ARTICULATED ACCOUNTING: ACCRUALS, CASH FLOW AND THE DOUBLE-ENTRY CONSTRAINT ON EARNINGS

Ehsan Khansalar
Kingston Business School
and
Stuart McLeay
Lancaster University Management School

ABSTRACT

Motivated by comments by the FASB, IASB and CFA Institute on the need for greater articulation in financial reporting, this paper explores a model design for explicitly articulated financial statement variables. The estimation of articulated earnings components described in this paper uses a system of structural regressions, where the framework of simultaneous linear equations allows for the most basic property of accounting – double entry – to be incorporated within the model as a constraint that recognizes the zero-sum articulation of financial statement variables.

INTRODUCTION

In principle, financial statements should articulate, and the underlying double-entry logic should hold across the different statements that are prepared. For example, at a basic level, sales revenues in the income statement and cash collections from customers in the cash flow statement should reconcile with the movement in trade receivables in the balance sheet after allowing for write-downs. However, detailed articulations of this kind appear to be opaque to investors for most line items other than shareholders' equity (Moehrle et al., 2010; Casey et al., 2016). Indeed, representatives of the Chartered Financial Analysts' Institute, in their proposals for a comprehensive business reporting model, have commented that, for most companies, it is difficult for even the most skilled analyst to create a reliable direct method cash flow statement from existing reported data, and that even to approximate such a statement is time-consuming (CFA Institute, 2005). The real challenge, however, is not the great effort required but rather the fact that the articulation between the balance sheet and the income statement is almost always obscured, with most companies providing insufficient information to permit a skilled analyst to clearly identify the entries affecting accounts receivable in order to determine cash inflows from sales. Along similar lines, the International Accounting Standards Board stresses in its 2008 discussion paper on financial statement presentation (issued jointly with the Financial Accounting Standards Board) that entities need to disaggregate cash receipts and payments in a manner that helps users to better understand how those cash flows relate to information presented in the income statement and balance sheet (International Accounting Standards Board, 2008).

The present study reconciles a simplified and articulated cash flow statement with all line items in the income statement and the opening and closing balance sheets, and then estimates components of future earnings consistent with the accounting identities that govern financial statement articulation. The statistical model uses a system of structural regressions with a framework of simultaneous linear equations that allows for the most basic property of accounting – double-entry bookkeeping – to be incorporated as a constraint within the model. Although research into the estimation of earnings from other financial statement information continues unabated (e.g. Sloan, 1996; Barth et al., 1999; Barth, Cram and Nelson, 2001; Dechow, Richardson and Sloan, 2008; Cheng and Hollie, 2008; Dechow, Ge and Schrand, 2010; Lev, Li and Sougiannis, 2010; Arthur, Cheng and Czernkowski, 2010), the application of a suitably constrained model to capture full accounting identities in the earnings relation is relatively new (Christodoulou and McLeay, 2014). This study introduces a constraint on two components that comprise earnings and proposes a joint estimation that is based on the accounting identities governing each of these two components.

The explanatory variables are the balance sheet changes that make up the total accrual and the movements in shareholders' equity, and related cash flow items from an articulated cash flow statement. The paper is concerned primarily with the development of the accounting-based model, and the exploratory results demonstrate how the double-entry constraint yields results that are interpretable within the context of a full set of articulated financial statements.

THE DETERMINISTIC CHARACTER OF ACCOUNTING VARIABLES

As mentioned above, although the estimation of earnings from cash flow data is discussed comprehensively in published work to date, the statistical models applied in such studies do not consider the full set of financial statement variables that record the calculation and distribution of cash flow and earnings, nor the articulation between these variables. This section sets out the background to the present study and considers the concept of financial statement articulation and the implications for the accounting variables involved.

An early attempt to explore financial statement articulation was published by Charnes, Cooper and Ijiri (1963). Their method introduces the notion of constraints that articulate accounting variables using the core duality specification of debit and credit, illustrated for a small set of accounting variables. This is the same notion of articulation across financial statements that is employed in this study, and as outlined in the work of Mann (1984): a case study that demonstrates how the full set of accounting identities govern the basic financial statements. Mann's concern is primarily with the linkages between the beginning and ending balance sheets, the income statement and the cash flow statement, but his case study nevertheless reflects the key ideas on the implications of double entry to be found in the influential theoretical works discussed in Charnes et al. (1963), and which continue to be debated by Ijiri and his followers (see, for example, Demski et al., 2006).

Whilst Charnes et al. (1963) only briefly examine the possible relations between mathematics and double entry, Ellerman (1985) formalises the conventional accounting equation with respect to the duality principle, whereby the construction of positive and negative integers as ordered pairs corresponds to the debits and credits of double-entry bookkeeping in *T*-accounts. An important issue concerns the way in which such accounting numbers are appropriately signed, which is operationalised in Arya et al. (2000) by embedding the double-entry accounting structure in a matrix representing all of the firm's transactions, where debits to any account are denoted by +1, and credits are denoted by –1. We adopt this convention in the analysis reported in this paper.

Demski et al. (2006) point out that the duality of accounting variables not only records 'what' has happened but also 'why' it happened; that is, put simply, the record of what has taken place in the firm (a *Dr* or *Cr* entry) has its mirror reflection in why these things have occurred (the offsetting *Cr* or *Dr* entry). They develop this thinking into two key rules concerning the articulation of financial statements, which are the principles on which we also build in this paper:

Rule 1: Beginning balances + *increases* = *decreases* + *ending balances*

Rule 2: A change in an account cannot occur without causing a corresponding change in another account

Note that the value of any one of the accounting variables can be deduced using Rule 1 if the values of the other variables are already known. Indeed, the inference need not stop here. Having calculated a variable by deduction, this makes it possible for the inferential process to continue to other variables, with a domino-like effect resulting from the combination of Rules 1 and 2. For example, if the beginning and ending inventory is known, then as soon as an entry for the transfer out to cost of goods sold is recorded the purchases of inventory can be deduced using Rule 1. When the purchase is entered on the debit side of the inventory account, the same amount will be entered on the credit side of accounts payable, in accordance with Rule 2, thereby creating a chain reaction. It is this deterministic character of double-entry bookkeeping that underlies the model-building in the current paper, by constraining the estimation to reflect the relationship between accounting variables that is encapsulated in the two rules in Demski et al. (2006).

ARTICULATED ACCOUNTING

As indicated above, the approach taken in this study is to draw together into one model all accounting variables reported as financial statement line items in the opening and closing balance sheets, the income statement, and, by a process of deduction, a reconciling cash flow statement. Below, we explain the process of imposing signs onto the accounting variables employed, the articulation between these variables, the arrangement of the underlying accounting identities into structural equations linking explanatory variables and response variables, the generalised modelling framework that is involved, and the constraints that are imposed.

In order to operationalise the consequences of double entry among financial statement variables, appropriate signs are imposed on the variables, as mentioned, based on whether they arise from debit or credit entries in accounting journals: assets (debit balances) are presented as positives, and liabilities (credit balances) as negatives. Therefore an increase in assets takes the positive sign, and an increase in liabilities (and in equities) takes the negative, and vice versa for decreases. The result of imposing signs on balance sheet changes in this way leads to the zero summation of all balance sheet changes. Following the same logic, we also impose appropriate signs on the income statement variables and cash flow statement variables. For instance, credit entries recorded as sales (*SAL*) take the negative sign, and debit entries recorded as customer receipts (*REC*) take the positive sign. Likewise, debit entries recorded as cost of goods sold (*CGS*) take the positive sign, and credit entries recorded as supplier payments (*PAY*) take the negative sign. Again, the summation of all accounting variables is equal to zero in both the income statement and cash flow statement, and it follows that the summation of the full set of accounting variables is equal to zero.[1]

Table 1 provides a summary of all financial statement variables employed in this study, together with their three-letter variable names, specifying whether they are sums of positive (*Dr*) or negative (*Cr*) entries. The first two columns summarise the balance sheet changes and the income statement, and the last column contains the derived cash flow statement, which is computed by deduction from the appropriate line items in the other two statements.[2]

The Balance Sheet Identity

To begin with, it is worth considering the most basic accounting identity governing the duality of accounts, where total assets must equal the sum of total liabilities and total equities. This can be rearranged as the following zero-sum identity:

$$\text{Total Assets} - \text{Total Liabilities} - \text{Total Equities} \equiv 0 \tag{1.1}$$

Equation 1.1 makes explicit the convention adopted in this study, where all assets are positively signed and all liabilities and equities negatively signed. By allowing for short-term and long-term components of both total assets and total liabilities, the accounting identity may then be extended as:

TABLE 1: SIGN ALLOCATION TO FINANCIAL STATEMENT VARIABLES

Balance Sheet			**Income Statement**			**Cash Flow Statement**		
Assets (+), Liabilities (–)			*Expenses (+), Revenues (–)*			*Receipts (+), Payments (–)*		
Cash and short-term investments	*CSI*	+	Sales	*SAL*	–	Customer receipts	*REC*	+
Accounts receivable	*ARE*	+	Cost of goods sold	*CGS*	+	Supplier payments	*PAY*	–
Inventory	*INV*	+	Selling and administrative expenses	*SAE*	+	Other operating cash flow	*OOC*	–/+
Prepaid expenses	*PRE*	+	Other operating expenses	*OOE*	+	Exceptional cash flow	*ECF*	–/+
Other current assets	*OCA*	+	Extraordinary credits	*ECR*	–	Tax payments	*TXP*	–/+
Property, plant and equipment	*PPE*	+	Extraordinary charges	*ECH*	+	Capital expenditure [net of disposals]	*CED*	–/+
Long-term receivables	*LTR*	+	Other (income)/expenses	*OIE*	–/+			
Other investments	*OIN*	+	Income taxes	*ITX*	+	Debt issues [net of repayments]	*DIR*	+/–
Other long-term assets	*OLA*	+	Depreciation and amortization	*DDA*	+			
Accounts payable	*APA*	–	Interest expense on debt	*IED*	+	Net dividend [net of capital contribution]	*NDC*	–/+
Short-term debt	*STD*	–	Interest income	*IIN*	–			
Accrued payroll	*ACP*	–	Minority interest in earnings	*MIE*	+			
Income tax payable	*ITP*	–	Net income: profit (loss)	*INC*	+/–			
Other current liabilities	*OCL*	–						
Long-term debt	*LTD*	–						
Provision for risks and charges	*PRC*	–						
Deferred income	*DIN*	–						
Deferred tax	*DTX*	–						
Other long-term liabilities	*OLL*	–						
Shareholders' equity	*SEQ*	–						
Preferred stock	*PST*	–						
Minority interest	*MIN*	–						
Dividend payable	*DPA*	–						

$$\text{Current Assets} + \text{Long-term Assets} - \text{Current Liabilities} - \text{Long-term Liabilities} - \text{Total Equities} \equiv 0 \tag{1.2}$$

By extending Equation 1.2 further to incorporate all of the line items in the balance sheet, as presented in Table 1, the accounting identity can be fully specified as:[3]

$$CSI + ARE + INV + PRE + OCA + PPE + LTR + OIN + OLA - APA - STD - ACP - ITP - OCL - LTD - PRC - DIN - DTX - OLL - SEQ - PST - MIN - DPA \equiv 0 \tag{1.3}$$

Again, the double-entry articulation constraint on the full set of variables is implicit in Equation 1.3, given that the sum of these variables must equal zero.

The Income Statement

We use a simple subdivision of the income statement, whereby net income is equal to operating income before depreciation *plus* other revenues and expenses. Operating income before depreciation (*OID*) is computed as:

$$OID \equiv SAL - CGS - SAE - OOE \tag{2.1}$$

and other revenues and expenses (*ORE*) as:

$$ORE \equiv ECR - ECH + OIE - ITX - DDA - IED + IIN - MIE \tag{2.2}$$

As $OID + ORE$ is equal to net income (*INC*), it follows that the full identity for net income may be written as:

$$SAL - CGS - SAE - OOE + ECR - ECH + OIE - ITX - DDA - IED + IIN - MIE \equiv INC \tag{2.3}$$

We then rearrange the income statement as a zero-sum identity, consistent with the sign convention adopted in this paper, as set out in Table 1, whereby net income (*INC*) takes a positive sign when a profit or a negative sign when a loss:

$$- SAL + CGS + SAE + OOE - ECR + ECH - OIE + ITX + DDA + IED - IIN + MIE + INC \equiv 0 \tag{2.4}$$

The Cash Flow Statement

As mentioned in the Introduction, we calculate the articulated values in the cash flow statement directly from the reported values in the balance sheets and income statement, with embedded sign as shown in Table 1. Specifically, receipts in the cash flow statement take the positive sign and payments take the negative sign, revenues in the income statement take the negative sign and expenses the positive sign, and, from the opening and closing balance sheet, increases (decreases) in asset accounts take the positive (negative) sign, whilst increases (decreases) in liability and equity accounts take the negative (positive) sign. Taking this approach, we provide a demonstration below of the articulating condition for each of the eight cash flow statement line items listed in Table 1.

Customer Receipts

By articulating the change in accounts receivable (ΔARE) and customer receipts (REC) with sales (SAL), then the related zero-sum identity is expressed as follows:[4]

$$\Delta ARE - SAL + REC \equiv 0 \tag{3.1}$$

Supplier Payments

In the same way as the change in accounts receivable plus sales articulates with customer receipts, as shown above, then supplier payments (PAY) are derived from changes in accounts payable (ΔAPA) and purchases (PUR). The latter is computed as cost of goods sold (CGS) plus selling and administrative expenses (SAE), adjusted for changes in inventory (ΔINV) and changes in accrued payroll (ΔACP). In this case, the related zero-sum identity is the following:

$$\Delta INV - \Delta APA - \Delta ACP + CGS + SAE - PAY \equiv 0 \tag{3.2}$$

Other Operating Cash Flow

In addition to customer receipts and supplier payments, other operating cash flow (OOC) is computed from the changes in other current liabilities (ΔOCL), other current assets (ΔOCA), prepaid expenses (ΔPRE) and deferred income (ΔDIN), along with the related income statement item, other operating expenses (OOE). Based on the data analysed later in the paper, our default assumption is that other operating cash flow (OOC) is more likely to comprise net cash payments (–) than net cash receipts (+). Hence, the third cash flow statement zero-sum identity will be given as:

$$\Delta OCA + \Delta PRE - \Delta OCL - \Delta DIN + OOE - OOC \equiv 0 \tag{3.3}$$

Exceptional Cash Flow

Exceptional cash flow (ECF) is more likely to comprise net cash payments than net cash receipts and thus takes the negative sign by default. ECF is articulated with changes in other long-term assets (ΔOLA), other long-term liabilities (ΔOLL) and provision for risks and charges (ΔPRC), together with the income statement entries for extraordinary credits (ECR), extraordinary charges (ECH) and other (income)/expenses (OIE).[5] The zero-sum identity is given by:

$$\Delta OLA - \Delta OLL - \Delta PRC - ECR + ECH - OIE - ECF \equiv 0 \tag{3.4}$$

Tax Payments

The variables from which the cash flow statement item tax payments (TXP) is calculated are the changes in deferred tax (ΔDTX) and income tax payable (ΔITP), in addition to the related income statement entry for income taxes (ITX):

$$-\Delta DTX - \Delta ITP + ITX - TXP \equiv 0 \tag{3.5}$$

Capital Expenditure

The next variable in the summarised cash flow statement is capital expenditure (*CED*), which is net of asset disposals. *CED* is derived from the balance sheet changes in property, plant and equipment (ΔPPE), long-term receivables (ΔLTR) and other investments (ΔOIN), adding back the income statement charge for depreciation and amortization (*DDA*), as follows:

$$\Delta PPE + \Delta LTR + \Delta OIN + DDA - CED \equiv 0 \tag{3.6}$$

Debt Issues

The cash flow statement variable debt issues (*DIR*) is net of debt repayments, and also offsets related short-term investment flows. *DIR* is calculated from the balance sheet changes in short-term debt (ΔSTD), long-term debt (ΔLTD) and cash and short-term investments (ΔCSI), together with interest expense on debt (*IED*) and interest income (*IIN*) from the income statement:

$$\Delta CSI - \Delta STD - \Delta LTD + IED - IIN + DIR \equiv 0 \tag{3.7}$$

Net Dividend

The last variable in the cash flow statement is net dividend (*NDC*), which is stated net of any capital contribution. *NDC* is derived from the balance sheet changes in shareholders' equity (ΔSEQ), preferred stock (ΔPST) and minority interest (ΔMIN), together with the net profit (loss), i.e. net income (*INC*), as well as the minority interest in earnings (*MIE*) from the income statement:

$$-\Delta SEQ - \Delta PST - \Delta MIN - \Delta DPA + INC + MIE + NDC \equiv 0 \tag{3.8}$$

We are now able to complete the full articulation between all variables, which is based on the financial statement information for United States (US) companies stored in the Worldscope database. The comprehensive reconciliation is presented in Table 2, for the average firm-year 1995–2009, i.e. as the mean of 18,949 firm-year observations for each variable. The double-entry condition is evident in the zero sum for each single line item across financial statements, and for each separate financial statement, and for the table as a whole.

Restating Income as Cash Flows and Accruals

The main variables of interest are operating income before depreciation (*OID*) and other revenues and expenses (*ORE*), which are jointly estimated from their prior year cash flow components together with related accruals in the form of asset and liability changes. *OID* is computed as sales (*SAL*) *less* cost of goods sold (*CGS*), selling and administrative expenses (*SAE*) and other operating expenses (*OOE*), all of which are included in the accounting identities in Equations 3.1, 3.2 and 3.3. Thus, by substitution of the balancing items from each of these identities into Equation 2.1, we may rewrite *OID* to obtain the following cash flow and accrual representation:

$$\begin{aligned} OID \equiv\ & (\Delta ARE + REC) + (\Delta INV - \Delta APA - \Delta ACP - PAY) \\ & + (\Delta OCA + \Delta PRE - \Delta OCL - \Delta DIN - OOC) \end{aligned} \tag{4.1}$$

TABLE 2: ARTICULATION OF FINANCIAL STATEMENTS (US$000S)

Operating Accruals		$000s	Operating Income Before Depreciation		$000s	Operating Cash Flow		$000s	Sum
Δ Accounts receivable	Δ*ARE*	7,982	Sales	*SAL*	–535,680	Customer receipts	*REC*	527,698	0
Δ Payables net of inventory		–471	Purchases		452,114	Supplier payments	*PAY*	–451,643	0
Δ Inventory	Δ*INV*	5,001	Cost of goods sold	*CGS*	339,169				
Δ Accounts payable	Δ*APA*	–4,026	Selling and administrative expenses	*SAE*	112,945				
Δ Accrued payroll	Δ*ACP*	–1,446							
Δ Other items		–4,409	Other operating expenses	*OOE*	6,775	Other operating cash flow	*OOC*	–2,366	0
Δ Other current assets	Δ*OCA*	2,586							
Δ Prepaid expenses	Δ*PRE*	313							
Δ Other current liabilities	Δ*OCL*	–6,197							
Δ Deferred income	Δ*DIN*	–1,111							
Non-Operating Accruals		**$000s**	**Other Revenues and Expenses**		**$000s**	**Non-Operating Cash Flow**		**$000s**	**Sum**
Δ Other non-current items		13,332	Non-operating (income)/ expenses		11,112	Exceptional cash flow	*ECF*	–24,444	0
Δ Other long-term assets	Δ*OLA*	17,677	Extraordinary credits	*ECR*	–906				
Δ Other long-term liabilities	Δ*OLL*	–2,101	Extraordinary charges	*ECH*	14,385				
Δ Provision for risks and charges	Δ*PRC*	–2,244	Other (income)/expenses	*OIE*	–2,367				
Δ Tax deferrals and accruals		–304	Income taxes	ITX	15,458	Tax payments	*TXP*	–15,154	0
Δ Deferred tax	Δ*DTX*	–185							

(*Continued*)

TABLE 2: (*CONTINUED*)

Non-Operating Accruals		$000s	Other Revenues and Expenses		$000s	Non-Operating Cash Flow		$000s	Sum
Δ Income tax payable	*ΔITP*	–119							
Δ Long-term assets		15,510	Depreciation and amortization	*DDA*	22,598	Capital expenditure [net of disposals]	*CED*	–38,108	0
Δ Property, plant and equipment	*ΔPPE*	13,324							
Δ Long-term receivables	*ΔLTR*	46							
Δ Other investments	*ΔOIN*	2,140							
Δ Financial items		–9,476	Net interest		4,519	Debt issues [net of repayments]	*DIR*	4,957	0
Δ Cash and short-term investments	*ΔCSI*	8,899	Interest expense on debt	*IED*	7,341				
Δ Short-term debt	*ΔSTD*	–2,415	Interest income	*IIN*	–2,822				
Δ Long-term debt	*ΔLTD*	–15,960							
Δ Equities		–22,164	Income including minority interests		23,104	Net dividend [net of capital contribution]	*NDC*	–940	0
Δ Shareholders' equity	*ΔSEQ*	–60,681	Net income: profit (loss)	*INC*	22,757				
Δ Preferred stock	*ΔPST*	38,951	Minority interest in earnings	*MIE*	347				
Δ Minority interest	*ΔMIN*	–389							
Δ Dividend payable	*ΔDPA*	–45							
Sum of variable means		*0*			*0*			*0*	

Note: The source of all balance sheet and income statement data is Worldscope. Table 2 reports the firm-year average for each financial statement line item, for the estimation sample described in Table 3. The final row confirms that the variable means sum to zero; the sign allocation is described in Table 1. The final column shows the zero-sum articulation of balance sheet changes, related income statement line items, and, by deduction, cash flow statement line items.

Similarly, by substituting the balancing items from Equations 3.4–3.7 into Equation 2.2, together with the equity identity in Equation 3.8 (which is adjusted for *INC* in order to specify the minority interest in earnings), we obtain the following cash flow and accrual representation of *ORE*:

$$\begin{aligned} ORE \equiv\ & (\Delta OLA - \Delta OLL + \Delta PRC - ECF) - (\Delta DTX + \Delta ITP + TXP) \\ & + (\Delta PPE + \Delta LTR + \Delta OIN - CED) + (\Delta CSI - \Delta STD - \Delta LTD + DIR) \\ & - (\Delta SEQ + \Delta PST + \Delta MIN + \Delta DPA - NDC + INC) \end{aligned} \tag{4.2}$$

A STRUCTURAL MODEL WITH DOUBLE-ENTRY ARTICULATION CONSTRAINT

To account for the structured information set that has been assembled, a generalised system is employed for explaining earnings using prior cash flows and accruals, based on lagged values of the accounting identities for operating income before depreciation and other revenues and expenses, as derived in Equations 4.1 and 4.2, with the deterministic relationships of accounting articulation arising from double entry introduced into the system as a constraint.

The response variables are drawn from the financial statements of each firm *i* in year *t*, and the explanatory variables are lagged variables from the prior year's financial statements. The double-entry articulation constraint is applied to the parameters on these lagged accounting variables, so that the coefficients add up to zero, and the accounting outputs therefore obey the same rules as the accounting inputs. The autoregression process that is assumed here is restrictive, but it serves two purposes. First, the data that we model are drawn from financial statements that systematically contrast the current period with prior-period comparatives, including explicit reconciliations of movements from one financial position to the next. Second, the earnings-based research that motivates this paper, as cited in the Introduction above, mainly involves one-period estimating models. Hence the joint autoregression of order one in *OID* and *ORE* used as the base model here, adapted for the double-entry articulation constraint suggested in the econometric analysis of Christodoulou (2015), and presented (in summary form) in Equation (5) below:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} OID_{it} \\ ORE_{it} \\ 0 \end{bmatrix} = \begin{bmatrix} \beta_{\Delta ARE} & \cdots & \beta_{OOC} & 0 & \cdots & 0 \\ 0 & \cdots & 0 & \beta_{\Delta OLA} & \cdots & \beta_{NDC} \\ \beta_{\Delta ARE} & \cdots & \beta_{OOC} & \beta_{\Delta OLA} & \cdots & \beta_{NDC} \end{bmatrix} \begin{bmatrix} \Delta ARE_{it-1} \\ \vdots \\ OOC_{it-1} \\ \Delta OLA_{it-1} \\ \vdots \\ NDC_{it-1} \end{bmatrix} + \begin{bmatrix} \gamma_{10} & \gamma_{1j} \\ -\gamma_{20} & -\gamma_{2j} \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ J_{it} \end{bmatrix} + \begin{bmatrix} u_{1\,it} \\ u_{2\,it} \\ 0 \end{bmatrix} \tag{5}$$

Specifically, the first row of the above matrix represents a regression of operating income before depreciation (OID_{it}) on lagged values of the eleven cash flow and accrual variables in Equation 4.1, from the change in accounts receivable ($\Delta ARE_{it\text{-}1}$) through to other operating cash flow ($OOC_{it\text{-}1}$). The regression in the second row is on lagged values of the twenty cash flow and accrual variables in Equation 4.2, from the change in other long-term assets ($\Delta OLA_{it\text{-}1}$) through to the net dividend ($NDC_{it\text{-}1}$), excluding the balancing income statement variable (*INC*) in Equation 4.2. The structural coefficients allow for the inclusion of model intercepts γ_{10} and γ_{20}, together with industry binary indicators for sector $j = 1$ to J. The intercept and industry coefficients are the same across the two equations, but with opposite sign. The final equation provides the double-entry articulation constraint, that the sum of the thirty-one response coefficients is zero, such that the estimated marginal contributions obey the laws of double entry where the sum of debit entries equals the sum of related credit entries.

Each one of OID_{it} or ORE_{it} is a valid least squares equation (regression) on its own, and can be estimated separately as an appropriately identified and constrained regression; however, using the structural model with two joint equations, as presented above, it is unrealistic to expect that the equation errors (u_{1it} and u_{2it}) would be uncorrelated, particularly when the explanatory variables for both equations are linked through a zero-sum identity, as is the case in the sample estimations on which we report below.

SAMPLE SELECTION AND DATA

Sample Selection

The initial usable sample, referred to in Table 3, is 24,025 firm-year observations, which includes all firm-year panels between 1995 and 2009, and excludes firm years where there are missing values for either the dependent or independent variables. A sample of US listed firms is employed in order to make use of the high level of disaggregation in income statement and balance sheet data in available databases.

The first step in preparing this form of dataset, given the observations that are downloaded, is to ensure that the balance sheet balances and that the income statement adds up correctly. This involves imposing signs onto the variables, as described above, based on their accounting formulation (*Dr* or *Cr*). Interestingly, we find in some cases that the summation is close to zero, but not precisely equal to zero (between +\$10 and –\$10). Observations for which the sum of the balance sheet or income statement is not between +\$10 and –\$10 (3,302 observations) are taken out of the usable sample, but any small remaining discrepancies are rounded into the cash flow statement derivations. Note that whilst such errors may be due to mistaken transcription by the data provider, and similar processing errors, the most common cause is the lack of disaggregation in source financial statements, which can leave some lower-level cells empty in the database. Hribar and Collins (2002) make reference to the same issue when they note how measurement errors can arise during the computation of additional variables.

A further 748 observations are dropped because they have inconsistent signs, e.g. zero or negative sales ($SAL \leq 0$); a list of the rational signs required of all variables is presented in Panel B of Table 3.

The final step identifies those observations in the sample that unnecessarily distort the estimation, using the same criteria regarding studentized residuals as

TABLE 3: CONSTRUCTION OF THE ESTIMATION SAMPLE

Panel A: Outliers, Infrequent Observations and Inconsistent Signs

Initial usable sample	24,025
Firm-years where financial statement identities do not hold	–3,302
Inconsistent signs (see Panel B)	–748
Number of outliers in first estimates of *OID*	–547
Number of outliers in first estimates of *ORE*	–479
Estimation sample, 1995–2009	*18,949*

Panel B: Rational Signs for the Usable Sample

$SAL \leq 0$*	$PRE \geq 0$	$ACP \leq 0$	$LTD \leq 0$
$CGS \geq 0$	$OCA \geq 0$	$ITP \leq 0$	$PRC \leq 0$
$SAE \geq 0$	$LTR \geq 0$	$DPA \leq 0$	$DIN \leq 0$
$CSI \geq 0$	$OIN \geq 0$	$OCL \leq 0$	$OLL \leq 0$
$ARE \geq 0$	$PPE \geq 0$	$STD \leq 0$	$MIN \leq 0$
$INV \geq 0$	$OLA \geq 0$	$APA \leq 0$	$PST \leq 0$

* The sales variable was further restricted to $SAL \geq \$1$m, in order to remove the smallest firms from the sample, following Lev et al. (2010).

Panel C: Industry Distribution

Sector	**Number of Observations**
Basic materials	659
Consumer goods	2,568
Consumer services	2,712
Health care	2,969
Industrials	4,792
Oil and gas	782
Technology	4,467
Total	*18,949*

employed by Kim and Kross (2005) in their estimation of the earnings and cash flow relationship in the US, leaving an estimation sample of 18,949 firm-years.

Note that financial institutions and utility companies were dropped from the usable sample before the above procedures were carried out, with the observations in the estimation sample relating to firms from seven broad industries, as shown in Panel C of Table 3.

For each variable, the mean values before deflation (for the estimation sample of lagged values) are given in Table 2 above. For example, the firm-year average increase in accounts receivable (ΔARE) is \$7.982m, the average sales (*SAL*) is \$535.680m, and these two variables articulate with the average cash inflow in the form of customer receipts (*REC*) of \$527.698. The operating costs (*CGS* + *SAE* + *OOE*) sum to \$458.889m (\$339.169m + \$112.945m + \$6.775m), which, when deducted from sales of \$535.680m, results in operating income before depreciation (*OID*) of \$76.791m for the average firm-year. The second component of net earnings is other revenues and expenses (*ORE*), which amounts to a \$54.034m excess of expenses over revenues for the average firm-year. It follows that net income (*INC*) is equal to \$22.757m on average.

RESULTS

This section describes the model estimation. Note that the articulation of parameter estimates in accordance with accounting identities lowers the log likelihood to 36,223 for the constrained joint estimation of *OID* and *ORE*, from 38,951 for the seemingly unrelated regression when unconstrained, and from 16,581 and 22,350 for the two separate ordinary least squares estimations of *OID* and *ORE.* The Akaike information criterion also provides a suitable likelihood-based measure of the relative goodness of fit, confirming the change in model fit attributable to fitting the articulation condition (see Table 4, Panel A). A likelihood-ratio test of the null hypothesis that the parameter vector satisfies the constraint, based on a comparison of the unrestricted and the restricted models, confirms that the procedure adopted here is a significant component of the model.

In Panel B of Table 4 we tabulate the findings. For convenience, the mean lagged value of each explanatory variable is given in the first column of tabulated data, which are the same figures as those shown in the articulation demonstration in Table 2. The deflator used for this table is the sum of the absolute value of all input variables, which is a superior generator of uniformly distributed predictors. This use of an aggregated deflator is based on the transactions-based approach suggested in Christodoulou and McLeay (2009).

The first set of financial statement line items (the first two rows) in Panel B of Table 4 shows the effect of the explanatory variables *REC* and ΔARE when estimating operating income. As can be seen, the coefficients on *REC* (customer receipts) and ΔARE (the change in accounts receivable) are 0.7289 and 0.5256 respectively, indicating that, for a \$1 increase in cash receipts from customers (i.e. a marginal unit cash sale), *OID* will increase by 72.9 cents; however, for a \$1 increase in accounts receivable (i.e. a marginal unit credit sale), *OID* will increase by only 52.6 cents, suggesting that *REC* contributes more than ΔARE to the prediction of future changes in *OID*. Furthermore, to evaluate the predictive ability of cash flows versus accruals, we should consider not only the marginal contributions to income measured by the estimated coefficients, but also the precision implied by the standard errors (*REC* 0.0035; ΔARE 0.0108). It can be seen that not only is the coefficient of *REC* larger than the coefficient of ΔARE, its standard error is about *one-third* the standard error of ΔARE, implying much greater precision in estimation for the cash flow variable *REC* than the accrual variable ΔARE.

The outcome described above can also be observed in the second group of line items in Panel B of Table 4 (rows 3 to 6). The cash flow variable, *PAY*, adds to the joint estimation of future *OID* both with greater marginal contribution and with greater accuracy than the articulated accrual variables ΔINV, ΔAPA and ΔACP,

TABLE 4: ESTIMATION RESULTS WITH DOUBLE-ENTRY ARTICULATION CONSTRAINT

Panel A: Goodness of Fit

	Ordinary Least Squares		***Unconstrained Model***	***Constrained Model***
	OID	*ORE*	*OID + ORE = INC*	
Log likelihood	16,581	22,350	38,951	36,223
Akaike information criterion	–33,125	–44,647	–77,811	–72,358
Breusch–Pagan statistic			37.61	217.73
Residual correlation			–0.0446	–0.1072
Likelihood ratio test			Chi 5455.2, $p < 0.0001$	

Panel B: Estimation Results

		Means		**Coefficients**			**Linear**
		Raw ($000s)	*Deflated*	*OLS*	*Zero-Sum Constraint*	*Standard Error*	**Prediction**
Operating Income before Depreciation							
1. Customer receipts	*REC*	527,698	1.2316	0.7764	0.7289	0.0035	0.8977
Δ Accounts receivable	*ΔARE*	7,982	0.0159	0.6788	0.5256	0.0108	0.0084
2. Supplier payments	*PAY*	–451,643	–1.1598	0.7719	0.7238	0.0036	–0.8395
Δ Inventory	*ΔINV*	5,001	0.0094	0.6223	0.4934	0.0133	0.0046
Δ Accounts payable	*ΔAPA*	–4,026	–0.0077	0.5717	0.3747	0.0153	–0.0029
Δ Accrued payroll	*ΔACP*	–1,446	–0.0029	0.4728	–0.2965	0.0400	0.0008
3. Other operating cash flow	*OOC*	–2,366	–0.0101	0.7477	0.5695	0.0089	–0.0058
Δ Other current assets	*ΔOCA*	2,586	0.0028	0.6107	0.0623	0.0242	0.0002
Δ Prepaid expenses	*ΔPRE*	313	0.0005	0.4534	–1.2798	0.0570	–0.0006
Δ Other current liabilities	*ΔOCL*	–6,197	–0.0078	0.5850	0.2833	0.0144	–0.0022
Δ Deferred income	*ΔDIN*	–1,111	–0.0018	0.7225	0.2094	0.0293	–0.0004
	OID	76,791					
Other Revenues and Expenses							
4. Exceptional cash flow	*ECF*	–24,444	–0.0341	0.1051	0.0303	0.0062	–0.0010
Δ Other long-term assets	*ΔOLA*	17,677	0.0167	–0.0383	–0.2550	0.0076	–0.0043

(*Continued*)

TABLE 4: Panel B: (*CONTINUED*)

		Means		Coefficients			Linear
		(Raw) $000s	*(Deflated)*	*OLS*	*Zero-Sum Constraint*	*Standard Error*	**Prediction**
Δ Other long-term liabilities	*ΔOLL*	–2,101	–0.0012	0.0922	–0.2205	0.0139	0.0003
Δ Provision for risks and charges	*ΔPRC*	–2,244	–0.0010	–0.0145	–0.8263	0.0158	0.0008
5. Tax payments	*TXP*	–15,154	–0.0227	0.4165	0.2215	0.0229	–0.0050
Δ Deferred tax	*ΔDTX*	–185	–0.0002	0.1087	–0.3517	0.0394	0.0001
Δ Income tax payable	*ΔITP*	–119	–0.0005	0.3891	–0.3905	0.0392	0.0002
6. Capital expenditure [net of disposals]	*CED*	–38,108	–0.0664	0.8066	0.4648	0.0151	–0.0309
Δ Property, plant and equipment	*ΔPPE*	13,324	0.0170	0.7155	0.1739	0.0162	0.0030
Δ Long-term receivables	*ΔLTR*	46	–0.0004	0.8085	0.2235	0.0205	–0.0001
Δ Other investments	*ΔOIN*	2,140	0.0022	0.7909	0.2403	0.0188	0.0005
7. Debt issues [net of repayments]	*DIR*	4,957	–0.0065	0.6003	0.1001	0.0168	–0.0007
Δ Cash and short-term investments	*ΔCSI*	8,899	0.0119	0.6051	–0.0684	0.0169	–0.0008
Δ Short-term debt	*ΔSTD*	–2,415	–0.0027	0.6052	–0.0665	0.0176	0.0002
Δ Long-term debt	*ΔLTD*	–15,960	–0.0115	0.5880	–0.0893	0.0172	0.0010
	ORE	–54,034					
8. Net dividend [net of capital contribution]	*NDC*	–940	0.0681	0.0099	–0.0388	0.0034	–0.0026
Δ Shareholders' equity	*ΔSEQ*	–60,681	–0.9219	0.0028	–0.2071	0.0054	0.1909
Δ Preferred stock	*ΔPST*	38,951	0.8835	0.0028	–0.2071	0.0054	–0.1830
Δ Minority interest	*ΔMIN*	–389	–0.0004	0.0514	–0.4771	0.0309	0.0002
Δ Dividend payable	*ΔDPA*	–45	0.0000	0.0272	–0.6507	0.0350	0.0000
	INC	22,757					
Sum of fixed effects							–0.0505
Totals		*0*	*0.0000*	*13.6862*	*0.0000*	*n/a*	*0.0214*

Note: The average operating income before depreciation (*OID*$_t$ \$76.791m, *OID*$_{t+1}$ \$83.600m) and the average other revenues and expenses (*ORE*$_t$ \$–54.034m, *ORE*$_{t+1}$ \$–55.501m, which include the minority interest in earnings) sum to the average net income (*INC*$_t$ \$22.757m, *INC*$_{t+1}$ \$28.099m). The clean surplus equilibrium for the average firm in period *t*, which includes current net income (\$22.757m), is shown in the last section of Table 2. The linear predictor for the average firm is given in the last column of Table 4, Panel B, summing to the deflated *INC* for period *t+1* (0.0214).

having the largest coefficient (0.7238) and the smallest standard error (0.0036). On the face of it, it may be inferred from the coefficient on *PAY* that a $1 increase in cash payments to suppliers and employees (i.e. the marginal cash cost of goods sold) will lead to a decrease in *OID* of 72.4 cents. In this context, however, it is important to note that the mean deflated customer receipt equals 1.2316 whilst the mean deflated supplier payment is –1.1598, and hence the relative contributions to the linear predictor of earnings are 0.8977 from *REC* (1.2316 × 0.7289) and –0.8395 from *PAY* (–1.1598 × 0.7238). To interpret the accrual-based coefficients (ΔINV 0.4934; ΔAPA 0.3747; ΔACP –0.2965), we must recognise that overheads are absorbed first into inventory values, and these inventories are then released into cost of sales, so a full analysis in this respect will require a more extensive structural model. Interestingly, however, the average firm appears to more than cover the financing of its inventory changes ($5,001m) with accounts payable and accrued payroll ($4.026m + $1.446m = $5.472m), and the weighted contribution of these three variables to the linear prediction of future earnings is positive overall (0.0046 – 0.0029 + 0.0008 = 0.0025). Again, as was the case above for cash receipts from customers, the low standard error suggests that cash payments to suppliers have greater forecasting precision than the associated accrual variables.

With regard to the third set of line items, whilst it is evident that the other operating cash flow variable (*OOC*) contributes more than the accrual variables ΔOCA, ΔOCL and ΔDIN in explaining future *OID*, a change in prepaid expenses (ΔPRE) has a substantial counter-effect (–1.2798). However, the volume of prepayments is low overall ($0.313m), and inaccuracy in estimation is high (the standard error is 0.0570). The key result is that *OOC* has a lower standard error (0.0089) by comparison with prepaid expenses and the other related accruals, again implying much greater precision in prediction for the cash flow variable.

In summary, regarding the estimation of future *OID*, using a structural model that includes a double-entry articulation constraint on the simultaneous equations employed, the cash flow variables (*REC*, *PAY* and *OOC*) tend to have a higher marginal impact than most of the accrual variables, especially when the weighted contribution to linear prediction is considered. Moreover, the cash flow variables have the smallest standard errors amongst all of the predictor variables, providing evidence of their greater precision in forecasting.

The second part of Panel B in Table 4 describes the joint linear estimation of other revenues and expenses (*ORE*). Reflecting the key finding reported above, the standard error on each of the cash flow variables (*ECF*, *TXP*, *CED*, *DIR* and *NDC*) is smaller than the related accrual-based changes in assets and liabilities. The greatest marginal contribution to future *ORE* results from the high estimated coefficient on capital expenditure, *CED* (0.4648). With regard to debt issues and changes in cash and investments, there is no evidence to discriminate between the impacts on *ORE* prediction. Overall, for the net dividend flows and equity changes, the coefficients show little predictive power, apart from a direct substitution effect arising from the increase in equity and the decrease in preferred stock for the average firm.

Overall, the findings indicate the superiority of operating cash flow variables over related accrual variables in the estimation of future earnings, with the most pervasive finding being that all cash flow variables – operating and non-operating,

TABLE 5: ESTIMATION RESULTS WITH DOUBLE-ENTRY ARTICULATION CONSTRAINT – BY INDUSTRY

		Basic Material	Consumer Goods	Consumer Services	Health Care	Oil and Gas	Technology	Industrial
Operating Income before Depreciation								
1. Customer receipts	*REC*	0.7819***	0.8076***	0.7507***	0.7580***	0.7379***	0.7228***	0.6985***
Δ Accounts receivable	*ΔARE*	0.6680***	0.8548***	0.5877***	0.5573***	0.5599***	0.4241***	0.5422***
2. Supplier payments	*PAY*	0.7528***	0.8067***	0.7531***	0.7562***	0.7364***	0.7190***	0.6967***
Δ Inventory	*ΔINV*	0.5006***	0.5093***	0.5542***	0.5457***	0.5676***	0.4767***	0.4537***
Δ Accounts payable	*ΔAPA*	0.5797***	0.6548***	0.4586***	0.4296***	0.4197***	0.4084***	0.3201***
Δ Accrued payroll	*ΔACP*	–0.2727**	–0.0681	0.9497***	–0.6490***	0.0827	–0.6551***	0.0179
3. Other operating cash flow	*OOC*	0.5223***	0.1924*	0.6888***	0.6798***	0.6521***	0.6558***	0.0359
Δ Other current assets	*ΔOCA*	–0.1532*	–0.5458***	0.2192	0.3121***	0.3261***	0.2654***	–0.4223***
Δ Prepaid expenses	*ΔPRE*	–1.5534***	–1.7435***	–0.062	–0.8467***	–1.7099***	–0.5241***	–1.1663***
Δ Other current liabilities	*ΔOCL*	0.2599***	0.2614**	0.6363***	0.2644***	0.3631***	0.3956***	–0.2014***
Δ Deferred income	*ΔDIN*	0.4302***	–0.7040***	0.3808	0.3718***	–0.2328**	0.1954***	–0.3973***
Other Revenues and Expenses								
4. Exceptional cash flow	*ECF*	0.0658***	–0.0003	0.0581**	–0.0134	0.0512***	0.0328*	0.0392***
Δ Other long-term assets	*ΔOLA*	–0.1204***	–0.3563***	–0.1901***	–0.1678***	–0.2297***	–0.3287***	–0.2008***
Δ Other long-term liabilities	*ΔOLL*	–0.0417	–0.2380***	–0.0894	–0.2455***	–0.2191***	–0.2926***	–0.0731**
Δ Provision for risks and charges	*ΔPRC*	–2.7654***	–0.7190***	–1.2383***	–0.3047***	–0.4689***	–1.3560***	–0.5762***
5. Tax payments	*TXP*	0.3346***	0.3056***	0.3052***	0.4273***	0.1979***	0.2422***	0.2260***
Δ Deferred tax	*ΔDTX*	–0.2786***	–0.186	0.0998	–0.1560***	–0.2888***	–0.3691***	–0.2128***
Δ Income tax payable	*ΔITP*	–0.3483**	0.2434	0.1678	–0.0259	–0.2914***	–0.4542***	–0.074

(*Continued*)

TABLE 5: (*CONTINUED*)

		Basic Material	Consumer Goods	Consumer Services	Health Care	Oil and Gas	Technology	Industrial
6. Capital expenditure [net of disposals]	*CED*	0.4877***	0.4676***	0.8314***	0.3774***	0.4076***	0.6570***	0.5542***
Δ Property, plant and equipment	Δ*PPE*	0.2924***	0.2187**	0.6108***	0.1387***	0.1241***	0.3755***	0.2629***
Δ Long-term receivables	Δ*LTR*	0.3048***	0.3126**	0.6527***	0.2326***	0.2496***	0.3912***	0.023
Δ Other investments	Δ*OIN*	0.3611***	0.3443***	0.7920***	0.2710***	0.2429***	0.3010***	0.4200***
7. Debt issues [net of repayments]	*DIR*	0.3970***	0.3814***	0.2159*	0.0711	0.0853**	0.1896***	0.2027***
Δ Cash and short-term investments	Δ*CSI*	0.3262***	0.1876**	0.0883	–0.037	–0.0690*	–0.0089	0.0994***
Δ Short-term debt	Δ*STD*	0.3348***	0.2087***	0.1638	0.0154	–0.0638*	–0.0459	0.0601
Δ Long-term debt	Δ*LTD*	0.2954***	0.1587**	0.1063	–0.0451	–0.0899***	–0.0805*	0.1054***
8. Net dividend [net of capital contribution]	*NDC*	0.0221***	–0.0502***	–0.0284**	–0.0272***	–0.0531***	–0.0619***	–0.0519***
Δ Shareholders' equity	Δ*SEQ*	–0.0783***	–0.2529***	–0.1431***	–0.1270***	–0.2039***	–0.2873***	–0.1534***
Δ Preferred stock	Δ*PST*	–0.0783***	–0.3875***	–0.1789***	–0.1151***	–0.2604***	–0.3195***	–0.1559***
Δ Minority interest	Δ*MIN*	–0.1125*	–0.2461***	–0.0674	–0.9779***	–0.5043***	–1.3058***	–0.3458***
Δ Dividend payable	Δ*DPA*	–1.9145***	–1.4179***	–8.0737***	–2.4701***	–1.1191***	–0.3627***	–0.7266***
Observations		*659*	*2568*	*2712*	*2969*	*782*	*4467*	*4792*

Note: The table does not report *t*-statistics; *p*-values less than 0.001 (***), 0.01 (**) and 0.1 (*) are indicated accordingly.

employed in the estimations of both *OID* and *ORE* – display lower standard errors in prediction by comparison with accruals.

The methodological rigour introduced by the articulation constraint is shown in the totals given in the last row of Table 4, Panel B. Consistent with accounting practice, the sum of appropriately signed balance sheet changes, and the cash flow statement line items obtained by deduction, is shown to be zero for the average firm in the sample. Second, the sum of unconstrained parameter estimates is shown to be non-zero, whereas the sum of constrained parameter estimates is zero, reflecting our underlying argument that, when forecasting accounting numbers, the accounting identities involved should govern the marginal changes that are predicted. Finally, the last row of the final column provides confirmation that the components of the linear predictor, as reported here, sum to the expected value of future scaled income ($INC_{t+1} = 0.0214$).

Estimation by Industry

As a further check on the results, the seemingly unrelated regressions were estimated again within each industry. As shown in Table 5, the results are relatively robust. For instance, in the estimation of future *OID*, *REC* has a larger significant coefficient than ΔARE across all industries except consumer goods, and *PAY* is always larger than the corresponding accruals. Some inconsistency exists in the third line item, but overall the cash flow variables are marginally superior (as judged by larger significant coefficients) to the accrual variables in explaining future cash flows.

In the estimation of future *ORE*, the predominance of investing cash flow on capital expenditure (*CED*) is consistent across all industries, whilst, as is the case for the pooled sample, there is no evidence across industries to discriminate between the impacts on *ORE* prediction with regard to debt issues and changes in cash and other financial investments, nor with regard to net dividend flows and equity changes.

Analysis by industry, despite involving much smaller numbers of observations, demonstrates the consistency of the main results.

CONCLUSION

The articulation of financial statements is an inherent outcome of the double-entry system; each transaction recorded in accounting books must be reflected both as a debit and a credit, whether the transaction arises from a cash payment or receipt, or from an accrual that is based on expected payments and receipts. One property of such a system is that it is possible to generate articulated cash flow statement variables from (a) revenues and expenses in the income statement, and (b) changes in the relevant line items in the balance sheet, as demonstrated in this paper. Based on this framework, we expected that a model that employs all available variables in accordance with their governing accounting identities, with appropriate identification, would be preferable to other models that do not consider the double-entry equilibrium. Based on Christodoulou (2015), we also argue that a marginal adjustment to any one accounting input must result in an equal adjustment across all other related variables, comprising all debit entries and their offsetting credit entries, thus summing to zero within the system as a whole. The constraint in the third row of Equation 5, where we require all coefficients estimated by a regression that employs the full set of articulated accounting variables to sum to zero, implements this central argument in this paper.

The standard regression model would assume that the equations in the first two rows of Equation 5 (describing the two components of earnings) are unrelated, and consequently that the equation residuals are uncorrelated. The appropriately constrained structural model assumes that the two linear earning predictors are simultaneous equations, related through their correlated residuals, and that the accounting relations between the predictor variables can be imposed as a constraint based on the double-entry system, as mentioned. The results reveal that, in estimating *OID* in particular, the cash flow variables tend to have larger coefficients, and smaller standard errors than the accruals variables. In particular, lower standard errors suggest the greater precision of cash flow variables in predicting future earnings.

Our findings are important for standard setters, investors and business managers. As set out in the *Statement of Financial Accounting Standards No. 1*, a primary objective of financial reporting is to provide information useful to decision-makers. Estimating future earnings is a complex task confronting not only equity investors but also creditors and others, and estimates and projections are the primary means by which managers convey credible forward-looking proprietary information to investors. Accrual and cash flow accounting information is highly relevant to such estimations; thus the research results presented in this paper provide useful guidance for those who regulate accounting on the basis that estimating future earnings is a key objective.

Finally, the results of this study show that, even when articulation between financial statements is lacking, thus preventing investors from properly appreciating the links between a firm's balance sheet, income statement and cash flow statement, an appropriately constrained structural model may still enable us to reach unbiased estimates of future earnings. This paper outlines an important issue, with a view to persuading both the FASB and IASB to improve their framework so that investors will be able to better understand the *articulation between financial statements*, and enable analysts to make unbiased and articulated estimations of the future performance of a company.

ACKNOWLEDGEMENT

The authors are grateful to Dr Demetris Christodoulou of the University of Sydney, who first developed the econometric modelling approach used in this paper, and which is reported in his PhD thesis, 'The Character of Financial Accounting Variables and Their Use in Empirical Research: Application to the Analysis of Earnings and Accruals in Europe' (University of Athens, 2005), and in an unpublished working paper, 'The Double-Entry Constraint and the Unbiased Estimation of the Equilibrium Level of Accruals' (2010).

ENDNOTES

1 A similar approach is adopted in a recent article by Casey et al. (2016).

2 In practice, when non-operating events such as acquisitions, disposals and accounting changes take place, articulation breaks down (see Hribar and Collins, 2002). However, as the main focus here concerns model development for a complete set of financial statement items, we avoid reported cash flow data and generate articulated cash flows instead. Clearly, further empirical application of the model will take into consideration the full reconciliation with reported cash flow data.

3 For definitions of all three-letter abbreviations used in equations, see the variable descriptors set out for financial statements in Tables 1 and 2.

4 A key assumption here is that long-term receivables (*LTR*) and other long-term assets (*OLA*) do not include balances arising from trading, relating to sales (*SAL*). As this paper is concerned with demonstrating an already extensive model, the need to disaggregate other items potentially related to sales should be considered in empirical applications. The same applies to Equation 3.2, and the possible need to allow for any other long-term liabilities (*OLL*) that may relate to cost of goods sold (*CGS*).

5 The variable other (income)/expenses (*OIE*) in Equation 3.4 includes a number of other Worldscope income statement line items that are present in the database but are reported infrequently, i.e. pre-tax equity interest earnings, equity interest earnings, discontinued operations, extraordinary items and gain or loss on sale of assets, and after tax other income/expense. Likewise, the variable other investments (*OIN*) in Equation 3.6 comprises another infrequent Worldscope line item, investment in unconsolidated subsidiaries, and another balance sheet variable in Equation 3.6, shareholders' equity (*SEQ*), includes the final infrequent Worldscope item, non-equity reserves.

REFERENCES

Arthur, N., Cheng, M. and Czernkowski, R. (2010). Cash Flow Disaggregation and the Prediction of Future Earnings, *Accounting & Finance*, Vol. 50, No. 1, pp. 1–30.

Arya, A., Fellingham, J.C., Glover, J.C., Schroeder, D.A. and Strang, G. (2000). Inferring Transactions from Financial Statements, *Contemporary Accounting Research*, Vol. 17, No. 3, pp. 365–385.

Barth, M.E., Beaver, W.H., Hand, J.R.M. and Landsman, W.R. (1999). Accruals, Cash Flows, and Equity Values, *Review of Accounting Studies*, Vol. 4, Nos. 3&4, pp. 205–229.

Barth, M.E., Cram, D.P. and Nelson, K.K. (2001). Accruals and the Prediction of Future Cash Flows, *The Accounting Review*, Vol. 76, No. 1, pp. 27–58.

Casey, R.J., Gao, F., Kirschenheiter, M.T., Li, S. and Pandit, S. (2016). Do Compustat Financial Statement Data Articulate?, *Journal of Financial Reporting*, Vol. 1, No. 1, pp. 37–59.

CFA Institute (2005). *A Comprehensive Business Reporting Model: Financial Reporting for Investors*, Charlottesville, VA: CFA Institute.

Charnes, A., Cooper, W.W. and Ijiri, Y. (1963). Breakeven Budgeting and Programming to Goals, *Journal of Accounting Research*, Vol. 1, No. 1, pp. 16–43.

Cheng, C. and Hollie, D. (2008). Do Core and Non-Core Cash Flows from Operations Persist Differentially in Predicting Future Cash Flows?, *Review of Quantitative Finance and Accounting*, Vol. 31, No. 1, pp. 29–53.

Christodoulou, D. (2015). The Accounting Identity Trap: Parameter Identification under Rank Deficiency, Working paper, the University of Sydney.

Christodoulou, D. and McLeay, S.J. (2009). Bounded Variation and the Distribution of Scaled Earnings, *Accounting and Business Research*, Vol. 39, No. 4, pp. 347–372.

Christodoulou, D. and McLeay, S.J. (2014). The Double Entry Constraint, Structural Modeling and Econometric Estimation, *Contemporary Accounting Research*, Vol. 31, No. 2, pp. 609–628.
Dechow, P., Ge, W. and Schrand, C. (2010). Understanding Earnings Quality: A Review of the Proxies, Their Determinants and Their Consequences, *Journal of Accounting and Economics* Vol. 50, No. 2, pp. 344–401.
Dechow, P.M., Richardson, S.A. and Sloan, R.G. (2008). The Persistence and Pricing of the Cash Component of Earnings, *Journal of Accounting Research*, Vol. 46, No. 3, pp. 537–566.
Demski, J.S., FitzGerald, S.A., Ijiri, Y., Ijiri, Y. and Lin, H. (2006). Quantum Information and Accounting Information: Their Salient Features and Conceptual Applications, *Journal of Accounting and Public Policy*, Vol. 25, No. 4, pp. 435–464.
Ellerman, D.P. (1985). The Mathematics of Double Entry Bookkeeping, *Mathematics Magazine* Vol. 58, No. 4, pp. 226–233.
Hribar, P. and Collins, D.W. (2002). Errors in Estimating Accruals: Implications for Empirical Research, *Journal of Accounting Research*, Vol. 40, No. 1, pp. 105–134.
International Accounting Standards Board (2008). Preliminary Views on Financial Statement Presentation, Discussion paper issued jointly with the Financial Accounting Standards Board.
Kim, M. and Kross, W. (2005). The Ability of Earnings to Predict Future Operating Cash Flows Has Been Increasing—Not Decreasing, *Journal of Accounting Research*, Vol. 43, No. 4, pp. 753–780.
Lev, B., Li, S. and Sougiannis, T. (2010). The Usefulness of Accounting Estimates for Predicting Cash Flows and Earnings, *Review of Accounting Studies*, Vol. 15, No. 4, pp. 779–807.
Mann, H. (1984). A Worksheet for Demonstrating the Articulation of Financial Statements, *The Accounting Review*, Vol. 59, No. 4, pp. 669–673.
Moehrle, S., Stober, T., Jamal, K., Bloomfield, R., Christensen, T.E., Colson, R.H., Ohlson, J., Penman, S., Sunder, S. and Watts, R.L. (2010). Response to the Financial Accounting Standards Board's and the International Accounting Standard Board's Joint Discussion Paper Entitled Preliminary Views on Financial Statement Presentation, *Accounting Horizon*, Vol. 24, No. 4, pp. 149–158.
Sloan, R.G. (1996). Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings?, *Accounting Review*, Vol. 71, No. 3, pp. 289–315.