THE STOCK FLOW CONSISTENT APPROACH: DEFINITION, COMPONENTS AND SIMULATION

Özgür Bayram SOYLU[65]
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Abstract: *The main purpose of this study is to explain the components of the stock flow consistent approach under certain assumptions. The stock flow consistent approach is a macroeconomic model based on national income and production accounts and flow of funds accounts. In addition, the stock flow consistent approach allows for integration of the real and financial sectors of the economy. Under the assumption of an open economy, the household sector, the firm sector, the banking sector, the government sector and the rest of world sector are included. The components of stock flow consistent approach are balance sheet, transaction flow matrix and behavioral equations. These components reflect the behavioral dynamics of economic decision-making units. Finally, there is a simulation application in the study.*

Key words: *Balance sheet, Transaction flow matrix, Behavioral equations, Simulation*

1. THE STOCK FLOW CONSISTENT APPROACH

The stock flow consistent approach is a macroeconomic model based on national income and production accounts and flow of funds accounts**.** As stated in studies related to most stock flow consistent, the stock flow consistent approach has emerged in the 1970s under the leadership of Wynne Godley in Cambridge, the approach presented once again by Tobin (1982) has been a focus of interest in Post-Keynesian economics with the study of Godley and Lavoie (2007).

Stock flow consistent approach ensures that the whole economy is in consistency by providing integration between stocks and flows of all sectors of the economy with its own calculation rules (Soylu, 2017:16). As Godley and Lavoie (2007:13) have stated, Tobin (1982) presented the basic dynamics of the stock flow consistent approach, providing a different framework than the standard macro models in the Nobel lecture:

1. Tracking of stocks and precision regarding time,
2. Several assets and rates of return,
3. Modelling of financial and monetary policy operations,
4. The budget constraint and the adding-up constraint.

Godley and Lavoie (2007) exhibit the stock flow consistent approach necessity based on the deficiencies of the standard national income matrix. “What form does personal saving take? Where does any excess of sectoral income over expenditure actually go to – for it must all go somewhere? Which sector provides the counterparty to every transaction in assets? Where does the finance for investment come from? And how are budget deficits financed?”. These questions arised by Godley and Lavoie (2007;6) as to be answered. The transaction flow matrix, which is one of the components of the stock flow consistent approach, responds to these questions.

Soylu (2017), summarizes the basic dynamics of the stock flow consistent approach as follows:

[65] PhD, Ankara,Turkey

1. "*quadruple entry principle*": It's a principle attributed to Copeland (1949). Any change in the sources of a sector has to be compensated by at least one change in the use of funds of the same sector;
2. "everything *comes from somewhere and everything goes somewhere*";
3. *No black holes:* The asset of a sector is the liability of another sector;
4. *Emphasis on how financial flows that are not shown in national income, finance investments or deficits.*

The four features listed above will be addressed in the accounting process of the stock flow consistent approach. In other words, it will clearly show in the balance sheet and transaction flow matrix.

2. THE COMPONENTS OF STOCK FLOW CONSISTENT APPROACH

The model applied in this paper identifies five different sectors of the steady state country: household sector, firm sector, banking sector, government sector and the rest of world sector. In this study, the rest of world is considered as a whole. Assuming that each sector has assets and liabilities. This model builds on Detzer (2016) and Godley and Lavoie (2005). The stock flow consistent models are being developed in multi-country as well as in Lavoie and Daigle (2011) and Godley (1999) studies. These models are designed to have the same sectoral structure in each country.

The stock flow consistent approach has three components. The first of these is the ***balance sheet***. Table 1 demonstrates the balance sheet of the model. As mentioned above, the balance sheet matrix contains five sectors. The balance sheet matrix indicates the assets (+) and liabilities (-) of these sectors. According to the stock flow consistent principle, every row and every column must sum to zero. This principle also applies to the transaction flow matrix. When the columns of each sector are examined, it is seen that the sum of assets or liabilities in the columns constitutes net wealth. The net wealth with minus sign (-) will cause the sum of the other elements in the columns to be necessarily zero. This ensures that the balance sheet is consistent (Godley and Lavoie, 2007). In addition, each column in the balance sheet matrix reflects the budget constraint of that sector.

It is assumed that the household has a treasury bills ($+B_h$) in first column. In other words, the household's wealth ($-V_h$) consists of the treasury bills.

Column 2 shows the assets and liabilities of the firms sector. It is assumed that the firm sector needs domestic loans ($-L_f$) to finance its investments and has fixed capital (+K). The loan requirement is provided by the financial sector (banking sector) and the fixed capital is not a liability in terms of other sectors. It is also assumed that the firm sector acquires bank deposits ($+ M_f$). ($-V_f$) represents the net worth of firm sector.

Column 3 shows the asset and liability of the banking sector. It is assumed that banking sector supply loans (L) to firms and accept deposits (-M) from firm sector and also banking sector demand loans (L_{2b}) from the rest of world sector. It is assumed that the net worth of the banking sector (V_b) is equal to zero.

The government sector is in the fourth column of the balance sheet matrix. It is assumed that the government sector supply treasury bills to households ($-B_s$). In other words, the government

sector is in debt. Therefore, the treasury bills constitute the net worth of the government sector ($-V_g$).

Column 5 introduces the rest of world sector. It is assumed that the rest of world sector supply loans ($+L_2$) to the domestic banking sector. ($-V_{row}$) represents the net worth of the rest of world.

Table 1. Balance Sheet Matrix

	Households	Firms	Banks	Government	Rest of World	∑
Fixed Capital		+K				**+K**
Loans	$-L_h$	$-L_f$	+L			**0**
External Loans			$-L_{2b}$		$+L_2$	**0**
Deposits		$+M_f$	-M			**0**
T. Bills	$+B_h$			$-B_s$		**0**
Balance	$-V_h$	$-V_f$	$-V_b$	$-V_g$	$-V_{row}$	**-K**
∑	**0**	**0**	**0**	**0**	**0**	**0**

Table 2 describes the transactions and flows between the sectors in the country and the rest of world sector. **The transaction flow matrix (second component)** is based on the rule that every row and every column must sum to zero. The transaction flow matrix clearly shows what is meant by the "everything comes from somewhere and goes somewhere" principle. Positive (+) sign describes sources of funds and negative (-) sign describes uses of funds in the transaction flow matrix.

Households earn interest (+rb (-1). Bh (-1)) on treasury bills they hold while earning wages (+ WBs) and profit gains (+ FDf) from firms sector. Household pay interest on loans (rl(-1).Lh(-1)) to banking sector for financing their consumption expenditure (Cd).

Özgür Bayram SOYLU
He received his PhD. degree in Economics, Hacettepe University Department of Economics. His research is focused on political economy and macroeconomic models.

Firms sector has two accounts, namely the current account and the capital account. The current account describes the earnings and expenditures of the firm sector. The capital account describes how the firm sector finances its expenditure. Firms produce consumption goods and services to households (+Cs), government expenditures (+G), investments (+I), exports (Ex) and interests on deposit (+rd(-1). Mf (-1)), which are included in the current account of the firm sector, constitute the earnings of the firm sector. Firms pay taxes on their sales to government sector (-Tf) and wages to households (-WBd), interest on loans (-rl(-1). Lf(-1)) to banking sector. The firms sector also carries out import (-Im) activities from the rest of world sector. Firms sector distribute some of their profits (-Ff) to the household (+FDf) and the remaining portion (undistributed profits) (+FUf) in their capital account for the financing their investments. ($+\Delta Lf$) represents new loans in the capital account of firms sector.

Banking sector also has two accounts - current account and capital account -. The current account also describes the earnings and expenditure of the banking sector. The capital account describes the additions or discontinuities to banking sector's assets or liabilities. Banking sector receive interests on loans ($+rl_{(-1)}$. $L_{(-1)}$) to the firms and household sector, pay interests to rest of world on loans ($-rl_{2(-1)}$. $L_{2b\,(-1)}$) and to firms on deposit ($-rd_{(-1)}.M_{(-1)}$). Bank profits equal to difference between the interest income and interest expense as shown in the capital account.

Table 2. Transaction-flow matrix

	Household	*Firms*		*Banks*		*Government*	*Rest of world*	∑
		Current	Capital	Current	Capital			
Consumption	$-C_d$	$+C_s$						0
Investment		+I	-I					0
Government Exp.		+G				-G		0
Exports		+Ex					$-Im_{row}$	0
Imports		-Im					$+Ex_{row}$	0
Taxes		$-T_f$				+T		0
Wages	$+WB_s$	$-WB_d$						0
Firms Profits	$+FD_f$	$-F_f$	$+FU_f$					0
Banking Profits				$-F_b$	$+F_b$			0
Interest on loans	$-rl_{(-1)}.L_{h(-1)}$	$-r_{l(-1)}.L_{f(-1)}$		$+ r_{l(-1)}.L_{(-1)}$				0
Interest on external loans				$-r_{l2(-1)}.L_{2b(-1)}$			$+r_{l2(-1)}.L_{2(-1)}$	0
Interest on deposit		$+rd_{(-1)}.M_{f(-1)}$		$- r_{d(-1)}.M_{(-1)}$				0
Interest on treasury bills	$+r_{b(-1)}.B_{h(-1)}$					$-r_{b(-1)}.B_{s(-1)}$		0
Change in								
ΔLoans	$+\Delta L_h$		$+\Delta L_f$		$-\Delta L$			0
ΔExternal loans					$+\Delta L_{2b}$		$-\Delta L_2$	0
ΔDeposit			$-\Delta M_f$		$+\Delta M$			0
ΔTreasury Bills	$-\Delta B_h$					$+\Delta B$		0
∑	0	0	0	0	0	0	0	0

The government sector receives tax (T) from firms sector to finance government expenditure. The government sector pay interests on treasury bills (rb(-1).Bs(-1)) to household sector. The difference between input and output determines the public sector borrowing requirement (PSBR). The government sector is issuing new treasury bills (+ΔBs) to cover this public sector borrowing requirement.

The exports of the firms (Ex) constitute the imports (Imrow) of the rest of world sector, the imports of the firms (Im) constitute the exports (Exrow) of the rest of world sector.

Behavioral equations are the last component of the stock flow consistent approach. Behavioral equations and definitions define the balance sheet matrix and transaction flow matrix constraints. It also reflects the behavior of the sectors and their decisions. The basic behavior of the sectors is included in behavioral equations.

The output level of the firm sector- the gross domestic product- is defined by the values of, consumption expenditures (C), investment expenditures (Is), government consumption expenditures (G), exports (Ex) and imports (Im). Also, it is defined by the wages (WBd), profits (F) and taxes (Tf) in terms of income.

$$Y = C + I_s + G + Ex - Im = WB_d + F_f + T_f \quad (1)$$

Firms sector profits (Ff) equal to difference between the sales (Y) and expenditures (taxes (Tf), wages (WBd) and pay interests on loans (rl(-1).Lf(-1)) of the firms.

$$F_f = Y - T_f - WB_d - rl_{(-1)}.L_{f(-1)} \quad (2)$$

The net lending (NL) of the firm sector is defined by:

$$NL = F_f - FD_f - I_d \quad (3)$$

$$NL = FU_f - I_d \quad (3a)$$

Firms sector finance their investment (Id) by loans demand and undistributed profits (FUf). The loans demand (ΔLf) of firm sector is defined as follow – as shown in capital account of firms sector-:

$$\Delta L_d = I_d - FU_f \quad (4)$$

Household's disposable income is equal to difference between their earnings and expenditures. As stated above, households earn interest (+rb(-1) .Bh(-1)) on treasury bills they hold while earning wages (+WBs) and profit gains (+FDf) from firms sector. Households pay interest on loans (-rl(-1). Lh(-1)) to banking sector.

$$YD = WB_s + FD_f + rb_{(-1)}.B_{h(-1)} - rl_{(-1)}.L_{h(-1)} \quad (5)$$

The change in household saving or net worth (ΔV) equals the difference between disposable income (YD) and consumption expenditures (C).

$$\Delta V = (YD - C) \quad (6)$$

Household consumption function is defined as a function of disposable income and reel worth level. α_1 refers to marginal propensity of consume related to income, α_2 refers to propensity to consume related to worth.

$$C = \alpha_1 YD + \alpha_2 V_{(-1)} \quad (7)$$

Bank profits equal to difference between the interest income and interest expense. Banking sector receive interests on loans and pay interests on external loans and deposits. Banking sector adds fund by deposits and external loans.

$$F_b = rl_{(-1)}.L_{1(-1)} - rd_{(-1)}.M_{(-1)} - rl2_{(-1)}.L_{2b(-1)} \quad (8)$$

As expressed in the transaction flow matrix, government sector collects tax from firms sector. The government sector debt is realized by supplying domestic treasury bills. The difference between input and output determines the public sector borrowing requirement (PSBR). The government sector is issuing new treasury bills ($+\Delta B_s$) to cover this public sector borrowing requirement. The government deficit (def_{gov}) is a negative sign of public sector borrowing requirement in the model. The government sector worth (V_{gov}) is defined as follows by being associated with government deficits.

$$PSBR = (G + rb_{(-1)}.B_{s(-1)}) - (T) \quad (9)$$

$$\Delta B_s = PSBR \quad (10)$$

$$def_{gov} = -(PSBR) \quad (11)$$

$$V_{gov} = V_{gov} - def_{gov} \quad (12)$$

Two important factors affecting import demand are the level of income and propensity to import in the domestic market. The import demand function (Im) is defined related to income level (Y) and propensity to import (μ) as follows.

$$Im = \mu.Y \quad (13)$$

$$Im_{row} = \mu_{row}.Y_{row} \quad (14)$$

$$\mu = \mu_{row} \quad (15)$$

The volume of imports made by the country's economy to the external sector determines the export volume of the rest of world sector (Ex_{row}). The volume of exports made out of the country's economy is the import volume (Im_{row}) of the rest of world sector.

$$EX_{row} = Im \quad (16)$$

$$IM_{row} = Ex \quad (17)$$

Current account balance (CAB) equals the difference between trade balance and net current transfers. Balance of Payments (BOP=0) is equal to the sum of capital (CAB) and finance

(KAB) accounts under the assumption that there are no net errors and omissions and reserve accounts. The net worth of the rest of world sector is related to the current account balance

$$CAB = Ex - Im - rl2_{(-1)} . L_{2(-1)} \quad (18)$$

$$CAB + KAB = 0 \quad (19)$$

$$V_{row} = V_{row(-1)} - CAB \quad (20)$$

The external loan demand (ΔL2) from the rest of world sector is defined as follows, as can be easily understood from the transaction flow matrix.

$$\Delta L_2 = -(CAB) = KAB \quad (21)$$

$$L_2 - L_{2(-1)} = Ex_{row} + rl2_{(-1)}. L_{2(-1)} - Im_{row} \quad (22)$$

$$\Delta L_2 = Ex_{row} + rl2_{(-1)}. L_{2(-1)} - Im_{row} \quad (22a)$$

The model is a based on the borrowing of the private sector and the government sector and the current account deficit. For detailed equations and sectoral behavioral, refer to Soylu (2017), Detzer (2016) and Khalil (2011).

3. SIMULATION

The macroeconomic model is calibrated by "Excel", "R", "Eviews" and "Minsky" (developed by Steve Keen) programs in the stock flow consistent approach. Simulation application is done by using "Eviews 7 Program" in this paper. Horizontal axis reflect the periods while the vertical axis reflect the values in the figures. The values of the variables are set at a reasonable level for simulation for the period 1990-2005.

The sample of simulation scenarios are modeled in the model. The scenario is evolution of GDP, government deficit and current account balance following an increase (30%) in government expenditure.

Figure 1.1, figure 1.2 and figure 1.3 show the effect of increasing in the government expenditures on the GDP, government deficit and current account balance respectively.

The increase in government expenditures affects the GDP level positively through equation (1), and affects the government deficit negatively through equation (11). Figure 1.3 reflects evolution of current account balance following an increase in government expenditure through equation (18).

$$Y = C + I_s + G + Ex - Im = WB_d + F_f + T_f \quad (1)$$

$$def_{gov} = -(PSBR) \quad (11)$$

$$CAB = Ex - Im - rl2_{(-1)} . L_{2(-1)} \quad (18)$$

Figure 1.1:Evolution of GDP following an increase in govt. expenditure

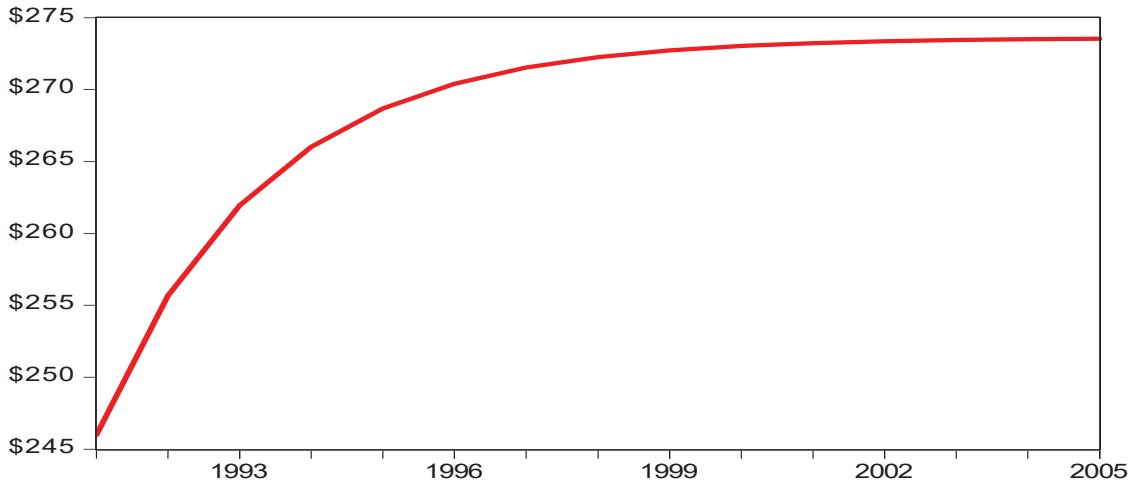


Figure 1.2: Evolution of government deficit following an increase in govt. expenditure

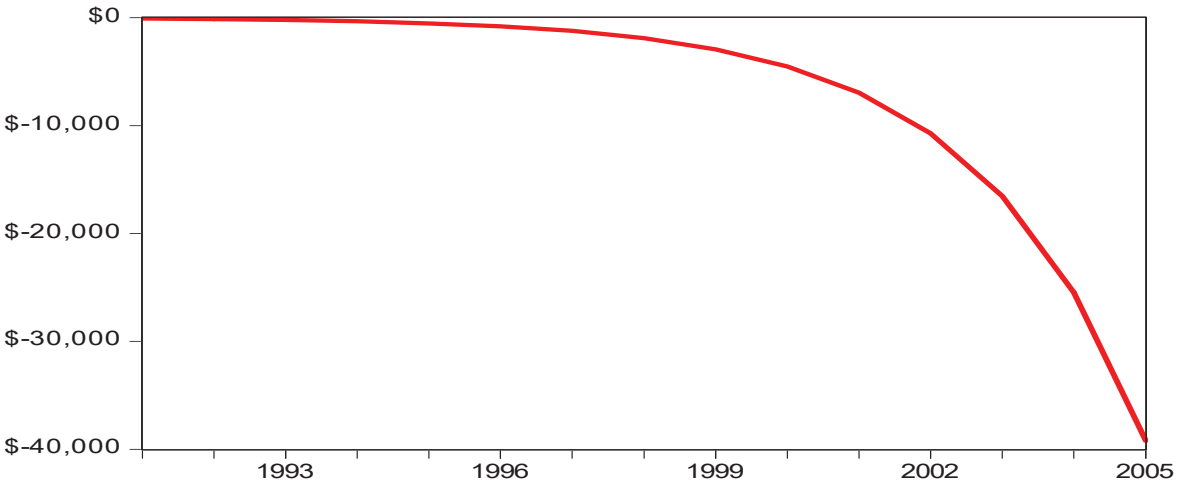
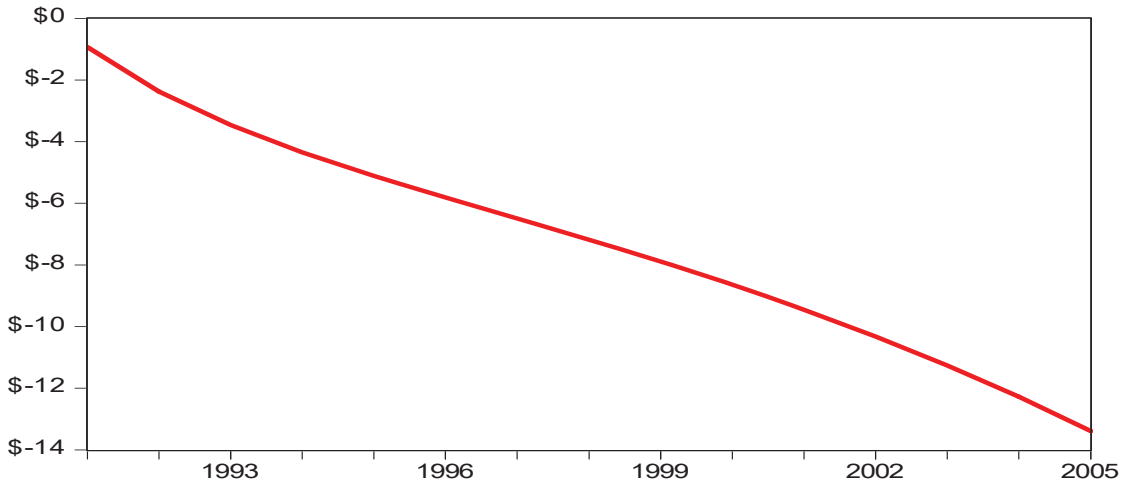


Figure 1.3: Evolution of current account balance following an increase in govt. expenditure



CONCLUSION

The stock consistent approach allows to be realistic and consistent for private and public sector borrowing periods for the simulation. Having a comprehensive accounting framework for stock flow consistency reveals the decision-making processes of economic decision-making units with the help of behavioral equations. The effects of changes in the real and financial structures of these sectors on the economic system are revealed through the simulations.

It is possible to see in detail the studies which are related to the stock flow consistency model in the literature as following areas:

1. *Modern financial sector models:* Le Heron and Mouakil (2008), Passarella (2014), Pedrosa ve Silva (2016).

2. *Agent based-stock flow consistent macroeconomics:* Michell (2014)

3. *Open economy models:* Godley (1999), Kinsella and Khalil (2012), Valdecantos and Zezza (2015)

4. *Distribution of personal income models: Dallery and Van Treeck (2011)*

5. *Environmental factors models:* Naqvi (2014)

6. *Other areas:* Dafermos (2014), Alvarez ve Ehnts (2015)

As a result, a summary of the stock flow consistent approach is presented in this paper. The components of the approach are introduced for this purpose. A simple model was established under the private, government sector and current account deficit assumption and also simulation application was carried out. This study demonstrates that a more complex and advanced version of the model may be a useful tool for macroeconomic analysis. The ability to use the stock flow consistent approach in different areas and generate policy outcomes provides an advantage for researchers and policymaker.

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