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Estimation of Temporal Characteristics of Accounts for Empirical Research

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There is a massive foreign currency translation literature, but virtually no empirical research exists that describes the results of applying alternative translation methodologies or which tests such methodologies against normative criteria. Empirical price level research and other areas of research are also restricted by the inability of researchers to estimate the temporal characteristics of the accounts of sample companies. This paper presents a method for achieving this estimation and tests its validity.

All foreign currency translation methodologies require that certain accounts be translated at the historical rate, the exchange rate that was in effect at the point in time an asset was acquired, a liability was incurred, a revenue or expense was recognized, or an element of owners' equity was recorded. Such a point in time is referred to in the present study as a temporal reference. Since some account balances (such as fixed assets and long-term debt) are the result of numerous transactions over a considerable period of time, such account balances are made up of components, each consisting of a currency amount and a temporal reference. The set of all such components is referred to in the present study as the temporal characteristics of a specific account balance. This set thus represents and describes a distribution of ages and related currency amounts of the account balance.

Purpose of the Study

Thirty years ago, (Patz, 1981) stated that the previous fifty years saw many opinions about foreign currency translation accounting, but virtually no empirical research to support those opinions. It is not correct to state that no empirical research in foreign currency translation has been done during the pasts eighty years. But research that translates a sample of actual companies' accounts from one currency to another, using actual exchange rates, to describe what happens when different translation methodologies are used or to test methodologies against normative criteria is essentially nonexistent.

There are several reasons for this void in the literature, each of which can be overcome with the results of the present paper. Companies use one translation method at a time, some methods have not been used for many years, some plausible methods have never been used and, except for the cumulative translation gains or losses, the effects of translation are buried in the consolidated accounts. Moreover, obtaining the further temporally referenced item by item data required to construct comparable results under alternative methods would task the patience of the most cooperative of firms. For these reasons, no broadly comparative and temporally sustained study, involving reasonably large samples of real firm data, appears to be available.

This study provides an essential tool, the estimation of temporal characteristics of subsidiaries' accounts, that researchers need to begin to fill this vacuum of empirical insight into the reporting consequences of alternative translation methodologies, and ultimately to a determination of which methodology is best under various normative criteria.

It should be noted that the estimation method described herein can be applied to other areas of inquiry, such as alternative methods of accounting for price changes.

LITERATURE REVIEW

The foreign currency translation literature, spanning eighty years, is enormous. This review will therefore concentrate on two parts of the literature, early studies which relate directly to the present study and studies which represent some of the advances during the past decade.

Three early studies, relevant to the estimation of temporal characteristics, are (Petersen, 1971), (Davidson et al., 1976), and (Parker, 1977). The purpose of these models is to generate estimated general price level data, a process which requires estimation of the temporal characteristics of financial statement numbers. (Parker, 1977), representative of the three studies, reported the results of applying general

price-level accounting techniques, as described in the Financial Accounting Standards Board's (FASB's) December 1974 exposure draft. The general price-level techniques were applied to each of 1,050 U.S. companies over a period of three years. The relevance to the present study is that its methodology involves construction of computer programs intended to produce approximations of the ages (temporal references) of accounts.

(Ketz, 1978) tested the validity of these three models and concluded that there is no significant difference in results among the three models and that each of the three models is sufficiently accurate for research purposes. The three models tested by Ketz are limited in that they estimate only the average ages of assets and liabilities so that the temporal characteristics of these account balances are assumed to consist of a single component.

The following studies are notable and representative of studies done in the most recent decade. (Pinto, 2002) applied game theory to the issue of currency translation method choice. A model of decision-making under uncertainty was developed based on the positive accounting theory assumption that managers will act opportunistically in their own self-interest when adopting reporting methods. The choice between the temporal rate method and the current rate method depends on the identification of the functional currency of a foreign subsidiary. This choice is made by managers based on six GAAP criteria. Managers can generally manipulate the functional currency choice, and thereby determine whether the temporal rate method or the current rate method will be used for translation. In the game model, a manager could decide where to locate investments and which translation method to use. They could pick a low growth environment (a developed country) or a high growth environment (a developing country). There were four actual outcomes, unknown to the manager when the investment and accounting choice was made: large or small appreciation of currency and large or small depreciation of currency. The study concludes that managers would opportunistically adopt the current rate method when manager compensation is a function of reported earnings, and the temporal rate method when manager compensation takes the form of stock options.

(Louis, 2003) empirically examined the association between change in firm value and the foreign translation adjustment for manufacturing firms. The research design was based on a regression of two independent variables, reported net income and the changed in the change in translation adjustment against fiscal year return as the dependent variable. The sample consisted of multinational manufacturing firms that had a nonzero cumulative translation adjustment, a total of 4,972 observations over the study period 1985-2001. For firms in the manufacturing sector, accounting rules for currency translation usually result in financial statement numbers opposite to the economic effects of exchange rate variations. Thus, the translation adjustment was found to be associated with a loss of value instead of an increase in value.

In another empirical study, (Pinto, 2005) tested the value relevance of foreign currency translation adjustments in an earnings and book value model. An equity evaluation model was used in which the market value of equity is the dependent variable with book value of equity and net income as the independent variables. The study observed that foreign currency translation adjustments are significantly value relevant when their parameter estimates are allowed to vary in the cross-section.

(Kwon, 2005) tested whether local investors price foreign exchange risk differently than foreign investors. American Depositary Receipts (ADRs) were used to differentiate between the two investor groups. The key was to observe the rate of return of an ADR and compare it with the expected rate of return, using a model in which the expected rate of return equals the observed rate of return minus the sum of the rate of return on the underlying share and the exchange rate in US dollars per foreign currency unit. The study showed that foreign investors generally price exchange risk differently from local investors, and that the source and magnitude of differences in exchange risk pricing vary significantly across countries.

(Iatridis et al., 2005a) studied the motives of managements of U.K. firms in early adoption or deferment of SSAP 20 "Foreign Currency Translation." The study used the empirical and theoretical findings of other studies to form a conceptual framework which, in part, observed that the timing of the adoption was a matter related to the objectives of the managers in consideration of market and economic conditions. Further, income smoothing was possible because of the flexibility in financial reporting, but could be mitigated by appropriate standardization of accounting practice.

(Iatridis, 2005b) empirically studied the U.K. stock market response to the implementation of the 1983 U.K. Statement of Standard Accounting Practice (SSAP) No. 20. The stock market appeared to have anticipated the implementation of SSAP 20. There was a positive stock market response in the official year of adoption, resulting from the income-stabilizing effects of the standard. The study also observed a significant relationship between stock returns and the accounting measures in the actual adoption period of the aggregate set of adopters.

(Iatridis et al., 2006) found that early adopters of the U.K. Statement of Standard Accounting Practice No. 20 were generally larger firms. Managements tended to adopt when the adverse economic consequences of adoption were likely to be minimal. They deferred adoption of the standard to influence their financial performance.

(Liu, 2006) used an accounting-based equity valuation model for multinational firms to examine the forecasting and valuation properties of foreign currency translation gains and losses. It found that translation gains and losses could be subdivided into a core component and a transitory component. The combined effect was that translation gains and losses were more transitory than transitory earnings.

(Chambers et al, 2007) is an empirical study which investigated the relationship between the components of other comprehensive income and stock market returns. If the transparency required by SFAS #130 made it easier for stock investors to process relevant information, the other comprehensive income components should be more associated with stock market returns after SFAS #130 than before. The S&P 500 index was used as a sample and regressions were performed (with components of the other comprehensive income as independent variables and stock market returns as the dependent variable) over ten years, four years before SFAS 130 and six years after. The study provided evidence that other comprehensive income is priced by investors on a dollar-for-dollar basis. Two components of other comprehensive income, foreign currency translation adjustment and unrealized gains and losses on available-for-sale securities, were found to be priced by investors. But the study suggests that investors pay greater attention to other comprehensive information reported in the statement of changes in equity, rather than in a statement of financial performance.

ESTIMATION OF TEMPORAL CHARACTERISTICS

Inventory

The method of estimating the temporal characteristics of inventory depends on the cost flow assumption adopted by the individual firm. The current year's purchases (cost of goods sold minus the beginning inventory plus the ending inventory) were assumed to have occurred at mid-year. For those firms using FIFO or LIFO, the cost of goods sold were subtracted from the goods available for sale in either FIFO fashion or LIFO fashion to determine the temporal characteristics of the ending inventory. The dates of acquisition of components of inventory are not relevant to the weighted average inventory valuation method, so the temporal references were assumed to be the middle of the particular year for those firms using the weighted average method.

Fixed Assets

The information needed to determine the temporal characteristics of fixed assets includes: (1) the ending total balance reported each year on the balance sheet for fixed assets, (2) the cost of acquisitions each year, (3) the temporal references of acquisitions in each year, (4) the cost of retirements each year, (5) the temporal references of the retirements each year, and (6) the temporal characteristics of the fixed assets at the end of the base year. Factors (1), (2) and (4) are readily available from various sources, and factor (3) is available to the nearest year from various sources, but factors (5) and (6) are not known and have to be estimated.

To estimate factors (5) and (6), the assumption is made that plant assets are retired on a FIFO basis. The account balance in the base year is assumed to be made up of twenty equal-sized components with temporal

references distributed over the previous twenty years. Generating ten years of data prior to the study period minimizes the impact of this assumption.

In each subsequent year, additions are assumed to have occurred at the middle of the current year, an assumption that allows a maximum of only a six-month error in the temporal reference of any given addition. Retirements are assumed to occur in FIFO fashion. Although it seems reasonable that companies are more likely to retire older assets than newer ones, this does not always occur, and errors in the estimation of the temporal references are possible. The significance of such potential errors was tested as indicated in the validation section below.

Financial statements usually divide fixed assets into categories such as Land, Buildings, and Machinery and Equipment. The estimation method described above is applied to each of these categories to achieve greater overall accuracy. However, since additions and retirements are often disclosed for total fixed assets only, rather than for the categories, allocation among the categories is necessary.

An increase in the balance of a given category between balance sheet dates represents the minimum amount of additions to that category during the current period, and a decrease represents the minimum amount of retirements from the category. The amount of additions allocated among categories is therefore

$$AA = TA - MA_1 - MA_2 - \ldots - Ma_i$$

where AA = allocable additions,
TA = total additions for fixed assets, and
MA = minimum additions for categories 1 through i.

AA is allocated among the categories proportional to the relative balances in the various categories on the current balance sheet date. The amount of retirement for each category is calculated as follows:

$$R_i = B_i + MA_i + A_i - E_i$$

where R_i = the retirements for category i,
B_i = the beginning balance of category i,
MA_i = the minimum addition to category i,
A_i = the allocated addition to category i, and
E_i = the ending balance of category i.

Long-Term Debt

Footnotes to financial statements divide long-term debt into categories, such as various bond issues, term notes, lease obligations, and miscellaneous. To estimate the temporal characteristics of long-term debt, the following information is necessary: (1) the amount of debt by category, (2) the date(s) debt was incurred (3), the temporal reference(s) of new debt, and (4) the temporal reference(s) of debt retired. For some categories of long-term debt, notably bond issues, factors (1) and (2) are nearly always provided in financial statement footnotes, so that the temporal characteristics of these categories are usually known. Fortunately, bonds often comprise a major part of long-term debt.

For categories other than bonds, factor (2), temporal references, are often not given in footnotes. To determine these temporal references, it is necessary to know factors (3) and (4). Factor (3) is estimated by assuming that new debt (when the exact date is not given) was incurred at mid-year. To estimate factor (4), it is assumed that the oldest debt is retired first.

Since it is not necessarily true that the oldest debt is retired first, there is a potential for error in the estimation of temporal characteristics and therefore of the translated balance. The significance of such potential errors was tested and validated as indicated below.

Current Assets and Current Liabilities

The temporal characteristic of current assets and current liabilities can be assumed to be the balance sheet date. By definition, these assets and liabilities will be eliminated within the operating cycle of the company, which nearly always is considerably less than a year.

Other Long-Term Assets

The information provided in the footnotes to financial statements varies considerably among companies in regard to other long-term assets. To the extent that the temporal references of other long-term assets are disclosed, they should be used. However, when the temporal characteristics of long-term assets are not disclosed, the following heuristic can be used: if the total of the components of other long-term assets for which temporal references are not known increases between balance sheet dates, a new component equal to the increase is added. This new component is assumed to have been added at mid-year and therefore has a temporal reference of six months prior to the balance sheet date. If the total of the components of other long-term assets for which temporal references are not known decreases between balance sheet dates, this amount is subtracted from the component(s) with the oldest temporal reference(s) in FIFO fashion.

Paid-In Capital

The temporal characteristics of common and preferred stock, paid-in capital in excess of par, and treasury stock are often available in financial statement footnotes. If not, it is necessary to rely on the current and previous balance sheet figures to determine either a net increase or decrease for the period. Increases are assumed to have occurred at the middle of the current year. Decreases are assumed to have occurred in FIFO style. This lack of more precise information could lead to less accuracy in the estimation of the temporal characteristics of these accounts than in the estimation of the temporal characteristics of fixed assets, as some capital stock may have been issued many years in the past.

Retained Earnings

Retained earnings is a residual, balancing figure, and therefore no temporal characteristics need be estimated.

Validation

As indicated above, (Ketz, 1978) tested the validity of three early systems for estimating temporal characteristics: (Petersen, 1971), (Davidson and Weil, 1976), and (Parker, 1977). Ketz concluded that each of the three models is sufficiently accurate for research purposes. The estimation system described herein adds precision to these three systems, and it is therefore highly unlikely that its use would be less exact. However, an elaborate test was devised and executed as shown below.

It was not possible to test the estimation system described herein against the actual temporal characteristics of real companies. Specifically tested was whether unknown random variations in temporal references could result in significant errors in the translated numbers. The test focused on fixed assets and long-term debt, the elements of financial statements which are relatively large and which are therefore most liked to be distorted by random variations in temporal references.

Fixed Assets

The six factors needed to determine the temporal characteristics of fixed assets were listed above. Of these six, factors (5) and (6), the temporal characteristics of retirements and of the fixed assets at the end of the base year were not known.

Three companies were selected at random from Moody's Industrial Manuals (General Dynamics, Hershey Foods, and Ingersoll-Rand). Factors (1) through (4) were noted for each company for each of twenty consecutive fiscal years (1990 to 2009). The temporal characteristics of the plant assets were estimated using the proposed method, then the reported plant assets numbers were translated from British pounds to U.S. dollars, using the temporal principle of currency translation.

For each of the three actual companies, forty "hypothetical" companies' financial statements were generated, using the same factors (1) through (4), but randomizing factors (5) and (6). Although the method for estimating the temporal characteristics of fixed assets in the herein proposed estimating method assumes

that the oldest assets are retired first, the hypothetical companies disposed of fixed assets randomly. Further, the estimated method described in this paper assumed (arbitrarily) that the temporal characteristics of the plant assets in the base year consisted of twenty equal-sized components whose temporal references were the twenty fiscal year ends preceding the base year. The original distribution for the hypothetical companies, however, was determined by dividing the base year figure into one hundred equal parts which were spread randomly over thirty years.

Translations were performed, using actual exchange rates and the resulting temporally-referenced data for the latter ten years (2000-2009). Factors (5) and (6) were randomized 120 times (forty times for each of the three actual companies) to provide 120 hypothetical companies and a total of 1,200 comparisons (120 hypothetical companies over ten years). The results of the comparisons were as follows:

	Maximum Single Error (%)	Average Error (%)
General Dynamics	10.94	2.99
Hershey Foods	4.98	2.04
Ingersoll-Rand	6.36	3.40
Overall	10.94	2.81

Seventeen percent of the estimates resulted in a translation error of less than 1%, 74% in errors of less than 5%, 99% in errors of less than 10%, and none of the estimates results in translation errors of more than 10.94%. All of the companies for which the larger observed translation errors occurred were hypothetical companies in which the hypothetical management usually retired fixed assets which had been acquired within the last one or two years, leaving the older assets in service, in effect a worst-case scenario. Since it is intuitive that the oldest plant assets are more likely to be retired than newer ones, it can be concluded that the method of estimating the temporal characteristics proposed in this paper would result in less overall error than observed for these 1,200 hypothetical firms. It is also intuitive that the effect of the original (1990) distribution on the 2000 and subsequent years' distributions is minimal. In fact, the purpose of the first ten years of unused data is to minimize this effect.

Long-Term Debt

The temporal characteristics of the hypothetical companies' long-term debt consisted of: (1) those temporal characteristics reported in the three real companies' financial statements and (2) randomized temporal characteristics for the long-term debt amounts for which temporal characteristics were not disclosed. For the hypothetical companies, it was assumed that the long-term debt for which the temporal characteristics could not be determined from footnotes could have been issued at any time over a twenty-year period ending with the balance sheet date. The results of these comparisons were as follows:

	Maximum Single Error (%)	Average Error (%)
General Dynamics	7.34	2.15
Hershey Foods	16.01	5.75
Ingersoll-Rand	8.29	2.17
Overall	16.01	3.36

Three percent of the estimations resulted in less than a 1% error, 26% in less than 5% error, 94% in less than 15% error, and no errors greater than 16.01% occurred. The hypothetical companies for which the greater estimation errors occurred were companies whose hypothetical managements consistently preferred to liquidate new debt instead of old debt, the worst case scenario. Such action may be reasonable if newer debt carries higher interest rates, but old debt eventually matures and must be either paid or refinanced with new debt. For these reasons, it can be concluded that the overall error resulting from the application of the method of estimation used in the estimation method herein described is somewhat less than observed in this test.

Conclusion

The temporal characteristics estimation method described in this paper opens up the possibility for empirical as well as sophisticated simulation research in certain fields where such research was not possible in the past. The use of this method is not a trivial exercise, particularly when a large sample size of actual companies is needed. But computer programs can be written, in various languages, to facilitate the details of the process.

REFERENCES

Chambers, D., Linsmeier, T., Shakespeare, C., & Sougiannis, T. 2007. An evaluation of SFAS No. 130 comprehensive income disclosures. *Review of Accounting Studies*, 12: 557-593.

Davidson, S., Stickney, C., & Weil, R. 1976. Inflation accounting. A guide for the accountant and the financial analyst. New York: McGraw-Hill.

Iatridis, G., & Joseph, N. 2005a. A conceptual framework of accounting policy choice under SSAP 20. *Managerial Auditing Journal*, 20: 763-778.

Iatridis, G. 2005b. An empirical investigation of the U.K. stock market response to the implementation of SSAP 20 'foreign currency translation'. *Investment Management & Financial Innovations*, 2: 108-126.

Iatridis, G., & Joseph, N. 2006. Characteristics of U.K. firms related to timing of adoption of statement of Standard Accounting Practice No. 20. *Accounting & Finance*, 46: 429-455.

Ketz, J. 1978. The validation of some general price level estimating models. *Accounting Review*. 53: 952-960.

Kwon, T., Bae, S., & Chung, J. 2005. Do foreign investors price foreign exchange risk differently? *Journal of Financial Research*, 28: 555-573.

Liu, J. 2006. On international accounting valuation. *Journal of International Accounting Research*. 5: 67-87.

Louis, H. 2003. The value relevance of the foreign translation adjustment. *Accounting Review*, 78: 1027-1047.

Parker, J. 1977. Impact of price-level accounting. *Accounting Review*, 52: 69-96.

Patz, D. 1981. Price parity translation: Methodology and implementation. *Accounting and Business Research*, 21: 207-216.

Petersen, R. 1971. An examination of the effects of changes in the general price level. Unpublished Ph.D. dissertation, University of Washington.

Pinto, J. 2002. Foreign currency translation method choice: Insights from game theory. *Journal of Applied Business Research*, 18: 25-34.

Pinto, J. 2005. how comprehensive is comprehensive income? the value relevance of foreign currency translation adjustments. *Journal of International Financial Management & Accounting*, 16: 97-122.

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