference would be that the estimated model would have to be transformed using the $\Omega^{-1/2}$ transformation. Moreover, in the case where some regressors are endogenous, the conclusion still remains valid, given that these variables are correctly instrumented for.

which can be rewritten as

$$\begin{aligned}
\ln(\frac{NC_{it}}{P_t}) &= \ln(\frac{C_{it}}{P_t}) \\
&+ \ln(1+\alpha_1\frac{NC_{it-1}}{NC_{it}} + \alpha_2\frac{NC_{it-2}}{NC_{it}} + \alpha_3\frac{NC_{it-3}}{NC_{it}} + \ ... \ + \ \alpha_p\frac{NC_{it-p}}{NC_{it}}) \\
&= \ln(X_{it})\beta + u_{it}.
\end{aligned}$$

Then, assuming that the second logarithm can be approximated by time and/or bank specific effects, this model can be rewritten as:

$$\ln(\frac{C_{it}}{P_t}) = \ln(X_{it})\beta + f_i + g_t + u_{it} \qquad (4)$$

which can be easily estimated using time and/or bank dummies or rewriting the model in terms of first differences to discard the banks specific effects if the number of banks in the sample is large, as one is not necessarily directly interested in those coefficients. This is, for example, the approach followed by Berger and Udell (1994) who estimate their model in terms of growth rates (which is not very different from the differences in logs). In doing so, they implicitly allow for the existence of individual effects, which make less problematic the substitution of the new credit production by the stock of oustanding loans.

Moreover, it is interesting to note than in this kind of model, it is completely indifferent to deflate or not the stock of credit. Indeed, model (4) can be written as

$$\ln(C_{it}) - \ln(P_t) = \ln(X_{it})\beta + f_i + g_t + u_{it}.$$

which estimation, given the presence of the time-dummies accounting for macroeconomic variables, can be shown, using the Frisch-Waugh theorem, to be strictly equivalent to that of the model:

$$\ln(C_{it}) = \ln(X_{it})\beta + f_i + h_t + u_{it}.$$

In that case, using panel data and including time dummies in the model allows to reduce the bias that can be caused by substituting the unobserved new credit production by the observed credit stock and to eliminate the question of correctly deflating this stock. In that case, the difficulty of correctly deflating loans that was outlined by Bernanke and Lown (1991, page 209) does not exist any more. This also explains why Kashyap ans Stein (1994) did not find any significant difference in their estimation of a loan equation using either deflated or nominal values. Indeed, their model was specified in terms of growth rates (which is, again, clearly very similar to a model written in logarithm differences), thus allowing implicitly for individual effects; it also contained some macroeconomic variables whose impact on their estimates was probably close to that which would have been obtained with time effects.

As we are now going to see, this set of results extends to the case where loans appear as an explanatory variable instead of being the dependent variable of the model.

3.2 Credit is an explanatory variable.

Indeed, consider now that the model to be estimated is

$$y_{it} = (\frac{NC_{it}}{P_t})\beta + w_{it} \tag{5}$$

whereas one estimates the model

$$y_{it} = (\frac{C_{it}}{P_t})\gamma + w_{it}. \tag{6}$$

Then, again, the estimated coefficient $\overset{\wedge}{\gamma}$ will be biased as long as the $\alpha's$ are not close to zero. But, again in this case, things get better if the model depends on the variables logarithm:

$$\ln(y_{it}) = \ln(\frac{NC_{it}}{P_t})\beta + u_{it}. \tag{7}$$

Indeed, in that case, one can also rewrite the model as:

$$\ln(y_{it}) = \ln(\frac{C_{it}}{P_t})\beta + f_i + g_t + u_{it} \tag{8}$$

as long as the approximation of the correcting factor by the sum of time and/or bank specific effects can be considered as acceptable. Here again, this is close to the approach followed by Lown and Peristiani (1996) who define their dependent variable as the difference between the bank interest rate at a given point in time and its average over banks, thus allowing implicitly for time effects and who include in their model several bank specific variables which probably have on the regression results an effect similar to that which would have been obtained with bank dummies.

It is interesting to note that, in this situation too, the question of deflating or not the loan variable is not important, given that the inflation effects are captured by the time dummies[6].

Then, it appears that, if individual banks panel data is available, one can expect the often made substitution of new credit production by the credit stock asset not to have harmful consequences; the condition being that the proportionality factor can be decomposed into the sum of time and bank specific effects.

If one has doubts about the quality of this approximation, it is possible to consider a further way to deal with the measurement error induced by the substitution. Indeed, one can write:

[6] In order for these results to remain valid when using time series or cross-section data, it would be necessary for the correcting term to be constant in the time dimension or across banks, respectively.

$$\ln(1+\alpha_1\frac{NC_{it-1}}{NC_{it}}+\alpha_2\frac{NC_{it-2}}{NC_{it}}+\alpha_3\frac{NC_{it-3}}{NC_{it}}+\ ...\ +\ \alpha_p\frac{NC_{it-p}}{NC_{it}})+\varepsilon_{it}=f_i+g_t \quad (9)$$

where ε_{it} is a measurement error. In the case where the credit production variable is the explained variable of the model, this has no other consequence than increasing the variance of the model disturbance. When this variable appears in the model as a regressor, one is then faced with an error in variables problem. Indeed, the estimation of model (8) by least squares leads to inconsistent estimates; it is well-known that the absolute value of the bias is an increasing function of the ratio of the measurement error variance to that of the measured variable. In our case, this means that the least squares estimates bias gets stronger as the previous approximation (given by equation (9)) gets worse. Nevertheless, even in the case where this approximation does not work well, it it still possible to get consistent estimates of the parameters by using an instrumental variables or a GMM estimation technique[7].

In other words, whatever the quality of the approximation, substituting the credit stock to the new credit production is not an obstacle to the obtention of consistent estimates, as long as one take this into account by adding banks and time dummies to the model and, if necessary, by using an appropriate estimation technique[8].

However, the question remains to check whether the previous approximation can be considered as acceptable. We have evaluated its quality on a sample of 15 french large banks for which we have observations of both the credit stock and the new credit production, observations that cover the period 1978-1992.

4 An evaluation of the quality of the approximation.

In this section we want to check whether one can consider the following approximation:

$$\ln(1+\alpha_1\frac{NC_{it-1}}{NC_{it}}+\alpha_2\frac{NC_{it-2}}{NC_{it}}+\alpha_3\frac{NC_{it-3}}{NC_{it}}+\ ...\ +\ \alpha_p\frac{NC_{it-p}}{NC_{it}})\simeq f_i+g_t,$$

as acceptable. This amounts to evaluate the quality of the following analysis of variance regression:

$$\ln(\frac{C_{it}}{NC_{it}})=f_i+g_t+\varepsilon_{it}.$$

As said above, this regression has been conducted on a panel of 15 large french banks observed quarterly over the period 1978-1992. Four sets of regressions have been realized, corresponding to total loans, as well as short term, medium term and long term ones, which results are presented in the table below

[7]e.g. other balance sheet items or combinations of them are likely to constitute valid instruments.

[8]This result obviously does not deny the interest of constructing series of credit production, in particular for characterizing and studying the conditions of macroeconomic activity.

INSERT TABLE 1 ABOUT HERE.

The first interesting result to note is that the ratio of total new loans to total loans assets is quite well explained by the individual and time effects; indeed, 86% of the total variance is explained by these effects; this means that the above claim that the replacement of the (generally unobserved) new loans by the (observed) total loan assets in econometric models can be done as long as the model includes individual (and time) specific effects; in that case such a replacement should not lead to important biases.

As could be expected, this approximation works even slightly better for short term loans. This is not really surprising because, for this category of credit, the difference beween new credit and credit assets is not as strong as it is for longer term credit. Indeed, if all short term loans where one quarter long, we would have an almost exact correspondance between these two measures, at least in a stationary state. Another reason why the previous approximation is almost as good for total loans as it is for short term ones is that short term loans appear to be the most important part of new credit, while long term ones constitute most of loans assets (cf. Baumel (1996)).

Unsurprisingly, for medium and long term loans, the previous approximation does not work as well. Then, if one is interested in long term credit, replacing new loans by assets should lead to both the inclusion of bank and time dummies and the use of an instrumental variables or GMM estimation technique. It must be said that we have checked that the sometimes proposed solution which consists in replacing these new credits by the first difference in assets does not lead to better results.

5 Conclusion.

In this paper, we support the use of bank panel data when studying behaviors that entail the inclusion of loans in a model. Indeed, we show that, using such data, one can replace the unobserved new loans by the observed corresponding stock of outstanding loans without inducing strong biases, as long as bank and time specific effects are included in the model; a solution that cannot be used when working with either time series or cross-section data. The validity of such a substitution, evaluated on a panel of 15 french large banks, observed over the period 1978-1992, and for which we have measures of both the new credit and the corresponding stocks, proves to be quite satisfactory .

Moreover, it is argued that, even when this approximation does not work well, there is no consequence for least squares estimates when credit is the dependent variable. When it is an explanatory one, it is still possible to get consistent estimates of the parameters by using instrumental variables or GMM estimation techniques.

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Table 1: Empirical evaluation of the approximation.

Dependent variable	R^2	F-Value	F value for time effects	F-value for indiv. effects
Total loans	0.858	68.43	4.47	337.98
Short term loans	0.869	74.84	2.49	379.74
Medium term loans	0.567	14.84	3.57	62.33
Long term loans	0.364	6.48	4.45	15.07

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