ACCOUNTING TURNOVER RATIOS AND CASH CONVERSION CYCLE

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Abstract

Financial statements, and especially accounting ratios, are usually used to evaluate actual managerial performance and predict the consequences of their decisions (firm value or financial distress). For a better understanding of the empirical results, and to improve the correct evaluation of managerial decisions, it is necessary to establish a link between accounting ratios and concrete managerial decisions. This paper analyses the relationship established between accounting turnover ratios and the period of time spent concluding and operational process. In order to achieve this purpose, not only a set of possible averages of real conversion periods are defined, but also the conditions that guarantee that accounting turnover ratios offer a good approach to them are established. In general, the conditions which enable to approach accounting turnover ratios on good terms are difficult to accept in firms operating in growing or declining markets, with seasonal demand or with long operating cycles. On the other hand, some possible alternatives which, without needing more information, can help to measure real conversion periods of time in a more accurate way are also proposed and illustrated.

Keywords: Accounting, information, measurement, inventory control.

Introduction[2]

The recent research literature related to the analysis of accounting information can be classified into two fields: financial distress prediction and fundamental analysis.

The financial distress prediction research uses statistical techniques to classify firms into one of a number of mutually exclusive groups (Gombola, Haskins, Ketz and Williams, 1987; Platt and Platt, 1991, and, from another point of view, Retzlaff-Roberts, 1996).

On the other hand, fundamental analysis research tests which account information is the key value-driver that produces growth in corporate securities (Ou and Penman, 1989; Dechow, 1994 and Charitou, 1997).

In accordance with this belief in the utility of empirical research results, some authors have proposed to develop models with more theoretical content in order to increase the understanding of the results of empirical research. For instance, Lev and Thiagarajan (1993)[3], after the verifying that most of fundamental analysis is substantially a statistical search of the accounting information useful in security valuation, proposed to introduce "a search guided by theory or by experts; judgement as a natural extension of the statistical search procedure".

Following this idea, this work develops a theoretical interpretation of accounting turnover ratios. These ratios have been widely used in academic works[4] and professional practice[5]. The

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[3] See Lev and Thiagarajan (1993), page 191.

[4] See, for example, Williamson R. W. (1984).

[5] See Chen and Shimerda (1981).

underlying reason of their general acceptance consists in the fact that these ratios provide not only valuable information about working capital quality management, cash-generating ability of operations and short-term liquidity risk of a firm (Backer and Gosman, 1980; Stickney, 1993; Saccurato, 1994) but also about the operating efficiency level (Holstrom, 1994). On the other hand, in Ozcan and McCue (1996) a turnover ratio is considered in order to quantify a global financial performance index, and in Gombola, Haskins, Ketz and Williams (1987) and in Drake and Peavy (1995) turnover ratios have been tried to see whether they contain information useful in the prediction of future financial problems. Finally, the paper of Citron, Robbie and Wright (1997) illustrates how the lending bankers use restrictive ratio covenants (which include receivables days outstanding) in loan contracts.

This work starts by focusing on the turnover ratios and with their inverse interpreted as an approximation of the average days spent in an operational process[6]. These time variables integrate the global working capital time variable cash conversion cycle (net time-interval between actual cash expenditures on purchase of productive resources and the ultimate recovery of cash receipts from product sales):

(+)	Receivables conversion period
(+)	Inventory conversion period
(-)	Payment deferral period
(=)	Cash conversion cycle

The main objective here is to clarify the assumptions which must be posed to be able to deduce the amount of days spent completing an operational process from turnover ratios. Initially, in Section 1, different weighted averages of days that a group of units (commodities, sales or purchases, all three magnitudes which can be expressed not only in physical but also in monetary terms) have been in a concrete process until it has been completed are defined. After this, in Section 2, these averages of days are related to the usually employed accountant based turnover ratios. This relationship will allow us to evaluate the degree of reliability of the implicit assumptions made by the analyst who uses accounting information and turnover ratios in order to quantify the cash conversion cycle period. To support the discussion terms, and with the aim of offering the most correct possible solution we can find, an empirical application is presented as an illustration of the problems detected in the theoretical level (Section 3). This work concludes with presenting a synthesis of the main conclusions we have obtained.

1. Different possibilities in defining the real weighted average of days of inventory in process.

We will focus on the accounting period as the reference time in order to analyse the units (for example the inputs stock of raw materials) that have been processed. Raw materials are classified into three different groups:

a) Initial Stock:

Units which entered the previous period but which have not been consumed in starting the present accounting year, $\sum_{j=1-t}^{0} Q_j$, where Q_j is the value of the j batch. To simplify the notation, it will be assumed that all of these units leave the process before the conclusion of the

[6]This interpretation could be seen in textbooks -Foster (1986) pp. 68-69, research articles -Holmström (1994)- and ,specially, in Richards and Laughlin (1980).

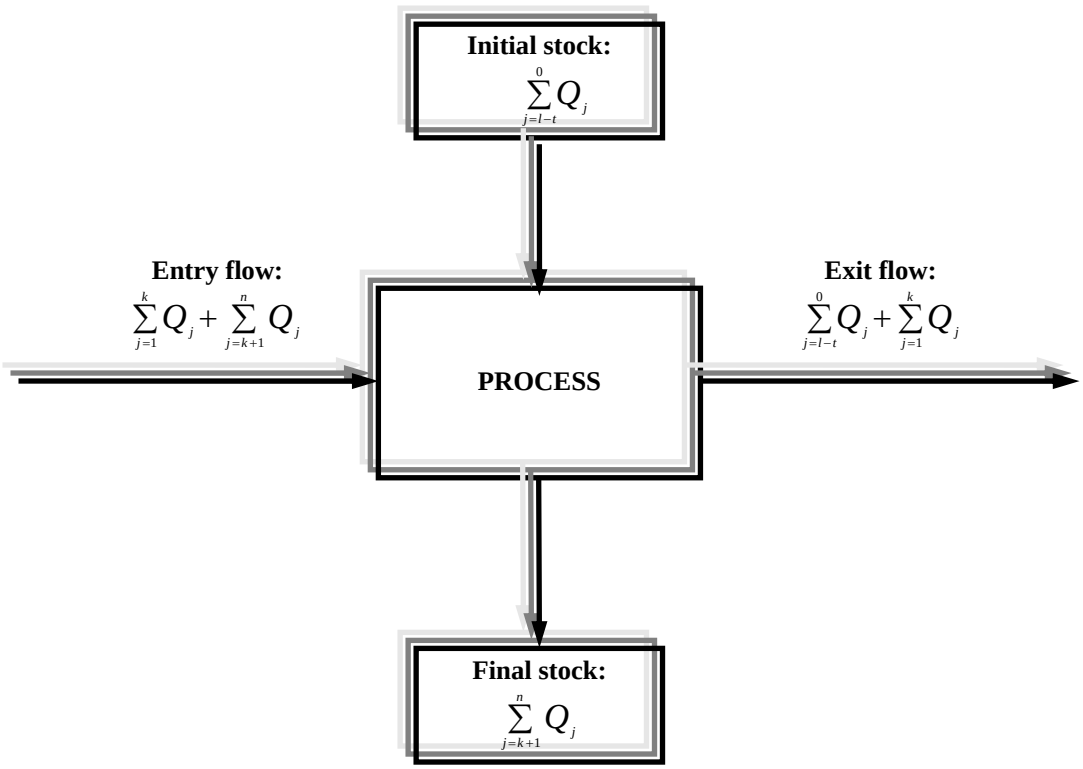
current accounting year. Those units which come in and go out of one process at the same time constitute a batch, and t is the number of batches with a date of entry previous to the current accounting year and a date of exit in the current period.

b) Units which enter and leave the process in the same period:

Their value is $\sum_{j=1}^{k} Q_j$, where k is the number of batches with entry and exit in the current accounting year.

c) Final Stock:

Those units which have registered the entry in the current period, but will be out during the next period. Their value is $\sum_{j=k+1}^{n} Q_j$, and n is the number of these batches.



Total flow: $\sum_{j=l-t}^{0} Q_j + \sum_{j=1}^{k} Q_j + \sum_{j=k+1}^{n} Q_j$

Flow of units which have registered entry and exit: $\sum_{j=1}^{k} Q_j$

Fig. 1. Current Accounting Year and Flows Considered

With the above classification, and taking into account different kinds of flows, alternative weighted averages of days (in Figure 1 we present the flows we are considering) can be defined.

In defining the time which batch j has been in the process as p_j, different weighted averages of days in one process, i.e., real average periods, can be computed:

Days Corresponding eo the Entry Flow

This average refers to the days, corresponding to current and next periods, in which the units which have been in the process have entered in the current accounting year. These days are weighted by the economic value of the units. So this average of days takes into account the units that enter the accounting year and leave this or the next year. That is to say:

$$p_{en} = \frac{\sum_{j=1}^{k} Q_j p_j + \sum_{j=k+1}^{n} Q_j p_j}{\sum_{j=1}^{k} Q_j + \sum_{j=k+1}^{n} Q_j} = \frac{\sum_{j=1}^{n} Q_j p_j}{\sum_{j=1}^{n} Q_j}.$$

Days Corresponding to the Exit Flow

This average comprises the units which have gone out of the current year. These days are weighted by the economic value of the units. So this average of days takes into account the initial stock and the units which enter and exit in the accounting year, algebraically:

$$p_{ex} = \frac{\sum_{j=1-t}^{0} Q_j p_j + \sum_{j=1}^{k} Q_j p_j}{\sum_{j=1-t}^{0} Q_j + \sum_{j=1}^{k} Q_j} = \frac{\sum_{j=1-t}^{k} Q_j p_j}{\sum_{j=1-t}^{k} Q_j}.$$

Days Corresponding to the Total Flow

We refers this average as the days, contained in the current period or in others, in which the units which have been in the process passed in it one or more days of the current accounting year. These days are weighted by the economic value of the units. So this average of days takes into account the initial stock and all of the units which have entered in the current accounting year, algebraically:

$$p_{to} = \frac{\sum_{j=1-t}^{0} Q_j p_j + \sum_{j=1}^{k} Q_j p_j + \sum_{j=k+1}^{n} Q_j p_j}{\sum_{j=1-t}^{0} Q_j + \sum_{j=1}^{k} Q_j + \sum_{j=k+1}^{n} Q_j} = \frac{\sum_{j=1-t}^{n} Q_j p_j}{\sum_{j=1-t}^{n} Q_j}.$$

Days Corresponding to the Units That Enter and Leave the Process in the Same Period

These days are defined as an average which computes the units that came in and went out of the process during the same period. These days are weighted by the economic value of the units. So this average of days takes into account only those units which enter and exit from the current accounting year, algebraically:

$$p_{fl} = \frac{\sum_{j=1}^{k} Q_j \, p_j}{\sum_{j=1}^{k} Q_j}.$$

Average of Days Corresponding to the Present Period

A weighted average that considers only the days corresponding to the current accounting year, p'j, during which all of the units have been in the process. In order to establish differences between the units that came in and went out during the accounting year ($p'_j = p_j$) and those which only came in or went out ($p'_j < p_j$), these units are weighted by coefficient (p'_j / p_j), algebraically:

$$p_p = \frac{\sum_{j=1-t}^{n} Q_j \, p'_j}{\sum_{j=1-t}^{n} Q_j \frac{p'_j}{p_j}} = \frac{\sum_{j=1-t}^{0} Q_j \, p'_j + \sum_{j=1}^{k} Q_j \, p_j + \sum_{j=k+1}^{n} Q_j \, p'_j}{\sum_{j=1-t}^{0} Q_j \frac{p'_j}{p_j} + \sum_{j=1}^{k} Q_j + \sum_{j=k+1}^{n} Q_j \frac{p'_j}{p_j}}.$$

The most important problem related to the averages which have just been defined is that the standard accounting systems do not provide any information related to the p days during which certain Q units have been in for a determined conversion period. For this reason, the experts have to approximate the average period of days using only financial account magnitudes. The problem is that this procedure implies the acceptance of some relationships that are far from been granted in advance. In the next section we shall describe what the implications and the real possibilities of the accounting information are to help in quantifying the average days of the true cash conversion cycle.

2. Accounting turnover ratios as an approximation of the real weighted average period.

In practice it is commonplace to use the accounting turnover ratios as a tool to approximate the average number of days. The accounting system generates information about the value of the initial stock, $\sum_{j=1-t}^{0} Q_j$; the final stock, $\sum_{j=k+1}^{n} Q_j$; the average daily stock[7] $As = \left(\sum_{j=1-t}^{n} Q_j \, p'_j \right) / 365$ and the value of the units which came in the process $\sum_{j=1}^{n} Q_j$ or those

[7]This information is not included in the financial statements, but, usually, can be easily extracted from the accounting information system.

that went out during the year $\sum_{j=1-t}^{k} Q_j$, that is to say, in the case of raw materials, those purchased and consumed.

With the aforementioned information, it is possible to compute these ratios:

$$a_{en} = \frac{As * 365}{EntryFlow} = \frac{\sum_{j=1-t}^{n} Q_j p'_j}{\sum_{j=1}^{n} Q_j},$$

$$a_{ex} = \frac{As * 365}{ExitFlow} = \frac{\sum_{j=1-t}^{n} Q_j p'_j}{\sum_{j=1-t}^{k} Q_j},$$

$$a_{to} = \frac{As * 365}{TotalFlow} = \frac{\sum_{j=1-t}^{n} Q_j p'_j}{\sum_{j=1-t}^{n} Q_j},$$

$$a_{ft} = \frac{As * 365}{Flowof\ unitsthathaveregistered\ entryand\ exit} = \frac{\sum_{j=1-t}^{n} Q_j p'_j}{\sum_{j=1}^{k} Q_j}.$$

Some of the former ratios are very extended and differ among themselves only in the flow which appears in the denominator[8]. As one can see, the accounting ratios, aen, aex, ato and afl do not coincide with any of the averages defined in the previous section, pen, pex, pto, pfl and pp.The reason is that these approximations are based on the accounting information that computes only the average daily stock of the current accounting year. The average days computed from the accounting turnover ratios consider, only as days of permanence of the units in the initial stock and in the final stock, those days during the current period, p'j, without considering the days corresponding to the previous or the following periods, (pj-p'j). Only in the average of days pp, we consider the days corresponding to the current accounting year, but in the denominator the weight of the initial and final stock is reduced, a correction which has not been carried out in the former accounting approximations is expressed.

If the initial and final stock were null, all of the theoretical average periods and accounting approximations would take on the same value: the average period corresponding to the units that have registered entry and exit during the current year (pfl). To sum up, the existence of

[8] Usually, the analyst quantifies the Receivables Conversion Period and the Payment Deferral Period by using aen and, on the other hand, the Inventory Conversion Period by means of aex . See, for instance, Richards and Laughlin (1980). This lack of homogeneity in choosing the flow could add degrees of imprecision to the cash conversion cycle analysis.

initial and/or final stocks makes it impossible to assure suitable strong similarities between any of the accounting turnover approximations and the weighted average of the cash conversion cycle (any exception must satisfy in each case the relationship shown in Appendix 1).

Despite these problems, it is important to consider that ratios ato and afl, not used in everyday practice, are the minimum and the maximum limit value, respectively, of the average of days in the year, pp, under feasible assumptions (see Appendix 2) of the average of days corresponding to the total flow, pto and also of the days corresponding to the units which enter and leave the process in the same period, pfl.

In conclusion, with only the accounting information none of the average periods defined in Section 1 can be computed, but it is possible to compute a maximum value (a_{fl}) and a minimum value (a_{to}) corresponding to the true value of three of the theoretical averages of days considered.

3. Empirical application.

As a way of illustrating the proposal included in previous section, financial statements of Martin Marietta Corporation will be used. These data have already been used in a former study which pointed out the crucial role of the different average periods when evaluating a firm's liquidity position (Richards and Laughlin, 1980). Assuming the propositions of Richards and Laughlin, we are concerned with the measurement problems of this average of days through the accounting information, more concretely the usual accounting based turnover ratio analysis. In this way, the possible errors committed are emphasized and, furthermore, some practical solutions to avoid, in part, these problems are proposed. In Table 1 the relevant information needed to compute the cash conversion cycle of Martin Marietta Corporation in four years[9], 0, 1, 2 and 3 is presented.

Table 1

Selected Financial Data for Our Case Study

	YEAR			
Year Ended December 31	**3**	**2**	**1**	**0**
Net sales	1,758	1,440	1,213	1,053
Cost of goods sold	1,269	1,030	876	774
Sales, general and administrative expense	192	161	142	132
Depreciation and amortisation	72	66	63	60
Total operating expense	1,533	1,257	1,081	966
Net operating income	225	183	132	87
Cash and short term investments	204	158	107	46
Notes and accounts receivable	283	227	178	147
Inventories	199	209	199	186
Prepayments and other current assets	16	11	11	14
Total current assets	702	605	495	393
Accounts payable	133	106	86	78
Salaries, benefits and payroll taxes	72	48	37	33
Income taxes	210	151	88	36
Current maturities of long-term debt	14	16	16	14
Total current liabilities	429	321	227	161

[9] The data was extracted by Richards and Laughlin (1980) from the Annual Report to Stochholders, 1978, and the reports to the SEC in 1975 and 1976.

Source: Richards and Laughlin (1980)

With the information in the table, the cash conversion cycle derived from accounting turnover ratios can be computed.

Table 2

Cash Conversion Cycle for Our Case Study

Accounting Approximation by Entry Flow, A_{en}

	YEAR		
Year Ended December 31	**3**	**2**	**1**
Accounting Turnover Ratios:			
Receivables Turnover	6.89	7.11	7.46
Inventory Turnover	6.17	5.10	4.62
Payables Turnover (*)	8.14	8.60	8.70
Cash Conversion Cycle:			
Receivables Conversion Period	53 days	51 days	49 days
Inventory Conversion Period	59 days	72 days	79 days
Operating Cycle	112 days	123 days	128 days
Payment Deferral Period	- 45 days	- 42 days	- 42 days
Cash Conversion Cycle	67 days	81days	86 days

Accounting Approximation by Exit Flow, A_{ex}

	YEAR		
Year Ended December 31	**3**	**2**	**1**
Accounting Turnover Ratios:			
Receivables Turnover	6.67	6.87	7.27
Inventory Turnover	6.22	5.05	4.55
Payables Turnover (*)	7.86	8.38	8.60
Cash Conversion Cycle:			
Receivables Conversion Period	55 days	53 days	50 days
Inventory Conversion Period	59 days	72 days	80 days
Operating Cycle	114 days	125 days	130 days
- Payment Deferral Period	- 46 days	- 44 days	- 42 days
Cash Conversion Cycle	68 days	81 days	88 days

(*) Cost of goods sold plus sales, general and administrative expenses divided by accounts payable plus salaries, benefits and payroll taxes.

Due to the fact that information about the daily average stock of inventories, receivables or payables is not possessed, these must be approximated as the average between initial and final stocks[10]. The first doubt that appears is which accounting turnover ratio should be used, the entry

[10]Richards and Laughlin (1980) implicitly use final stocks as a proxy of daily average stock.

(aen) or the exit (aex) flow version[11].The decision is not trivial since, with the exception that the initial existence is equal to the final existence, there could be differences between the days calculated by one method or another. Thus, the accounting approach that uses the entry flow will be superior to that which uses the exit flow when the initial stock is superior to the final stock. These differences increase when, in the same way, the differences between initial and final stocks increase, the ratio aex is great, and the entry flow is minor, analytically,

$$a_{en} - a_{ex} = \frac{Initial\,Stock - Final\,Stock}{Entry\ flow} a_{ex} = \frac{Initial\,Stock - Final\,Stock}{Exitflow} a_{en}\,.$$

The decision criteria in choosing the correct accounting ratio would be related to the one which best approximates one of the theoretical averages defined in Section 1. In other words, which of the assumptions defined in Section 1 contains more degrees of reliability. In our case, since it is very difficult to guarantee which of the assumptions is the most credible, the Receivables Conversion Period, the Inventory Conversion Period and the Payment Deferral Period with the entry (aen) and exit (aex) flow accounting versions are computed. As can be seen in Table 2, the differences are less than two days in all cases because the difference between initial and final stock in relation to entry or exit flow is negligible.

The analysis carried out in the previous section has shown that none of the previously calculated ratios could be interpreted as a weighted average of days which a number of units have been in a concrete process. The only information which is possible to extract is the interval of values between which three of the five average periods defined in Section 1 could be included in. As can be seen in Table 3, the Receivables Conversion Period in Year 3, could vary between 47 and 63 days, it could be 6 days under or 10 days above that calculated through the entry flow, which is 53 days, or 8 days under or above that which is calculated through the exit flow, which is 55 days. As one can appreciate, in Year 1 the intervals of the error vary between 37 days in the case of the Inventory Conversion Period and 10 days of the Payment Deferral Period. These intervals grow when the Cash Conversion Cycle is calculated; for example, for the Year 3, it could vary between 46 and 88 days, an interval of oscillation of 42 days.

Table 3

Maximum and Minimum Values of Cash Conversion Cycle

	YEAR		
MAXIMUM VALUE	**3**	**2**	**1**
Receivables Conversion Period (a_{fl})	63 days	61 days	57 days
Inventory Conversion Period (a_{fl})	70 days	90 days	102 days
Operating Cycle	133 days	151 days	159 days
- Payment Deferral Period (a_{tol})	- 45 days	- 38 days	- 38 days
Cash Conversion Cycle	88 days	113 days	121 days
	YEAR		
MINIMUM VALUE	**3**	**2**	**1**
Receivables Conversion Period (a_{to})	47 days	46 days	44 days
Inventory Conversion Period (a_{tol})	51 days	60 days	65 days
Operating Cycle	98 days	106 days	109 days

[11]We can also consider the total (ato) and the period (afl) flow, but in practice these ratios are not used.

- Payment Deferral Period (a_{fl})	- 52 days	- 49 days	- 48 days
Cash Conversion Cycle	46 days	57 days	61 days
	YEAR		
INTERVAL OF POSSIBLE VALUES	**3**	**2**	**1**
Receivables Conversion Period	16 days	15 days	13 days
Inventory Conversion Period	19 days	30 days	37 days
Operating Cycle	35 days	45 days	50 days
- Payment Deferral Period	7 days	11 days	10 days
Cash Conversion Cycle	42 days	56 days	60 days

The presented results show some links between the interval of variation of the possible values of the theoretical periods of stay, (pp, pto, pfl), and the accounting approaches through the flow of entries or exits, (aen, aex). That is to say, the more value for the accounting approaches the more value for the interval of variation[12,]

$$a_{to} - a_{ft} = \frac{365}{2}\frac{(initial\,stock + final\,stock)^2}{(total\ flow)(exercise\ flow)} = \frac{2}{\frac{365}{4}\left(\frac{1}{a_{en}} + \frac{1}{a_{ex}}\right)^2 - \frac{1}{365}}.$$

This situation is given because the weight of the initial and final stock inside the total flow of units decreases. In accordance with this idea, it is possible to increase the precision degree in the calculation of the theoretical periods by reducing the intervals of variation gathering the information of diverse years. Then, grouping several years together means that the weight of the initial and final stock inside the flow of total units is minor and it therefore diminishes the possibilities of error in the calculation of the average of days.

Table 4

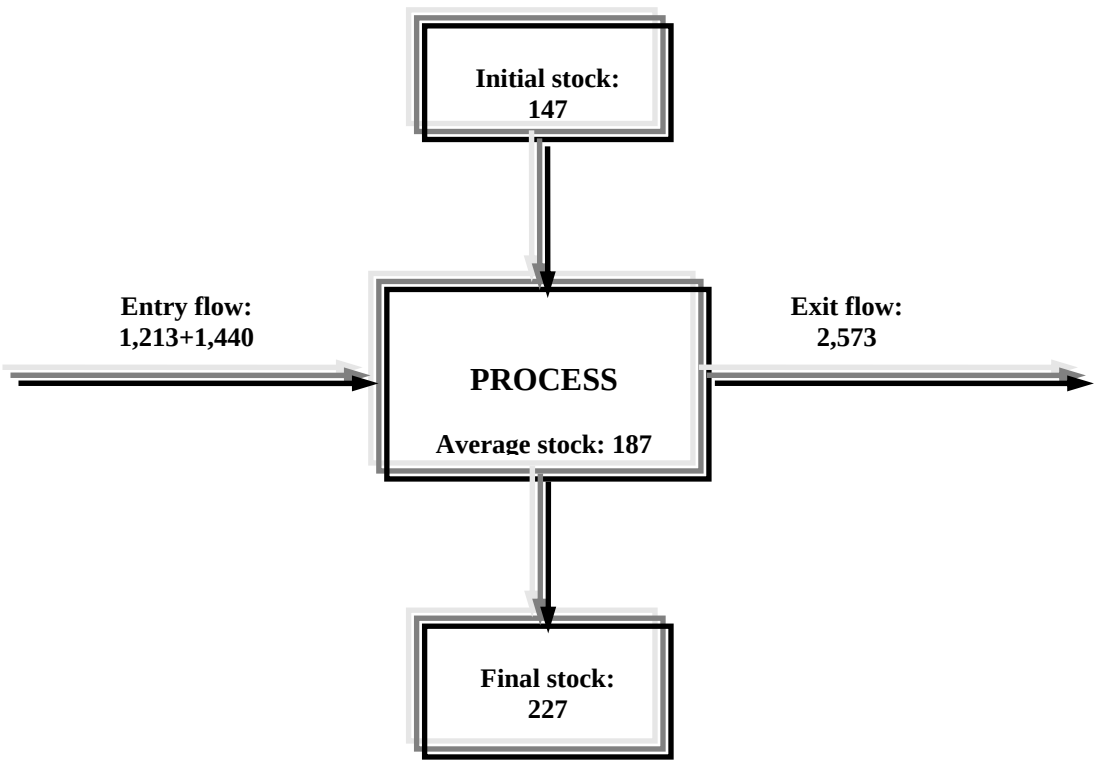
Cash Conversion Cycle with Reduced Error Term

	YEAR	
MAXIMUM VALUE	**(3+2)**	**(2+1)**
Receivables Conversion Period (a_{fl})	58 days	56 days
Inventory Conversion Period (a_{fl})	69 days	84 days
Operating Cycle	127 days	140 days
- Payment Deferral Period (a_{fitol})	- 43 days	- 42 days
Cash Conversion Cycle	84 days	98 days
	YEAR	
MINIMUM VALUE	**(3+2)**	**(2+1)**
Receivables Conversion Period (a_{to})	50 days	49 days
Inventory Conversion Period (a_{tol})	58 days	68 days
Operating Cycle	108 days	117 days

[12]We have considered that the average stock is equal to the average value of the initial and final stock.

-Payment Deferral Period (a_{fil})	-49 days	-47 days
Cash Conversion Cycle	59 days	70 days

The results obtained in aggregating years are presented in Table 4. To do this the flows corresponding to subsequent years are defined. Figure 2 presents the addition of receivables flows corresponding to Years 1 and 2 and Figure 3 the flows corresponding to Years 2 and 3.



Total flow: 2,800

Flow of units which have registered entry and exit: 2,426

Fig. 2. Flows Considered in Receivables Adding Years 1 and 2

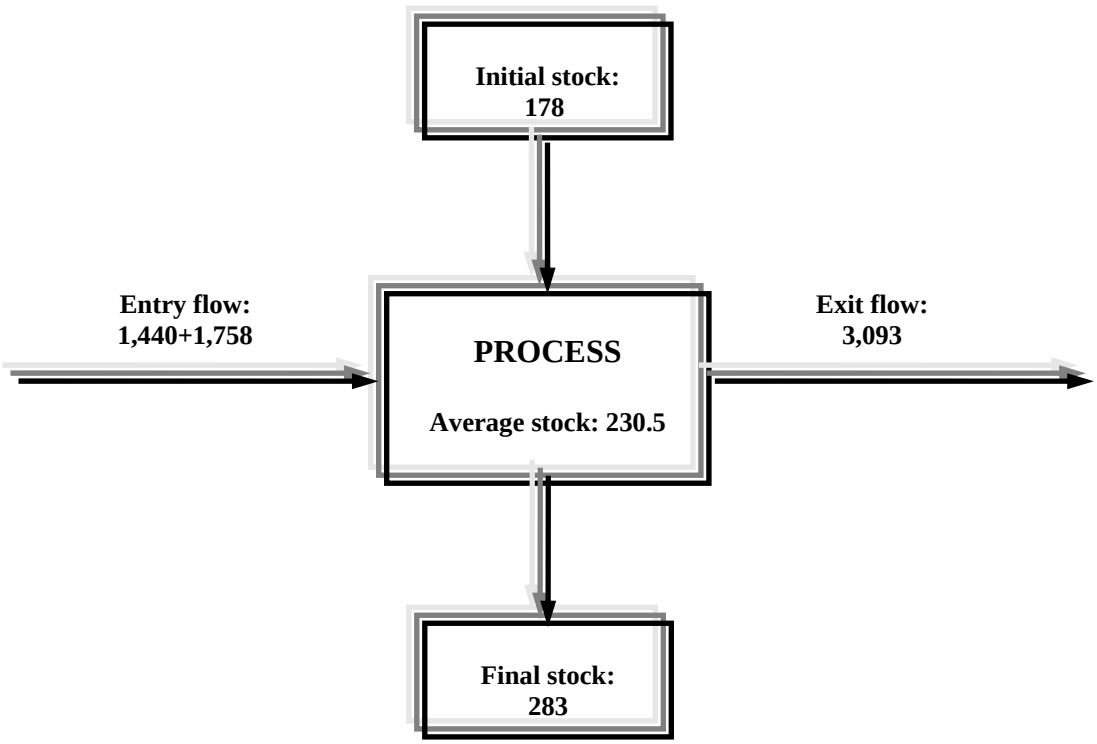


Fig. 3. Flows Considered in Receivables Adding Years 2 and 3

Table 4 shows that the interval of possible values corresponding to the Cash Conversion Cycle when we combine two years reduces the interval of possible values to half of the value presented in Table 3. In synthesis, taking periods of time with lengths of n years reduce the interval defined by the turnover accounting ratios n times, approximately, so it is possible to gain in precision. At the time of comparing different companies, or when we want to make predictions of the future, we could be interested in this increment in the precision of the interval. However, it also presents inconveniences, perhaps very important when the evolution of a concrete firm is evaluated, since the comparisons really are made between intervals of a minimum of n years. In the example shown in Table 4, one could only compare the evolution between Year 1 and Year 3, since Year 2 appears in all of the calculations.

Conclusion

This work has analysed the problems of evaluating the Cash Conversion Cycle through accounting information. To do so, different averages of days that a unit has been in a process have been defined. Afterwards, these definitions have been compared with the accounting approaches habitually used by analysts. One of the main contributions of this part of the work lies in showing the assumptions which are being carried out when the accounting approaches are interpreted as theoretical average periods which some units have been in in the operating process. The results show that in all of the cases assumptions must be carried out with a lack of knowledge about their

degree of fulfilment. The type of assumptions made seems to be more difficult to be fulfilled in the following situations:

a) In non steady state firms (firms which are growing or declining).
b) Firms devoted to activities which require maintaining long operating cycles.
c) Firms which, due to influential external factors, have non-stable working capital requirements.

It is interesting to highlight that the accounting information allows us to establish some limits between which some of the averages of defined days will vary, and that these limits will allow us to formulate a clearer interpretation of the accounting ratios.

Subsequently, a practical application of the proposed ratios has been carried out, with special emphasis on the problems of quantification. More specifically, the width of the intervals between which some of the theoretical average periods could vary is shown. The possibility of grouping the years considered in the average in order to gain precision in the calculation of the average periods analysed has also been proposed. This proposal has drawbacks, mainly, when the evolution of the Cash Conversion Cycle in a concrete company for a long period of time is analysed, since the comparisons are not carried out from year to year. In other words, a very precise quantification of the theoretical cash conversion cycle can be obtained, but the price to be paid is that the average period which must be considered contains periods of time which corresponds to two years or more. For this reason, this procedure is not very useful if we are interested in analysing the changes in the Cash Conversion Cycle with special focus on the very near short term periods of time.

Nevertheless, we believe that our proposal presents some interesting features which can be used by the analyst if increasing the reliability of the analysis is considered as a fundamental goal. So, then, if on a yearly basis the working capital management of two firms is being benchmarked, the differences between the periods derived from the accounting turnover ratios have to be taken note of with more interest if the interval of possible values (afl - ato) presents little differences rather than if these differences are big. In other words, as a tool in short term financial analysis, the interval could exercise as an indicator of degree of accuracy when we are quantifying the Cash Conversion Cycle using only external accounting information.

When the analyst has financial statements corresponding to several periods, this problem can be considerably reduced because he can reduce the interval of maximum and minimum values and, comparatively, he can also verify the impact of improvement or deterioration in the management of working capital magnitudes.

To conclude, our work has been directed towards providing additional tools for financial statements analysis in order to obtain a more accurate diagnosis or working capital management. Nevertheless, there are still some unsolved questions which need more attention in the future. Among them, a possible future extension could be how to make sure that conversion days measured by the same rules are being added: the receivables conversion period takes sales prices while the inventory conversion period is measured using operating costs rules.

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Appendix 1

Assumptions under Which the Accounting Approximations Will be Equal to the Different Average Days of Stay

	A_{to}	A_{en}	A_{ex}	A_{fl}
P_{to}	-	A	B	C
P_{en}	D	E	F	G
P_{ex}	H	I	J	K
P_{fl}	L	M	N	-
P_{p}	-	O	P	-

There is a letter only in those cases in which the condition of equality is more general than the case of initial and final stocks equal to zero.

A: $$\sum_{j=1}^{n} Q_j \;/\; \sum_{j=1-t}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{n} Q_j\, p_j$$

1. When the ratio between the entry flow and the total flow of units which were more than one day of the accounting year in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which have been present more than one day of the year in the process multiplied by the days, of this or other years, present.

B: $$\sum_{j=1-t}^{k} Q_j \;/\; \sum_{j=1-t}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{n} Q_j\, p_j$$

2. When the ratio between the exit flow and the total flow of units which were more than one day of the accounting year in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which have been present more than one day of the year in the process multiplied by the days, of this or other years, present.

C: $$\sum_{j=1}^{k} Q_j \;/\; \sum_{j=1-t}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{n} Q_j\, p_j$$

3. When the ratio between the units which came in and went out of the process during the year and the total flow of units which were more than one day of the accounting year in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which have been present more than one day of the year in the process multiplied by the days, of this or other years, present.

D: $$\sum_{j=1-t}^{n} Q_j \;/\; \sum_{j=1}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{n} Q_j\, p_j$$

4. When the ratio between the total flow of units which were more than one day of the accounting year in the process and the entry flow in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which came in during the process this year multiplied by the days, of this or other years, present.

E: $$\sum_{j=1-t}^{0} Q_j\; p'_j = \sum_{j=k+1}^{n} Q_j\,(p_j - p'_j)$$

5. When the sum of the initial stock multiplied by the days present in this year, is equal to the sum of final stocks multiplied by the days present in the next year.

F: $$\sum_{j=1-t}^{k} Q_j \;/\; \sum_{j=1}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{n} Q_j\, p_j$$

6. When the ratio between the units which came in and went out of the process during the year and the entry flow in the process is equal to the ratio of the sum of daily stock balance and the

sum of the value of the units which came in the process this year multiplied by the days, of this or other years, present.

$$\mathbf{G:} \sum_{j=1}^{k} Q_j \;/\; \sum_{j=1}^{n} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{n} Q_j\, p_j$$

7. When the ratio between the exit flow in the process and the entry flow of the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which came in the process this year multiplied by the days, of this or other years, present.

$$\mathbf{H:} \sum_{j=1-t}^{n} Q_j \;/\; \sum_{j=1-t}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{k} Q_j\, p_j$$

8. When the ratio between the total flow of units which were more than one day of the accounting year in the process and the exit flow in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which went out of the process this year multiplied by the days, of this or other years, present.

$$\mathbf{I:} \sum_{j=1}^{n} Q_j \;/\; \sum_{j=1-t}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{k} Q_j\, p_j$$

9. When the ratio between the entry flow of units in the process this year and the exit flow in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which went out of the process this year multiplied by the days, of this or other years, present.

$$\mathbf{J:} \sum_{j=k+1}^{n} Q_j\, p'_j = \sum_{j=k+1}^{0} Q_j\,(p_j - p'_j)$$

10. When the sum of the final stock multiplied by the days present in this year, is equal to the sum of initial stocks multiplied by the days present in the year before.

$$\mathbf{K:} \sum_{j=1}^{k} Q_j \;/\; \sum_{j=1-t}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1-t}^{k} Q_j\, p_j$$

11. When the ratio between the units which came in and went out of the process during the year and the exit flow in the process is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which went out of the process this year multiplied by the days, of this or other years, present.

$$\mathbf{L:} \sum_{j=1-t}^{n} Q_j \;/\; \sum_{j=1}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{k} Q_j\, p_j$$

12. When the ratio between the total flow of units which were more than one day of the accounting year in the process and the units which came in and went out of the process during the year is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which came in and went out of the process during this year multiplied by the days present.

$$\mathbf{M:} \sum_{j=1}^{n} Q_j \;/\; \sum_{j=1}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{k} Q_j\, p_j$$

13. When the ratio between the entry flow in the process during the year and the units which came in and went out of the process during the year is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which came in and went out of the process during this year multiplied by the days present.

$$\mathbf{N:} \sum_{j=1-t}^{k} Q_j \;/\; \sum_{j=1}^{k} Q_j = \sum_{j=1-t}^{n} Q_j\, p'_j \;/\; \sum_{j=1}^{k} Q_j\, p_j$$

14. When the ratio between the exit flow of the process during the year and the units which came in and went out of the process during the year is equal to the ratio of the sum of daily stock balance and the sum of the value of the units which came in and went out of the process during this year multiplied by the days present.

$$\mathbf{O:} \sum_{j=1-t}^{0} Q_j\,(p'_j / p_j) + \sum_{j=k+1}^{n} Q_j\,(p'_j / p_j) = \sum_{j=k+1}^{n} Q_j$$

15. The sum of the initial and final stocks balanced by the ratio between the days of this year present, p'_j,and the total days present, is equal to the final stock.

P: $$\sum_{j=1-t}^{0} Q_j (p'_j / p_j) + \sum_{j=k+1}^{n} Q_j (p'_j / p_j) = \sum_{j=1-t}^{0} Q_j$$

16. The sum of the initial and final stocks balanced by the ratio between the days of this year present, p'_j,and the total days present, is equal to the initial stock.

Appendix 2

Assumptions under Which Accounting Ratios a_{to} and a_{fl} are the Inferior and Superior Limits of the Average Periods of Presence p_{to}, p_{fl}, and p_p.

1) Ratio ato will be always less than or equal to the value of the average days of stay of the yearly total flow pto.

2) Ratio af will be greater than or equal to the value of the average days of presence of the yearly total flow pto, when:

$$\sum_{j=1-t}^{0} Q_j \left(1-\frac{p_j - p'_j}{p_t}\right) + \sum_{j=k+1}^{n} Q_j \left(1-\frac{p_j - p'_j}{p_t}\right) \geq 0$$

a) The balanced average days of presence only in the previous year of the initial stocks is not greater than the average days of presence of the yearly total flow.

b) The balanced average days of presence only in the next year of the final stocks is not greater than the average days of presence of the yearly total flow.

Proposition 2 is also true if one of the conditions, a) or b), is not fulfilled, but their absolute value is less than the absolute value of the other condition.

3) Ratio ato will be less than or equal to the value of the average days of presence of the units which came in and went out during the year pfo, when:

$$\sum_{j=1-t}^{0} Q_j \left(1-\frac{p'_j}{p_f}\right) + \sum_{j=k+1}^{n} Q_j \left(1-\frac{p'_j}{p_f}\right) \geq 0$$

a) The balanced average days of presence only in this year of the initial stocks is not greater than the average days of presence of the units which came in and went out during the year.

b) The balanced average days of presence only in this year of the final stocks is not greater than the average days of presence of the units which came in and went out during the year.

Proposition 3 is also true if one of the conditions, a) or b), is not fulfilled, but their absolute value is less than the absolute value of the other condition.

4) Ratio afl always will be greater than or equal to the value of the average days of presence of the units which came in and went out during the year pfl.

5) Ratio ato always will less than or equal to the value of the average days of presence in the year pp.

6) The ratio afl always will be greater than or equal to the value of the average days of presence in the year pp.

All of these relations could be obtained with some algebra. The authors will make all of the information requested available.